DO HUMAN CAPITAL AND COST EFFICIENCY AFFECT RISK AND CAPITAL OF COMMERCIAL BANKS? AN EMPIRICAL STUDY OF A DEVELOPING COUNTRY

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ABSTRACT

As a striking force and operational optimization, human capital and cost efficiency of commercial banks are worth considering factors in decision making. Using simultaneous equation models this study delves the interrelationship between bank risk, capital and efficiency of a sample developing country-Bangladesh incorporating new dimension human capital efficiency along with existing cost efficiency through Stochastic Frontier Analysis (SFA). The empirical results of generalized methods of moments estimator (GMM estimator) from 2000-2015 show that capitalized commercial banks are more capable of absorbing risk and enhancing human capital efficiency. Increasing amount of risk leads banks to improve their level of capital but that reduces the cost efficiency of banks. We also find the significant impact of risk and capital on the efficiency of banks. With the increase of capital and risk, the human capital of banks behaves more efficiently whereas the efficiency of cost reduces substantially. Although no significant relationship observed between risk and human capital efficiency in risk equation, the inefficiency of cost find inversely associated with risk and positively associated with capital in risk and capital equations respectively.

Contribution/ Originality: This study originates new estimation of technical efficiency named Human capital efficiency along with existing cost efficiency using Stochastic Frontier Analysis to examine the simultaneous relationship between risk, capital, and efficiency of a sample Asian country Bangladesh.

1. INTRODUCTION

The Recent financial crisis has shaken most of the financial markets and institutions globally. Economic crisis and increasing competition force banks to act more efficiently. Increased competition influences banks to take more risk to keep in competition. Again escalations of risk draw the attention of the regulators who try to balance risk-taking behavior through enforcing capital requirements of banks (Altunbas et al., 2007). And human capital, that is employees are the main driving force of the banking industry. Proper management and efficiency of employees (subsequently human capital efficiency) can make the banks successful. Human capital efficiency refers the productivity of the employees in generating assets and income using cost and other resources of the organizations. In fact, it is the measurement of how productive the employees are in generating resources and income using cost

and minimum liabilities. With the expansion of number of banks, it is become increasingly difficult to ignore the interrelationship between risk, capital, and efficiency. This is mainly because of increasing competition and compliance issue of risk imposed by regulatory authorities. Growing concern of Basel accord; Basel I in 1988, Basel II in 1999 and finally Basel III in 2010 to provide a stable position in international banking system shows the concerns of authorities in managing risk and capital requirements of banks.

Banking crisis becomes a worldwide phenomenon that also hits in Asia (Sun and Chang, 2011). The snowball effect of banking crisis hits the small countries like Bangladesh. A large volume of loans defaulted, a significant proportion of classified loans occurred, rescheduling culture of credit adjustment become prevalent. Noncompliance with regulations has drawn the attention of the government and regulatory authority to strict the banking regulation in Bangladesh (Bangladesh-Bank, 2012-2013; Isshaq *et al.*, 2015). So with the passage of time, it is growingly important to balance between risk and capital, confirming the efficiency of banks in an intensively competitive market that affects the value of the bank (Schaeck and Cihák, 2012; Tan and Floros, 2013; Miah and Sharmeen, 2015). The risk of banks is not an independent issue of analysis. There is still question about the appropriate and satisfactory technique of determining risk (Amarante, 2016). But in analyzing risk, efficiency and capital requirements considered as important determinants along with others. On the other hand, the risk is also treated as an important determinant along with other factors in measuring capital requirements and efficiency of banks. The financial crisis of Asia in 2007 validates the more in-depth look at the relationship between risk, capital, and efficiency of Asian Banks (Tan and Floros, 2013). The existing literature examines the relationship between risk, the level of capital and efficiency yield conflicting conclusion because of the non-exclusive hypothesis of the study (Altunbas *et al.*, 2001).

This study is the extension of previous works focusing efficiency, capital and risk measures. We consider Bangladesh as a sample country of Asia that was not previously addressed. Again considering two types efficiency measures this study depicts the importance of human capital efficiency and cost efficiency in bank risk and capital requirement decisions. The study is expected to explore empirically through constructing new facts and evidence and unfolding a new dimension of efficiency-human capital efficiency in Bangladesh as a sample country of Asia.

In the organization of the paper, Section 2 reviews the literature relevant to the study and development of hypothesis; Section 3 describes the data and methodology explaining the relationship between risk, capital and efficiency. Section 4 draws the empirical results, section 5 shows the test of robustness, and finally, Section 6 summarizes and concludes the paper.

