Capital Adequacy, Operating Efficiency and Credit Risk of Nepalese Commercial Banks: A Simultaneous Equation Framework

- Usha Kumari Sedhai[2] and Kapil Deb Subedi[3]

Abstract

This study tests the hypothesis on interrelationship of bank capital, credit risk and operating efficiency of Nepalese Commercial Banks. Simultaneous equations framework was used to avoid endogenity and simultaneous bias errors in estimated coefficients in separate equations of capital, risk and efficiency. Following the past literatures, a Two-Stage Least Squares (2SLS) regression method was employed to estimate the endogenous effect of bank capital on its relationship with efficiency and risk. Simultaneous equation strategy is chosen to alleviate the endogeneity effect among efficiency, banking risk, and capital adequacy. As per the moral hazard principles, a negative effect of efficiency on risk-taking was found. The weak performers are more vulnerable to risk-taking than high performing commercial banks. In contrast, capital and bank size are positively related to efficiency, and it indicates the increase in capital base and bank size reduces the credit risk. There is a negative relationship between risk and off-balance sheet items. Moreover, the larger off-balance sheet activities tend to decrease the bank efficiency and induce bank risk. On the risk equation, it was found that capital and size are negatively related with risk and positively related with efficiency which means large banks have lower risk than smaller ones. Banks that own more loans and advances have positive relation with risk, however the banks can offset such risks through expansion of their capital base and improving its cost efficiency. More capital tends to absorb adverse shocks and reduces the likelihood of failure; hence the major implication of this study is; the regulatory agencies should be aware enough to mitigate the banking risks first, through capital adequacy framework, and then improving their cost efficiency through the flexible interest rate corridors during the countercyclical economic shocks.

Keywords: *Capital Adequacy, Capital Risk, Endogeneity, Efficiency, Simultaneous Bias, 2SLS*

I. Introduction

Banking is highly regulated industry in the world. Apart from the products and its services, banking regulation covers its institution. The aim of the bank regulation is to increase prudential practices that will reduce the level of risk that bank are exposed to (Suhartono, 2012). Capital regulation is one of the key instruments of modern banking regulation. The regulation aims to increase a cushion during economic shocks and a mechanism to restrain bank to take excessive risk taking. The theoretical foundation on the relationship between bank capital and risk mainly stems from the principles of moral hazard that arise due to the agency problem. These moral hazards in banking industry are tested in strands of empirical works to show whether the increase in capital regulation forces bank to increase their risk or vice versa

[2] Graduate Student at MBA Program, Boston International College, Chitwan, Nepal
[3] Associate Professor, Boston International College, Chitwan, Nepal

(Altunbus, Santiago, Edward. & Gardener, 2007). Bank capital and risk positioning are simultaneously determined and are affected by both exogenous and endogenous factors.

In their study of interrelationship between capital and efficiency, Altunbus et.al., (2007) do not find a positive relationship between inefficiency and bank risk-taking. Inefficient European banks appear to hold more capital and take on less risk. Empirical evidence is found showing the positive relationship between risk on the level of capital (and liquidity), possibly indicating regulators' preference for capital as a mean of restricting risk-taking activities. The financial strength of the corporate sector has a positive influence in reducing bank risk-taking and capital levels. There are no major differences in the relationships between capital, risk and efficiency for commercial and savings banks although there are for co-operative banks. In the case of co-operative banks, capital levels are inversely related to risks and inefficient banks hold lower levels of capital. Some of these relationships also vary depending on whether banks are among the most or least efficient operators.

The regulatory agencies have focus on bank capital adequacy to cushion against the distress risk of banks so a number of measures have been framed to implement the countercyclical convergence of risk with capital. After 2017 AD, the paid-up capital of Nepalese commercial banks has been increased through regularity framework prescribed by NRB, as commercial banks should have minimum eight billion paid up capital. (NRB Unified Directives,2076). With implementation of these new provision, it is very important to assess the impact of bank capital on interrelation between risk and efficiency. As the level of capital might have positive effect on such relationship. For example, banks might increase the incentives of lowering capitalization and undertake more higher non-performing loans in future since the moral hazard problems are rampant in banking industry. However, in the case of healthier capitalized banks moral hazard problems may be lower and they can be both more efficient and less risky than low capitalized ones. In the frame of capital costs, which are higher in the case of highly capitalized banks, maximization of revenues through increase of risk-taking level has to be taken in consideration.

In recent years, Nepalese banking systems have become increasingly integrated and liberalized on the road to greater product and service deregulation. This progressive process of financial integration is enhancing competition and emphasizing the importance of improved efficiency of financial institutions. Regulators have tried to counterbalance these incentives by given capital adequacy a more prominent role in the banking regulatory process. In this sense, due to both regulatory and market pressures, most Nepalese banks have been under pressure to boost their efficiency. Hence, studying the relationship between risk-taking, capital levels and efficiency in the case of Nepalese banking system is very important. While there are few studies on the relationship between capital and risk for the Nepalese banking system, there is still a gap in the studies of operating efficiency as an endogenous covariate in relationship of bank capital and risk. This study aims to fill up this by on analyzing the possible variables to be used for the estimation of interrelationship among operating efficiency, bank capital and risk-taking.

1.2 Literature Review and Study Framework

Capital is the financial shock absorber of any commercial organization. It comprises of the mix of debt, preferred stock and common equity. Amount of capital held and how these assets are structured is vital in preventing severe financial distress and failure of the organization. So the underlying mix of capital comprises various degree of risk. The risk generated in the organization creates the financial instability in the organization. To maintain stability and to maximize the profit objective of the firm, shareholders appoint managers, who work on the best interest of the

management. So to sustain in the competitive market, managers involve in various types of risk management activities mainly portfolio management of the firm. Such type of activities may create the incentive for the managers. So the incentive and the risk taking activity may create agency problem in the firms. In order to maintain financial stability in the organization as well as in the economy; various studies have been conducted on the capital requirement, risk taking behavior of the firms and agency problem management. Major contributing theories to the capital structure and risk management are Modigliani and Miller (MM) Theory and Markowitz Portfolio theory.

1.2.1 The Modigliani-Miller Theorem

Under a certain market price process, in the absence of taxes, bankruptcy costs, agency costs, and asymmetric information, and in an efficient market, the value of a firm is unaffected by how that firm is financed. It does not matter if the firm's capital is raised by issuing stock or selling debt, Modigliani and Miller (1958). If financial markets are assumed to be complete and depositors are perfectly informed about the failure risk of banks, the Modigliani and Miller indeterminacy principle applies. This, however, requires that shareholders do not have a possibility to exploit depositors.

Some studies state that the Modigliani-Miller theorem is not applicable to banks. In a world with complete markets and in the absence of any frictions, there would not be a need for financial intermediaries. Information theories suggest that a primary rationale for the existence of banks is that they have an information advantage in monitoring firms. Hence, depositors lack information in order to fully assess the riskiness of bank portfolios. Thus, they are not able to efficiently monitor and sanction banks. This information advantage of banks gives rise to moral hazard, (Sealey, 1985 & altensperger & Milde, 1987).

In a banking context, this means that if depositors cannot interfere into the bank’s activity and/or cannot observe the bank’s actions, interest rates fail to fully reflect the risk of bankruptcy. Moral hazard arises, i.e., banks will have an incentive to increase leverage and risk (Galai & Masulis: 1976) and (Green, 1984) who describes the hidden action phenomenon for firms which are financed both with equity and debt.

1.2.2 Portfolio Models Markowitz

Portfolio theory asserts that the riskiness of a single asset is entirely different from that of a portfolio of assets. According to this theory, a single asset may be very risky when held in isolation, but not much risky when held in combination with other assets in a portfolio. Portfolio models assume that the bank’s objective function is to maximize the expectation of a utility function that describes the preferences of the risk- averse owner-manager. To break it down to a mean-variance framework, one has to either assume a quadratic utility function or a probability distribution which can be described by its first two moments, Markowitz (1952). Most work done in this field assumes a single period framework. Equity and deposits are modeled as securities with fixed returns. Banks thus face the well- known Markowitz portfolio selection problem with additional restrictions on the sign of the shares invested in equity (negative), deposits (negative), and assets (positive). For banks with low risk aversion, insolvency will become more probable if stricter capital regulation is imposed. Thus, the result of higher capital-asset ratios in terms of the average probability of failure is ambiguous, while the intra-industry dispersion of the probability of failure unambiguously increases. Koehn and Santomero (1980) found that capital regulation

alone fails to reduce the probability of failure. To be effective, capital requirements have to be combined with asset regulation.