2. LITERATURE REVIEW AND DEVELOPMENT OF HYPOTHESIS

Ongoing debate that started in the early of the empirical research examining the relationship between risk, capital, and efficiency in developed countries still going on (Tan and Floros, 2013). Different researchers come forward with unending and counterfactual conflicts whether efficiency has supremacy to risks or risks significantly influence the efficiency of banks (Altunbas *et al.*, 2007). Controversy also goes side by side whether optimum capital requirements reduce the level of risk or level of risk decides the optimum level of capital. Again consensus conclusion not yet been done on the relationship between capital regulations and efficiency and level of risk and efficiency. Based on different debates of the previous study, review of literature survey has divided into following parts (1) Literature regarding the relationship between risk and efficiency, (2) Literature relating to the relationship between risk and capital regulation (3) Literature relating to the relationship between capital regulation and efficiency. Also, a hypothesis on managerial perspective discussed at the bottom part of the literature review.

2.1. The Relationship between Risk and Efficiency

The general expectation between risk and efficiency is negative. That means increased efficiency will manage risk substantially. So, a negative correlation is expected to observe in the study, but different outcome also found in

the literature regarding this relationship. Different kind of research, for example, Berger and DeYoung (1997); Kwan and Eisenbeis (1997); Berger and DeYoung (1997); Deelchand and Padgett (2010); Fiordelisi *et al.* (2011) and Nguyen and Nghiem (2015) among others spectacle negative relationship between the efficiency and risk. But opposite results also found in literature too. Literature mentioning positive relationship are Tan and Floros (2013) on China, Miah and Sharmeen (2015) on Bangladesh; Isshaq *et al.* (2015) on Ghana among others. Again literature dealing with bank efficiency linked by Kwan and Eisenbeis (1997) evidencing the relevance of efficiency in determining risk.

Commenting differently, Altunbas *et al.* (2007) mention no significant relationship between inefficiency and risk-taking behavior of commercial banks. To delve the relationship following hypotheses are constructed:

H_1: There is a significant negative association between cost efficiency and risk of banks.

H_2: There is a significant impact of human capital efficiency on the bank risk, i.e., negative relationship between efficiency and risk is expected. That means with the increase of human capital efficiency risk will be managed substantially.

H_3: There is the significant positive impact of risk on the human capital efficiency, i.e., positive relationship between risk, and human capital efficiency is expected. That means it is expected that employees' of banks will act more efficiently with the increase of risk.

2.2. The Relationship between Capital Requirement and Risk

Up gradation of Basel accord with the passage of time, conveys a clear message to banking industry about the apparent relationship between risk and capital requirements. Although the debate is still going about the significance of capital in controlling risk. Sun and Chang (2011) opine that risk-averse banks are more likely to choose capital based finance than risk neutral banks to manage the risk level. It refers that capital base finance act as a mitigating risk tool. From the empirical evidence on 14 Islamic countries, Abdul *et al.* (2014) opine that capital requirement has a significant impact on the lending activities of bank and act as a shock absorber for credit risk. Thus it is clear that capital has considerable influence on risk.

Some literature address the positive relation between risk and capital such as Ghosh (2014); Ahmad *et al.* (2009); Altunbas *et al.* (2007); Lin *et al.* (2005); Blum (1999) and Shrieves (1992) among others. Whereas Chang and Chen (2016); Nguyen and Nghiem (2015); Maji and De (2015); Agusman *et al.* (2014); Fiordelisi and Mare (2013); Guidara *et al.* (2013); Zhou (2013); Agoraki *et al.* (2011); Deelchand and Padgett (2010); Zhang *et al.* (2008); Agusman *et al.* (2008); Iwatsubo (2007); Jacques and Nigro (1997); Karels *et al.* (1989) address negative association between capital and risk. Again some authors define the relationship differently. Kim and Santomero (1988) demonstrate capital regulation is an ineffective tool in controlling risk. Rime (2001) opines that regulatory pressure on capital requirements has a significant impact on banks' behavior but no major impact of capital requirement found at risk. The mixed result also found in other studies, for example, Calem and Rob (1999) point out U-shape relationship between capital and risk. Iwatsubo (2007) opines that capital adequacy regulation does not preclude the risk-taking behavior of banks. No particular connection but capital management has a different effect on bank risk-taking (Laeven and Levine, 2009). Relevant hypotheses of examining the association are:

H4: There is a significant negative association between risk and capital regulation of banks.

2.3. The Relationship between Capital Requirement and Efficiency

Since capital is one of the costly sources of financing, efficiency becomes the relevant issue in determining the level of capital. Studies show the positive correlations between efficiency and level of capital are Manlagnit (2015); Pessarossi and Weill (2015); Fiordelisi *et al.* (2011); Chiu *et al.* (2008); Girardone *et al.* (2004); Kwan and Eisenbeis (1997); Lee and Chih (2013) and Naceur and Omran (2011) among others.

On the contrary, evidence of Maji and De (2015); Deelchand and Padgett (2009); Altunbas *et al.* (2007) and Rao (2005) among others report negative relationships between efficiency and capital.