Rochet (1992) showed that risk-sensitive capital regulation can reduce the probability of default if the risk-weights are chosen proportional to the systematic risks of the assets (market-based risk-weights). According to his model, all banks will continue to choose a portfolio on the efficient line with capital-restricted banks choosing a less risky portfolio. As a consequence, their default risk decreases. Rochet also considered limited liability of banks. With bankruptcy, the relationship between utility of shareholders and asset returns is no longer uniformly convex or concave. For low values of capital requirements, banks will tend to choose risky investments for the same reasons as described in the complete market setup. For higher values of capital requirements, this strategy will, however, be deterred due to risk aversion. To avoid risk-loving behavior, capital requirements should thus be set at sufficiently high levels.

1.2.3 Bank Capital and Risk

Risk can be understood as the possibility of loss or danger. Rahman et al. (2018) analyzed the relationship between risk taking capital regulation, and performance in the banking sector. The empirical results show a significant negative relationship between risk-taking and capital regulation. Results also reveal that there is a significant positive relation between capital regulation and performance, and a significant negative relationship between risk and performance. This study provides various suggestions about risk management and capital adequacy for the regulators, stakeholders, and government. It is assumed that the higher capital requirements will have a positive impact on banking sector risk (Lee & Chih, 2013), but empirical results are mixed. Several studies have shown that there is a positive relationship between risk and capital.

Abbas et. al. (2020) investigated containing large commercial banks, according to the information of FDIC on 31 December 2019. The study includes only 937 active banks whose continuous data is available in ranging from 2003 to 2019. Moreover, it drop the banks with a common equity ratio of less than 4.5% of risk-weighted assets on 31 December 2019. The regulators impose a restriction on the activities (for example, restrictions on lending, level of liquidity, and dividend payments) of those facing difficulties in meeting the regulatory requirements. A two-step GMM had been used to control the endogeneity, simultaneity, heteroscedasticity, and auto-correlations issue. The findings conclude that the impact of risk-based capital is higher and more significant to decrease risks of large commercial banks. The outcomes confirm that the impact of non-risk based capital ratios on risk-taking is positive and in line with the regulatory hypothesis that is in line with regulators' recommendations. Similarly, the relationship between risk-based capital ratios, capital buffer ratios, and banks' risk-taking is negative. The findings justified the regulators' efforts because when banks increase their capital against their risky assets, their risk goes down. The findings remain robust throughout the analysis. The study revealed that capital ratios' impact on influencing risk-taking is more significant for under-capitalized banks than well-capitalized commercial banks. The findings are heterogeneous for pre, pro, and post-crisis periods.

1.2.4 Bank Efficiency and Risk

Rozzani and Rahman, (2013) reviewd the determinants of conventional and Islamic bank efficiency in Malaysia.This study was performed on 19 conventional banks and 16 Islamic banks that operated in Malaysia from the years 2008 to 2011. An overall view of the results indicated that the levels of profit efficiency for both conventional and Islamic banks in Malaysia were highly similar. Further, it observed that efficiency would be better for conventional banks with the increment of bank size and also the decrement of both operational cost and credit risk, while the efficiency for Islamic banks would be better with only the decrement of operational cost. The major conclusion of this study from evidence from both conventional and Islamic models was there was significantly negative relationship between operational cost and efficiency and also negative relationship between credit risk and efficiency.

1.2.5 Relationship between risk, capital and efficiency

Zeb and Sattar (2017) investigated the impact of financial regulations on financial soundness and profit efficiency of banks for a sample of 21 commercial banks in Pakistan for the period 2008-2014. They calculated profit efficiency using Data Envelopment Analysis, and financial soundness using Z-score for each bank. They found that profit efficiency was positively related to reserve ratio and non-performing loan to assets ratio of banks. They further proved that loan to deposit ratio and liquidity ratio were positively and significantly related to profit efficiency. Further, they identified that different size of banks had different impact on financial soundness and profit efficiency of banks.