Again from the empirical study on Chinese banks, Lee and Chih (2013) show that capital regulations have a significant impact on the efficiency of large and small banks. But no meaningful relationship between capital and efficiency also trace out by few literature, for example, Guidara *et al.* (2013) and Zhang *et al.* (2008). Guidara *et al.* (2013) opine that capital buffer or maintaining an excess of capital over minimum capital requirement is the outcome of market discipline and no substantial evidence shows an association of return on equity and capital buffer of banks. The relevant hypotheses for examining the relationships are:

H_5:   There is a significant positive relationship between the efficiency of cost and capital adequacy.

H_6:   There is the significant positive impact of the efficiency of human capital on capital adequacy. That means with the increase of human capital efficiency banks will able to maintain adequate regulatory capital.

H_7:   There is a significant impact of capital adequacy on human capital efficiency. A positive relationship is expected there. That means with the increase of capital banks will be more able to support efficient human capital.

2.4. Hypotheses in Managerial Perspective

Showing the inter-temporal relationship between risk, capital and efficiency of banks, Berger and DeYoung (1997) submitted four behavioral hypothesis namely: bad luck, bad management, skimping and moral hazard. As the objective of our paper is to observe the managerial behavior of Bangladesh through observing risk, capital and efficiency of banks, these four hypotheses are relevant to the study and can be summarized as below:

Bad luck hypothesis refers that problem loan is the outcome of external events. To manage the increasing amount of problem loans by putting additional efforts, managerial cost increases that reduce the efficiency of banks. Nguyen and Nghiem (2015) address economic downturn as the possible reason for such external events of bad luck hypothesis. Associating the same relationship between risk and efficiency, bad management hypothesis holds that decrease in cost efficiency leads to an increase in credit risk. More specifically inappropriate monitoring and controlling of loan increase the cost inefficiency that points forward growing amount of nonperforming loans. Skimping hypothesis depicts that the increase in cost efficiency by skimping resources devoted to underwriting and monitoring credit precedes an increase in insolvency risk. Under this hypothesis, growing trend of cost efficiency in the short run deteriorates loan quality in the long run. Again, moral hazard hypothesis holds that low capital ratio induces banks to take more risky project resulting increased credit risk in future.

3. DATE AND METHODOLOGY

3.1. Model Specification

SFA in determining efficiency is used in the study as also employed by Altunbas *et al.* (2007; 2001; 2000); Kwan and Eisenbeis (1997); Girardone *et al.* (2004) and Niţoi and Spulbar (2015). This paper opted for production function of SFA in the determination of human capital efficiency. Methodologically the paper introduces this new dimension of efficiency named human capital efficiency of the banking industry along with cost efficiency to delve relationship between capital and risk. Detail estimation is given in Appendix A. SFA in determining inefficiency widely used in previous studies- Altunbas *et al.* (2001; 2007); Kwan and Eisenbeis (1997); Girardone *et al.* (2004); Bonin *et al.* (2005) among others . Simultaneous equations are also employed to examine the overall relationships between risk, capital regulation and efficiency in Bangladeshi banking sector by following Maji and De (2015); Tan and Floros (2013); Altunbas *et al.* (2007); Deelchand and Padgett (2009); Fiordelisi *et al.* (2011).

Four equations specify empirical models of the study. In first two equations, both cost and human capital inefficiency are considered to observe the relationships.

$$\text{Risk}_{it} = \alpha_o + \alpha_1 \text{CAPITAL}_{it} + \alpha_2 \text{INEFF}_{j,it} + \alpha_3 \text{LTA}_{it} + \alpha_4 \text{SIZE}_{it} + \alpha_5 \text{OBSTA}_{it} + \alpha_6 \text{Risk}_{it-1} + \varepsilon_{it} \qquad (1)$$

$$\text{CAPITAL}_{it} = \beta_0 + \beta_1 \text{RISK}_{it} + \beta_2 \text{INEFF}_{j,it} + \beta_3 \text{LTD}_{it} + \beta_4 \text{ROA}_{it} + \beta_5 \text{RD}_{it} + \beta_6 \text{IRTA}_{it} + \beta_7 \text{RWATA}_{it} + \beta_8 \text{CAPITAL}_{it-1} + \varepsilon_{it} \qquad (2)$$

$$\text{INEFF}_{C\ it} = \partial_0 + \partial_1 \text{RISK}_{it} + \partial_2 \text{CAPITAL}_{it} + \partial_3 \text{Tax}_{it} + \partial_4 \text{SIZE}_{it} + \partial_5 \text{LTA}_{it} + \partial_6 \text{GOVS} + \partial_7 \text{INEFF}_{C\ it-1} + \varepsilon_{it} \qquad (3)$$

$$\text{INEFF}_{HC\ it} = \mu_0 + \mu_1 \text{RISK}_{it} + \mu_2 \text{CAPITAL}_{it} + \mu_3 \text{ROA}_{it} + \mu_4 \text{DTA}_{it} + \mu_5 \text{LTA}_{it} + \mu_6 \text{OBSTA}_{it} + \mu_7 \text{INEFF}_{HC\ it-1} + \varepsilon_{it} \qquad (4)$$

Where,

The i subscript denotes the cross-sectional dimension across banks, and t indicates the time dimension. NPLTL is used as a proxy for banking risk and CAPITAL (total eligible capital to total assets) is used as a proxy for banks capital regulation. INEFF is used as a proxy for bank inefficiency which is derived from SFA (For details see Appendix A). $INEFF_{j,it}$ refers cost inefficiency and human capital inefficiency respectively (j= cost, human capital) for bank i at period t. This study uses SIZE, OBSTA, ROA, Tax, LTA, GOVS, RWATA, IRTA, RD, LTD and DTA as control variables and 'ε' refers error components.

Equation (1) explains the effect of eligible capital and inefficiency in risk, whereas equation (2) shows how risk and inefficiency affect the level of bank's eligible capital. Finally, equations (3) and (4) examine the effect of capital and risk on inefficiency. Eleven bank-level control variables are used because these variables are relevant to explain the relationships between risk, capital regulation, and inefficiency. Since the study based on single country exposure, macroeconomic variables are avoided due to similar effect on all banks.

3.2. Data and Variable Description

Banking industry of Bangladesh composed of 56 banks[1]. Before commencing the analysis, all listed banks under DSE[2] and state-owned commercial banks were selected from 2000 to 2015. Since information of all banks was not available, finally 32 banks including four state-owned commercial banks are taken as a sample, considering at least last five years consecutive available data. One bank's information (ICB Commercial Bank) is intentionally dropped due to outlier effect. This study adopts unbalanced panel data not to lose degrees of freedom. All information is collected from DSE library, and some information is collected from Bankscope database of Bureau van Dijk's company (web: www.bvdinfo.com), especially data that were not available in DSE library.

Table-1. Description of variables used in the study

Variables	Acronyms	Definition	Sources (Some reference)
Risk	NPLTL	Non-performing loans to total loans	Chaibi and Ftiti (2015); Niţoi and Spulbar (2015); Tan and Floros (2013).
	LLPTL	Loan loss provisions to total loans	Bougatef and Mgadmi (2016); Athanasoglou et al. (2008)
Capital	CAPITAL	Total eligible capital to total assets	Zhang et al. (2008)
	ETA	Book value of equity to total assets	Lee and Chih (2013); Tan and Floros (2013); Altunbas et al. (2007); Iannotta et al. (2007); Kwan and Eisenbeis (1997).
Inefficiency	$INEFF_C$	Inefficiency of cost measured through SFA	Altunbas et al. (2007); Altunbas et al. (2001); Deelchand and Padgett (2009); Tan and Floros (2013)
	$INEFF_{HC}$	Inefficiency of Human capital measured through SFA	Measured by authors using SFA.
Liquidity	LTA	Total loans and advances to total assets	Bougatef and Mgadmi (2016); Tan and Floros (2013); Lee and Chih (2013); Altunbas et al. (2007).
Size	Size	Logarithm of total assets	Bougatef and Mgadmi (2016); Chaibi and Ftiti (2015); Athanasoglou et al. (2008); Deelchand and Padgett (2010)
Non-traditional activity	OBSTA	Total off-balance sheet exposure to total assets	Tan and Floros (2013); Mongid et al. (2012); Deelchand and Padgett (2010)
Profitability	ROA	Return on assets	Deelchand and Padgett (2010); Bougatef and Mgadmi (2016); Mongid et al. (2012); Kwan and

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[1] As per Annual Report Bangladesh Bank 2014-2015 till December 2015.

[2] DSE (Dhaka Stock Exchange) one of the two stock exchanges in Bangladesh.

			Eisenbeis (1997)
Non-interest income ratio	RD	Non-interest income to total assets	Chaibi and Ftiti (2015); Nguyen and Nghiem (2015)
Revenue income	IRTA	Interest revenue to total assets	Jacques and Nigro (1997); Mongid et al. (2012).
Proportionate loan ratio	LTD	Total loan and advances to total deposit	Soedarmono et al. (2011)
Ratio of risk-weighted assets	RWATA	Total risk-weighted assets to total assets	Authors' calculation.
Tax	Tax	Total provision for tax	Deelchand and Padgett (2010)
GOVS	GOVS	Investment in Government securities	Authors' calculation.

Source: Authors' compilation following mentioned sources/references.
Note: By using software package Frontier 4.1 versions, we estimate the inefficiency of cost and human captial. Details of estimation explained in Appendix A.