Saeed et.al (2020) investigated the relationship between risk, capital and efficiency for Islamic and conventional banks using a dataset covering 14 countries. The z-score as a proxy for insolvency risk, and cost efficiency was estimated via a stochastic frontier approach and capitalization was reflected on the equity to assets ratio. An array of bank-specific, macroeconomic and market structure variables were used in a system of three equations, estimated using the seemingly unrelated regression (SUR) technique. They find the capitalization response to increases in insolvency risk is more pronounced for Islamic banks but has an approximately five-times smaller effect on risk mitigation compared to conventional banks. Higher cost efficiency is related to lower risk for conventional banks, but the opposite is true for Islamic banks. The link between cost efficiency and capitalization attests to a substitutional effect for the case of conventional banks, but a complementary effect for Islamic banks. Their findings give new insights on the use of efficiency to gauge capital requirements for financial institutions and are particularly relevant for regulators and policy makers in countries where both bank types operate.

1.2.6 Study framework

In theory, bank capital plays the role cushions for degree of loss faced by a bank in the event of a bankruptcy. Hence, a bank has a higher capital base will suffer lower risks and vice versa. However, when all deposits are insured with a flat premium rate, there occurs a negative relationship between risk and capital. Thus, the marginal cost of increasing bank risk and/or lowering the level of capital is zero as the insurance premium remains constant with risk or capital. After introduction of capital adequacy requirement in banking sector, it is argued that risk-taking activities are reduced significantly (Altunbas, Carbo, Garde & Molyneux, 2007). In contrast, it may further be argued that higher capital requirements lead to excessive risk-taking

by banks as this would lower the bank's charter value, thereby restricting bank's drive to behave cautiously (Hellman, Murdock and Stiglitz, 2000). Moreover, if capital cost of bank is taken as more expensive, banks will induce to more risks to generate a higher return on equity to cope with higher level of capital. Similarly, the moral hazard arguments also support the bank's tendency to take more risk when its intention is to exploit the deposits insurance schemes. Moral hazard occurs when central banks, and governments, assures economic agents to believe that they will get involved to protect an institution and its creditors in case of any failure. Moral hazards can further be hypothesized along the line of agency problems between managers and shareholders. In an unhealthy banking industry, managers will be less inclined to take on more risk. Added to that, well informed managers may employ an expansionary strategy which may end up being very risky. In banking industry, the ''too-big-to fail'' argument is also prudent in relationship of bank risk and capital. Large banks may rely too much on a public bailout in case of financial difficulties as they are conscious of their importance in the financial system.

In line with the capital buffer theory, banks aim at holding more capital than required since it plays the role of insurance against breach of the regulatory minimum capital requirement. More equity capital tends to absorb adverse shocks and thus protects the bank from being failure due to increase in loan default. Consequently, portfolio risk and regulatory capital are assumed to be positively related. Banks raise capital when portfolio risk goes up in order to keep up their capital buffer. Hence, the capital, efficiency and risk are more pronounced in banking industry to explore their relationship so as to develop plausible hypothesis and testing it for policy implications. Indeed, this study aims to work in line with this theoretical framework in case of Nepalese banking industry.

II. Research Approach

This research is based on the descriptive, correlational and casual comparative research design. Descriptive research design is used to describe the nature of variables used in this study. Correlational research design is used to determine if there is a relationship (or co-variation) between the study variables. Casual comparative research design is used to examine the casual relationship between risk, capital and efficiency in Nepalese commercial banks

2.1. Data and Sample

There were 27 commercial banks in Nepal till June 2021, so population of this study constitutes 27 commercial Nepalese banks. The 18 commercial banks were chosen as sample for this study and data were taken from 2011 AD to 2020 AD. hence, this study is based on 180 observations of 18 commercial banks for 10-year period. The sample banks were chosen on the basis of their ownership strata i.e. the joint venture banks, public sectors and the private sector banks having the largest and smallest capital base in their strata. capital. To obtain maximum number of observation data from 2011 to 2020 for 18 banks is collected, which includes 2/3 of total population. This study, thus is based on balanced panel data of 10 years period from 18 individual banks.

2.2. Model Specification

Two-Stage least squares (2SLS) regression analysis is a statistical technique that is used in the analysis of structural equations. This technique is the extension of the OLS method. It is used when the dependent variable's error terms are correlated with the independent variables. This situation is known as endogeneity, if we use the ordinary least square method (OLS) to run the estimation, in such case one may face simultaneous bias and inconsistent problem in the estimated results.