Table-2. Descriptive statistics of all variables (The monetary units are in BDT. million where applicable)

	Minimum	Maximum	Mean
Risk	0.0000	.4459	.072597
CAPITAL	-.1303	.1478	.076876
$INEFF_C$	.0106	.8105	.173746
$INEFF_{HC}$	.1446	.8985	.740291
Size	8.5707	13.8420	11.136345
OBSTA	.0298	.6751	.302768
LTA	.3393	.8375	.659666
ROA(%)	−13.5200	6.0500	1.378070
RWATA	0.0000	1.2726	.680954
RD	.0034	.1011	.029070
GOVS	0.0000	381600.3976	17515.404969
LTD	.4024	1.5434	.818293
Tax	−2852.3640	6620.4200	945.923987
IRTA	.0194	.1152	.078727
DTA	.4600	.9354	.809819

Source: Authors' calculation by using SPSS-20

Table 1 represents the details of variables used in the study and Table 2 presents the descriptive statistics of all variables. The mean of risk (NPLTL-Non-performing loans to total loans and advances), is 7.25% and the average of CAPITAL (Total eligible capital to total assets) is about 7.68%, but minimum value is negative in the studied period. That means that sample banks failed to maintain minimum capital requirements over the studied period. The mean value of cost inefficiency is about 0.1737 whereas human capital inefficiency is about 0.7403. The maximum value of cost inefficiency and human capital inefficiency are 0.8105 and 0.8985 respectively, and minimum values are 0.0106, 0.1446 respectively. Although maximum and minimum values of inefficiencies show a consistent pattern, the average value of inefficiency shows that Bangladeshi banks are more inefficient in human capital productivity on an average in comparison to cost efficiency.

Among the independent variables, no correlation value[3] shows above 0.70 except LTA and LTD. Since these two independent variables are not used in the same model, so models are free from major multicollinearity problem.

4. EMPIRICAL RESULTS

This section presents the empirical finding of simultaneous models that described in the data and methodology part where risk, capital, and inefficiency (Cost and Human capital) are the endogenous variables. Since in the models, the presence of endogeneity, heteroscedasticity, and serial correlations are observed, so GMM system panel

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[3] See Appendix B (Pearson's Correlation Coefficients between the variables).

estimator is applied developed by Arellano and Bover (1995) and Blundell and Bond (2000) to get the best-fit result. The estimated results from GMM estimator are presented in the following Table 3, 4, 5, and 6.

4.1. Examining the Relationship between Capital Requirement and Efficiency on Risk

Table 3 reports the summarized results of the estimation of risk equation using GMM for the period over the years 2000-2015. Non-performing loan to total loan used as a proxy for risk measure.

Table-3. Risk (NPLTL as the dependent variable)

Variables	Cost inefficiency model	Human capital inefficiency model
CAPITAL	-0.482142***(-5.76280)	-0.461719***(-4.02473)
$INEFF_C$	-0.076797**(-2.40838)	
$INEFF_{HC}$		0.020489(0.70658)
LTA	-0.08256***(-3.80833)	-0.050819***(-2.80001)
SIZE	0.011764***(4.71665)	0.007292**(2.35653)
OBSTA	-0.002878(-0.20752)	-0.015672(-1.47480)
RISK(-1)	0.688515***(44.66514)	0.703715***(26.05357)
C (Constant)	-0.007848(-0.40358)	-0.006571(-0.12753)
Adjusted R-squared	0.806543	0.804188
Hausman test, F(p-value)	61.8966(0.0000)	68.18292(0.0000)
Sercial correlation test (p-value)	0.00000	0.00000
Sargan test (p-value)	0.12550	0.11458
Panel Fixed/Random effect (p-value)	1.00000	1.00000
Observations	447	447
Number of banks	32	32

Notes: The table shows the empirical results of GMM panel estimator. Risk (NPLTL) is the dependent variable; ***, ** and * indicate level of significance at 1%, 5% and 10% respectively. For Hausman test p-values are in parentheses. t-statistics are shown in parentheses

The coefficient of CAPITAL is significant and negatively related to risk in both models. The first model shows the cost inefficiency whereas next one shows human capital inefficiency. The coefficient of capital refers that small capitalized banks in Bangladesh are taking more risk than capitalized banks. This result supports previous studies showed negative relations between risk and capital mentioned in the literature review section. Moral hazard hypothesis becomes evident there due to the presence of deposit insurance benefit (Deelchand and Padgett, 2009). Cost inefficiency model reports that cost efficient banks are taking more risk than inefficient counterparts which also confirms the previous findings of Miah and Sharmeen (2015) on Bangladesh and nullify the bad management hypothesis in the banking industry of Bangladesh. Although, there is a positive relationship between human capital efficiency and risk, but the relationship is not significant. LTA, SIZE, RISK(-1) variables show significant and the same directional, relationship with risk in both inefficiency of cost and inefficiency of human capital model. But no significant association is observed with OBSTA and risk in either of the inefficiency models. Large banks are taking more risk than small banks as the coefficient of SIZE portrays the significant positive association. Total loans and advances to total assets (LTA) are inversely related to bank risk, thereby indicates that loan growth is connected to the growth of nonperforming loans. The lag dependent variable of both models depicts that risk is persistently followed from the one year to the next year. Taking all together, the result of risk equations suggest that banks with more capital take less risk; and efficient banks are taking more risk than the less efficient counterpart.

4.2. Examining the Relationship between Risk, And Efficiency on Capital Requirement

Table 4 presents the empirical results for equation 2 that examines the effect risk and inefficiency on bank capital. Banks with higher risks hold more capital as reflected by the positive sign of coefficient RISK in both models. This indicates that banks with more risk maintain more regulatory capital.

Table-4. Bank Capital (CAPITAL as dependent variable)

Variable	Cost inefficiency model	Human capital inefficiency model
RISK	0.108801***(3.01979)	0.145011***(3.34961)
INEFF$_C$	0.039518***(3.74652)	
INEFF $_{HC}$		-0.035656***(-3.79070)
LTD	0.028234***(3.32240)	0.015168*(1.91613)
RWATA	0.023045*(1.85951)	3.06E-02**(2.41047)
ROA	0.010088***(5.26479)	0.009594***(4.89062)
RD	0.075367(1.50460)	0.184767***(2.81816)
IRTA	0.413552***(4.64987)	0.595014***(4.22412)
CAPITAL(-1)	0.591395***(6.97245)	0.69509***(7.48863)
C	-0.070452***(-4.07842)	-0.05857***(-3.59666)
Adjusted R-squared	0.687221	0.633226
Hausman test, F(p-value)	75.05029(0.0000)	71.08173(0.0000)
Sercial correlation test (p-value)	0	0
Sargan test (p-value)	0.30806	0.64157
Panel Fixed/Random effect (p-value)	1	1
Observations	447	447
Number of banks	32	32

Notes: The table shows the empirical results from GMM panel estimator. Capital is dependent variable measured as ratio of total eligible capital to total assets; ***, ** and * indicate level of significance at 1%, 5% and 10% respectively. For Hausman test p-values are in parentheses. t-statistics are shown in parentheses.

Both inefficiency models show a significant relationship with Capital and inefficiency, but human capital inefficiency shows negative correlation whereas cost inefficiency shows a positive relationship with capital. This refers that personnel efficiency of higher capitalized banks is greater than that of lower capitalized counterparts. Again positive significant INEFF$_C$ variable dictates that small capitalized banks are more cost-efficient than their highly capitalized counterparts. This result is inverse to the other previous studies based on single country, for instance, Manlagnit (2015) based on Philippines, Pessarossi and Weill (2015) based on China, and Mbizi (2012) based on Zimbabwe and similar to the study of Maji and De (2015); Deelchand and Padgett (2009) among others. Positive relationship with LTD refers banks with high capital base, rendering large proportion of loan and advances through mobilizing deposit. The significant positive coefficient of ROA refers that highly capitalized banks are enjoying more profitability than small capital based banks. Positive sign of the coefficient of RWATA refers that with the increase of risk-weighted assets banks tend to enhance their level of capital as it is consistent with maintaining minimum capital requirements regulations of Basel accord. Relation with IRTA and RD with capital refers that capitalized banks are generating more revenue income both in regular (IRTA) and diversified (RD) form than undercapitalized banks. But RD found insignificant in cost efficiency model. The capital of last year has significant influence in maintaining the regulatory capital of current year shown by the coefficient of CAPITAL(-1).

4.3. Examining the Relationship between Risk and Capital Requirement on Efficiency of Cost

GMM estimators of Equation 3 presents in Table 5 where dependent variable of this equation is the inefficiency of cost derived from SFA. The positive and significant coefficient of CAPITAL implies that capitalized banks are not as cost efficient as undercapitalized banks. This is evidencing positive relationship between capital and cost inefficiency in bi-direction; and contrast with the findings of Manlagnit (2015); Pessarossi and Weill (2015) and Fiordelisi *et al.* (2011).

The coefficient of RISK shows the significant positive relationship with inefficiency of cost. It demonstrates that banks with more risk are more cost inefficient than bank having low risk. This result evidencing the positive association between risk and cost inefficiency of Zheng *et al.* (2017) on Asian Banks. Bad management hypothesis becomes evident in that case. Tax and LTA are not significantly relevant in measuring inefficiency of cost. SIZE refers that large banks are more cost-efficient than small banks in Bangladesh. Again positive relation with GOVS and cost inefficiency suggests that with more restriction on investing in government sectors reduces the cost

efficiency of banks. Cost inefficiency of the current year is also the result of previous year cost inefficiency that shows the coefficient of lag variable INEFF$_C$ (-1).

Table-5. Inefficiency of cost (INEFF$_C$ as dependent variable derived from SFA)

Variable	Coefficient
RISK	2.73E-03***(3.34209)
CAPITAL	5.61E-03***(3.42938)
Tax	2.65E-08(0.74210)
SIZE	-0.000545***(-5.82555)
LTA	0.000916(1.48561)
GOVS	2.09E-08***(9.38943)
INEFF$_c$(-1)	1.128183***(716.00020)
C	0.002787***(3.68154)
Adjusted R-squared	0.99995
Hausman test, F(p-value)	122.1441(0.0000)
Sercial correlation test (p-value)	0
Sargan test (p-value)	0.17123
Panel Fixed/Random effect (p-value)	1
Observations	447
Number of banks	32

Notes: The table shows the empirical result of GMM panel estimator. Inefficiency of cost is the dependent variable measured through SFA ;   ***, ** and * indicate level of significance at 1%, 5% and 10% respectively. For Hausman test p-values are in parentheses. t-statistics are shown in parentheses.