This study adopts the approach suggested by Shrieves and Dahl (1992), Altunbas, Carbo, Garde & Molyneux (2007), Zeb & Ali (2019).) to estimate the relationship between risk, capital and efficiency. They underline that capital and risk decisions are made simultaneously and are interrelated. This endogeneity can make OLS estimators inconsistent and thus calls for the use of a simultaneous equation specification and estimation methodology. To allow for simultaneity between banks' risk, capital and efficiency, a system of equations is being used and estimated using two-stage least squares (2SLS) approach through panel data techniques.

$$EFF_{it} = \alpha_0 + \alpha_1 CAP_{it} + \alpha_2 RISK_{it} + \alpha_3 SIZE_{it} + \alpha_4 OBSTA_{it} + \varepsilon_i \quad \text{.....(1)}$$

$$RISK_{it} = \beta_0 + \beta_1 CAP_{it} + \beta_2 EFF_{it} + \beta_3 SIZE_{it} + \beta_4 NLTA_{it} + \varepsilon_i \text{..... (2)}$$

$$CAP_{it} = \gamma_0 + \gamma_1 RISK_{it} + \gamma_2 EFF_{it} + \gamma_3 SIZE_{it} + \gamma_4 ROA_{it} + \gamma_5 IRTA_{it} + \varepsilon \text{…….}_i \text{(3)}$$

In the given specifications, the each of the variables have been approximated with following measurements;

EFF_{it}= Interest revenue to interest expenses of bank $_i$ in period $_t$;

CAP_{it}= Total equity to total assets of bank $_i$ in period $_t$;

$RISK_{it}$= Loan loss provision to total assets of bank $_i$ in period $_t$;

$SIZE_{it}$= Logarithm of total assets of bank $_i$ in period $_t$; as indicator of bank Size;

$OBSTA_{it}$= Off-balance sheet items to total assets of bank $_i$ in period $_t$

ROA_{it}= Profit before tax to total assets of bank $_i$ in period $_t$ as indicator of profitability

$IRTA_{it}$= Total interest revenue to total assets of bank $_i$ in period $_t$

$NLTA_{it}$ = Net loan & advances to total assets of bank I in period t.

α, β, γ = Coefficients to be estimated; and

ε_i= error term.

Following the simultaneous equation framework, to estimate capital equation, risk is used as instrumental variables and vice versa. As the two-stage least square (2SLS) has been programmed in STATA, this study has employed this software to estimate the required regression equations. as explained earlier, the use of 2SLS equations are expected to avoid simultaneous bias for estimated coefficients.

III. Results and Discussions

This section presents results derived from the simultaneous model described above where risk, capital and cost inefficiency are the endogenous variables. Two stage least squares with fixed effects estimation has been used and the results for each equation are disclosed separately for ease of explanation. This study has adopted the 'balanced panel' approach, whereby each bank is represented in each time period. A panel data with long-time dimension might suffer through non-stationary problems of variables. Unit root test was conducted to investigate the nature of stationarity in data. The test statistics rejected the null confirming the non-stationary variables in the given data set.

3.1 Descriptive statistics

The table 1 depicts the descriptive and statistical summary of all dependent and independent variables used in this study. Efficiency as measured in ratio of interest income to interest expenses shows the average value of 2.01 indicating the substantial gaps in interest rate spreads. However, its minimum value is as less as 0.17 times and maximum value up to 4.66 times of interest expenses. The next important variable banking risk as measured in loan loss provision scaled by total assets has mean value of 0.53 % of total assets. Its maximum values are 4.23 % showing higher lending risks in some banks. Average bank capital measured as equity to total assets were 8.28% slightly above the minimum core capital ratio as prescribed by regulatory agency. However, some banks have as minimum as 0.3% capital base showing higher capital deficiency of the banks. All other control variables including bank size, loan & advances ratio, profitability and off-balance sheet assets are presented in the summary statistics.

Table 1

Summary statistics of study variables

Variables	N	Minimum	Maximum	Mean	Std. Deviation
EFFICIENCY	180	0.17	4.66	2.01	0.70
RISK	180	0.00	4.23	0.53	0.58
CAPITAL	180	0.30	22.26	8.28	2.84
SIZE	180	9.49	12.52	11.17	0.66
NLTA	180	6.47	97.00	63.73	12.04
ROA	180	0.03	3.99	1.62	0.62
IRTA	180	1.72	10.50	5.06	2.34
OBSTA	180	2.14	69.76	26.04	14.42

Notes: The figure of size is in log Rupees and other figures are in percentage.