4.4. Examining the Relationship between Risk and Capital on Efficiency of Human Capital

Table 6 presents the results for inefficiency of human capital that has explained in equation 4. The dependent variable is inefficiency of human capital of banks (INEFF$_{HC}$) derived from SFA. The table reports that the coefficient of RISK is negative and significant, meaning that banks are taking more risk with efficient human capital. One possible reason for such behavior is that bank with more efficient human capital relies more on their human capital in monitoring and recovering loans. The regulatory capital of banks also shows a negative association with bank's inefficiency of human capital.

Table-6. Inefficiency of Human Capital (INEFFHC as dependent variable derived through SFA)

Variable	Coefficient
RISK	-0.002448***(-2.76248)
CAPITAL	-8.76E-03***(-5.31975)
ROA	5.71E-05***(6.45219)
DTA	-0.001467**(-2.39436)
LTA	4.18E-04(1.44842)
OBSTA	-4.34E-04***(-3.59802)
INEFF$_{HC}$(-1)	0.99882***(772.39950)
C	0.006235***(4.26876)
Adjusted R-squared	99.99
Hausman test, F(p-value)	62.07735(0.0000)
Sercial correlation test (p-value)	0.0000
Sargan test (p-value)	0.20097
Panel Fixed/Random effect (p-value)	1.00000
Observations	447
Number of banks	32

Notes: The table shows the empirical results of GMM panel estimator. Inefficiency of human capital is the dependent variable measures through SFA ; ***, ** and * indicate significance at 1%, 5% and 10% respectively. For Hausman test p-values are in parentheses. t-statistics are shown in parentheses.

In the context of Bangladeshi banking industry, the finding explains that capitalized banks are capable of holding more efficient human capital than low capitalized banks. Positive coefficient of ROA presents that human capital of less profitable banks acts more efficiently than more profitable banks. Bank level control variables deposit

to total asset ratio (DTA) shows significant negative relationship with human capital inefficiency. It means banks with efficient human capital are more able to mobilize deposit than inefficient counterparts. But loan and advances to total asset (LTA) ratio shows no significant relations with human capital efficiency. The coefficient of off-balance sheet exposure to total assets (OBSTA) negatively associated with inefficiency of human capital, explaining that banks with active involvement in non-traditional activities hold more efficient human capital. Like cost efficiency, efficiency of human capital of Bangladeshi banks also significantly depends on previous year efficiency levels. This result suggests that human capital efficiency of banks accelerate with time duration.

In Table 3, 4, 5 and 6 the Hausman test implies that the capital and inefficiency are endogenous variables in risk equation, risk and inefficiency are endogenous variables in the capital equation, and risk and capital are endogenous variables in inefficiency equations. The p-value of Sargan test shows insignificant in all tables which mean that the study has valid instruments in all models. From the p-value of serial correlation test, there is no sufficient evidence to reject the null hypothesis of no serial correlation. The adjusted value of R-square (the percentage of variations explain by independent variables) in RISK equation is 80.65 % (in cost inefficiency model) and 80.42% (in human capital efficiency model), in CAP equation is 68.72 % (in cost inefficiency model) and 63.32 % (in human capital efficiency model) and in $INEFF_C$ and $INEFF_{HC}$ models are 99.99 % and 99.99% respectively.

5. TEST OF ROBUSTNESS

Robustness checks to validate the empirical result of GMM estimators is also conducted. Table 7, 8 and 9 present the regression results in robust tests.

Table-7. Robust Check [LLPTL and Risk (NPLTL) use as dependent Variable in Cost inefficiency model and Human capital inefficiency model respectively.]

Variables	Cost inefficiency model	Human capital inefficiency model
CAPITAL	-0.16186**(-2.479675)	
$INEFF_C$	-0.04826**(-2.250904)	
ETA		-0.33765***(-3.85117)
$INEFF_{HC}$		-0.00356(-0.179135)
LTA	-0.03729***(-3.530773)	-0.07539***(-3.864307)
SIZE	0.00572**(2.378013)	0.00473**(1.970565)
OBSTA	-0.00424(-0.521901)	-0.02048**(-2.063895)
LLPTL(-1)	0.72059***(22.95894)	
RISK(-1)		0.70055***(30.35626)
C (Constant)	-0.01031(-0.575291)	0.04617(1.264913)
Adjusted R-squared	0.73106	0.81115
Hausman test, F(p-value)	31.80523(0.0000)	69.13767(0.0000)
Sercial correlation test (p-value)	0.0000	0.0000
Sargan test (p-value)	0.169435	0.111667
Panel Fixed/Random effect (p-value)	1.0000	1.0000
Observations	447	447
Number of banks	32	32

Notes: The table shows the empirical results of GMM panel estimator. LLPTL instead of Risk used as dependent variable in cost inefficiency model and ETA instead of capital used as independent variable in Human capital inefficiency model; ***, ** and * indicate significance at the 1%, 5% and 10% respectively. For Hausman test p-values are in parentheses. t-statistics are shown in parentheses.