3.2 Correlation among variables

Table 2 portrays the Pearson's correlation coefficients among eight variables. If the p-value is less than level of significance, the null hypothesis shall be rejected, else accepted. In the table 2, fourteen coefficients are significant at 5 percent level of significance. Twelve coefficients have negative sign and remaining coefficient have positive sign.

Table 2

Correlation among variables

Variables	Efficiency	Risk	Capital	Size	NLTA	ROA	IRTA	OBTA
Efficiency	1.00							
Risk	0.104	1.00						
Capital	-0.018	0.460**	1.00					
Size	0.274**	-0.226	-0.445	1.00				
NLTA	-0.298	-0.11	0.167	-0.047	1.00			
ROA	0.426*	0.016**	0.150**	0.233	-0.036	1.00		
IRTA	-0.133	-0.194	-0.099	0.641**	0.216	0.217**	1.00	
OBTA	-0.169	-0.229	0.057	0.102	0.144	0.124**	0.316	1.00

**. ** denotes correlation are significant at the 0.05 and 0.001 percent level respectively.*

The p-value of risk in relation to efficiency is 0.166 which is higher than the level of significance at 5%, hence null hypothesis shall be accepted. However, Pearson's correlation coefficient is 0.104 that shows low degree of positive correlation between the risk and efficiency. In the case of capital in relation to risk, the p-value is 0.000, hence null hypothesis is rejected. This means that there is a significant relationship between risk and capital. Also, Pearson's coefficient is 0.460 which denotes that there is low degree of positive relationship between risk and capital. Moreover, the p-value of capital in relation to efficiency is 0.812, which is higher than level of significance at 5%, hence there is no significant relationship between capital and efficiency. Pearson's correlation coefficient is -0.018 which denotes that there is low degree of negative relationship between capital and efficiency.

The p-value of size in relation to efficiency is 0.000 which is less than level of significance at 1% level of significance, hence null hypothesis is rejected. This indicates that there is a significant relationship between size and efficiency. Also, Pearson's coefficient is 0.274 which means that there is low degree of positive relationship between size and efficiency. On other hand, the p- value of size in relation with risk and capital are -0.002 and 0.000 respectively, which are lesser than level of significance at 5%, hence, there are significant relationship of size with risk and capital. Pearson's correlation coefficients are -0.0226 and -0.047 which denote that there are low degree of negative relationship of size with risk and capital.

Similarly, the p-value of risk with NLTA is 0.141which is higher than the level of significance; hence null hypothesis shall be accepted reflecting no significant relationship between risk and NLTA. However, the Pearson's correlation coefficient is -0.11, which denotes low negative

correlation between the risk and NLTA. Moreover, capital has 0.044 p-value with ROA and 0.188 p-value with IRTA which are lesser than level of significance at 5% level of significance, hence null hypothesis is rejected in relation with ROA and accepted with IRTA. This means that there is a significant relationship of capital with ROA and no relation with IRTA. Also, Pearson's coefficients are 0.150 and -0.099 which describe that there is low degree of positive relationship of capital with ROA and low degree of negative relationship with IRTA. And p-value of efficiency with OBTA is 0.023 which is lesser than the level of significance; hence null hypothesis shall be rejected reflecting there is significant relationship between efficiency and OBTA. However, Pearson's correlation coefficient is -0.169, which shows low degree of negative relationship between efficiency and OBTA.

3.3. Determinants of efficiency

To account for a possible interdependence between the efficiency, risk and capital, the two- stage least squares (2SLS) regression model has been programmed in "STATA". In a first step, however, to make sure that 2SLS is an appropriate methodology, a test for the endogeneities of the efficiency, risk and capital is conducted using a Hausman test. Similarly, Sargan- over-identification test is used to know about the over identification. Applied to the efficiency equation, the value of Chi-square is 20.23 with probability of 0.004. It means Hausman test is significant and Hausman test rejects the null hypothesis of exogenous at the 5% level. Thus, it is concluded that OLS may lead to biased and inconsistent estimates in our sample.

In second stage, using two- stage least square, here efficiency (interest revenue to interest expenses) is used as the dependent variable. Exogenous variables used in this study are size (logarithm of total assets), off balance sheet item to total assets, capital and risk. The coefficients for these variables are estimated in table 3:

Table 3

Determinants of Bank Efficiency

Efficiency	**Coefficient**	**Std. Err.**	**Z**	**P>z**
Constant	-3.31	1.56	-2.12	0.034
Capital	0.104	0.042	2.48	0.013
Risk	-0.33	0.213	-1.56	0.118
Size	0.567	0.141	4.02	0
OBTA	-0.064	0.019	-3.28	0.001
Notes:				

RMSE = 0.996, Chi-square = 20.23 (0.004)
, and *** denotes Significant at10%, 5%and 1% level of significance*

The table 3 shows that bank Capital has a positive and significant coefficient implying that better capitalised firms operate more efficiently than undercapitalised ones. Regression result revealed that each 1% increase in Capital will increase efficiency by 0.104%. This finding is consistent with previous research which concludes that more capitalized bank operates efficiently than banks with less capital (Shrieves & Dahl, 1992; Berger & Young, 1997; Altunbas *et. al*., 2007). According to Berger and Young (1997), well capitalized banks are better run.

As regard to the effects of risk on efficiency, the results are in line with those in the risk equation. The equation is significantly related to efficiency where negative coefficient of risk is found with 0.33 values which means 1% change in risk leads 0.33% change in Efficiency in negative direction (which is positive when the same equation is estimated through ordinary least squares). It suggests that less efficiency may be the result of managing a larger amount of loans. Banks with higher risk profile tend to operate less efficiently than less risky banks. It is rational because higher risk banks tend to get higher chance of unrecovered loans. Size, measured by log of total assets has positive and significant coefficient of 0.567 with efficiency which means 1 point increment on size leads to 0.567 point increment on efficiency. In other words, larger banks are more efficient. The relationship is theoretically strong and can be explained by both economies of scale as well as economic of scope. Banks can enjoy higher efficiency when they can manage a larger amount of loan.

An off-balance sheet item to total assets (OBTA) appears to be negatively related to efficiency. Coefficient for OBTA is statistically significant at 5% level, which is also significant when the same equation is estimated through ordinary least squares, suggesting that banks that are more actively involved in OBS activities operate more efficiently or 1% change in OBTA leads to 0.064% change in Efficiency in negative direction.

3.4 Determinants of Risk

In this model, an accounting measure of bank risk (loan to total assets, RISK) is used as the dependent variable and capital, efficiency, size and NLTA as exogenous variables. Coefficient for capital and NLTA are statistically significant at 5% level. The coefficient for the NLTA was insignificant when the same equation is estimated through ordinary least squares. In the table 3.4, capital has positive and significant relationship with risk as predicted before. It means stronger capital is associated with higher risk taking behaviour. The coefficient of capital is 0.23; it is significant at 5% level of significance which means each 1% change in capital would lead to 0.239% changes in risk. Similarly, 1% change in efficiency lead to 0.801% change in risk in negative direction. In the case of the efficiency variable, the negative effect of efficiency on risk-taking supports the view that inefficient banks are more vulnerable to risk-taking than efficient ones.

Table 4
Determinants of banking risk

Risk	**Coefficient**	**Std. Err.**	**Z**	**P>z**
Constant	6.321	6.45	0.98	0.328
Capital	0.239	0.15	1.55	0.012
Efficiency	-0.801	0.899	-0.89	0.003
Size	0.35	0.463	0.77	0.444
NLTA	0.158	0.153	1.04	0.03
Notes:				

RMSE = 1.760, Chi- square =5.54(0.0236)
,,*** denotes Significant at 10%,5% & 1% level of significance*

Size found with positive coefficient means 1% change in size lead to 0.350% change in risk at positive direction. However, size coefficient is not significant in this equation. The coefficient of NLTA found 0.158 meaning that 1% change in NLTA leads to 0.158% change in NLTA.

The coefficient for NLTA is positive and significant meaning the existence of linear relationship between net loan and risk taking. Higher net loan to total asset is prone to higher credit risk. When the portion of loan to asset is bigger, it means bank asset is dominated by loan. In Nepalese commercial banking system, where the most important role of the banking industry is to perform intermediation, the higher portion of NLTA leads to a positive contribution to the credit risk.

3.5 Determinants of Capital

Commercial banks with higher risk hold a higher amount of capital as reflected by the positive and significant sign of Risk. Risk is found significant at 5%, level with coefficient of 1.770 meaning that 1% increase in Risk lead to 1.770% increase in Capital. This may suggest that there is sufficient level of intervention by regulators in forcing riskier commercial banks to hold more capital. The coefficient of efficiency is found significant at 5% level with coefficient value of 1.770 meaning that 1% change in efficiency leads to 1.770% change in capital in positive direction, the coefficient is insignificant when the same equation is estimated through ordinary least squares.

Table 5

Determinants of Capital

Capital	Coefficient	Std. Err.	Z	P>z
Constant	55.28	9.28	5.96	0.000
Risk	1.77	0.65	5.2	0.000
Efficiency	1.77	0.314	2.7	0.007
Size	-5.24	1.056	-4.96	0.000
ROA	0.036	1.056	0.07	0.942
IRTA	1.4	0.405	3.47	0.001

RMSE = 2.549, Chi- square = 99.30 (0.000)

, **, * denotes Significant at 10%, 5% & 1% level of significance*

Size has negative coefficient and not significant. The coefficient of Size is -5.240; it implies that 1% change in size lead to 5.240% change in Capital at negative direction. ROA has positive relationship with capital because ROA has coefficient of 0.036 means that 1% change in ROA leads 0.036% change in Capital. This relationship is significant at 5% level of significance, such that banks with higher earnings also tend to operate with high capital. Banks usually require considerable investment in retail infrastructure and human resources, and these in turn allow them to achieve high returns on assets. The coefficient for IRTA, ratio of interest revenue to total asset, an indicator how bank can generate revenue from its asset is positive and significant (which is also significant when the same equation is estimated through ordinary least squares) with the value of -1.217 meaning that 1% change in IRTA leads to 1.217% change in Capital. It

means even the bank can generate higher interest revenue, if the profit is less, the impact is not plausible. Referring to ROA which has positive coefficient, it may conclude that higher interest may come from higher risk.

IV. Conclusion and Implications

The study has focused upon the relationship between capital, risk and efficiency of commercial banks of Nepal and conclusively answered the objectives of the study. The major conclusion of the study is that capital, risk and efficiency affects the banking activities as these variables possess significant relationship in Nepalese commercial banks.

In efficiency equation, it was found that capital and size are positive and significant. It indicates a bigger capital ratio as well as bank size increases efficiency of Nepalese commercial banks. In terms of bank size, large banks enjoy better efficiency than smaller banks. Off-balance sheet to total assets has a negative and significant relationship with efficiency. It means bigger Off-Balance-Sheet activities decrease operating efficiency. In this equation, it can be concluded that efficiency is determined by capital and size meaning more capital and large sized banks can improve the operating efficiency of Nepalese commercial banks.

In risk equation, the results show that highly capitalized banks tend to have higher risk taking and efficient banks also have higher risk. Furthermore, large banks tend to have higher risk than smaller ones because the larger ones have diversified their investment which is investment in hydro projects and other businesses such as hotels and restaurants and other activities as there is higher credit risk. In this risk equation, we can conclude that in general capital, size and net loan to total assets are positively related while efficiency is negatively related.

In capital equation, banks that have higher risk tend to have higher capital and this relationship is significant also. Efficient banks have a positive but insignificant relationship with capital. Bank size has negative relationship with capital meaning larger banks tend to own less capital. This finding is not surprising because for large banks, they can attract more capital at faster and lower cost than smaller banks. The ratio of interest revenue to total assets, an indicator how bank can generate revenue from its assets is positive and significant and same with ROA.

Most studies concentrate on US and European banks, while empirical evidence has remained scarce for Asian banks. Added to that, to our knowledge, there are very few papers on this subject for commercial banks in Nepal. Thus, this study contributes to the literatures to shed light on the determinants of bank risk-taking and analyze its relationship with capital and efficiency in Nepalese Commercial banks.

It has revealed positive impact of capital on risk. Therefore, it is observed from the study that capital of bank is much sensitive towards risk. Nepal Rastra Bank makes plans and policies regarding the control of risk. Therefore, policy makers such as NRB in Nepal should seek to minimize risk when formulating monetary policy. As the growth of the commercial banks and the improvement in their efficiencies influence economic growth, understanding the determinants of the commercial bank efficiencies is helpful not only for the design of better management strategies but also general subject of interest for the investors, depositors and for the public concern (Jha, Hui & Sun, 2013).

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