Using LLPTL (loan loss provisions to total loans and advances) instead of risk in cost inefficiency model of risk equation and change one independent variable CAPITAL as ETA (equity to total assets) in Human capital inefficiency model robust check performed to compare the result of Table 3 and Table 7.

Table-8. Robust Check (ETA- Equity to TA , as dependent variable in both Inefficiency of cost and Inefficiency of human capital model)

Variable	Cost inefficiency model	Human capital inefficiency model
RISK	0.16506***(4.357589)	0.15495***(4.305143)
INEFF_C	0.05363***(5.260903)	
INEFF_HC		−0.05990***(−5.186554)
LTD	0.02860***(3.157804)	0.00660(0.696745)
RWATA	0.02356**(2.383364)	0.02454**(2.298504)
ROA	0.01094***(12.18578)	0.01099***(12.37097)
RD	0.15185***(2.844634)	0.32391***(4.424475)
IRTA	0.49268***(4.94927)	0.73714***(5.376611)
ETA(-1)	0.62141***(9.828922)	0.74280***(10.88618)
C	−0.09189***(−6.600933)	−0.05290***(−4.050669)
Adjusted R-squared	0.67185	0.62976
Hausman test, F(p-value)	71.43409(0.0000)	61.00475(0.0000)
Sercial correlation test (p-value)	0.0000	0.0000
Sargan test (p-value)	0.119066	0.50482
Panel Fixed/Random effect (p-value)	1.0000	1.0000
Observations	447	447
Number of banks	32	32

Notes: The table shows the empirical results of GMM panel estimator. ETA is used as dependent variable ; ***, ** and * indicate level of significance at 1%, 5% and 10% respectively. For Hausman test p-values are in parentheses. t-statistics are shown in parentheses

Again in the capital equation, ETA (Equity to total assets) used as dependent variable instead of CAPITAL (regulatory capital to total assets), whereas both in cost efficiency model and human capital efficiency model LLPTL (loan loss provision to total loan) is used instead of variable RISK to check robustness.

Table-9. Robust check (Inefficiency of cost and Inefficiency of human capital as dependent variable respectively in the models)

Variable	Cost inefficiency model	Variable	Human capital inefficiency model
LLPTL	0.00468***(2.618705)	LLPTL	−0.02146***(−3.584556)
CAPITAL	0.00388***(3.658963)	CAP	−0.01692***(−6.617731)
Tax	0.0000000282(0.817873)	ROA	0.00009***(2.870206)
SIZE	−0.00054***(−5.700679)	DTA	−0.00692***(−4.226737)
LTA	0.00029(0.505861)	LTA	0.00011(0.291016)
GOVS	1.89E-08***(10.27457)	OBSTA	−0.00026(−1.110402)
INF_COST(-1)	1.12801***(669.5219)	INF_HC(-1)	0.99759***(717.9573)
C	0.00334***(4.508728)	C	0.01276***(4.742005)
Adjusted R-squared	0.99995	Adjusted R-squared	0.99970
Hausman test, F(p-value)	109.9281(0.0000)	Hausman test, F(p-value)	41.01835(0.0000)
Sercial correlation test (p-value)	0.00000	Sercial correlation test (p-value)	0.0000
Sargan test (p-value)	0.254792	Sargan test (p-value)	0.963808
Panel Fixed/Random effect (p-value)	1.00000	Panel Fixed/Random effect (p-value)	1.00000
Observations	447	Observations	447
Number of banks	32	Number of banks	32

Notes: The table shows the empirical results from GMM panel estimator. Inefficiency of cost and Inefficiency of human capital are the dependent variable in cost inefficiency and human capital inefficiency model respectively. LLPTL (loan loss provision to total loan and advance considered as a measure of risk in both model; ***, ** and * indicate significance at the 1%, 5% and 10% respectively. For Hausman test p-values are in parentheses. t-statistics are shown in parentheses.

In robustness check, similar findings are observed and consistent with the baseline equations results. Only a few exceptions observed on the level of significance. Unfortunately, exception found on two independent variables OBSTA and RD. OBSTA found insignificant in baseline results of Risk equation with human capital inefficiency model, but it found significant in robust check. Again RD found insignificant in the capital equation with cost inefficiency model, but it found significant in robust result. Finally, OBSTA observed significantly in human capital

inefficiency equation model whereas finding insignificant in the robust test. Thus in delving the relationship between risk, capital and efficiency results are plausible considering few exception between the baseline results and robust test results.

6. CONCLUSION

This paper empirically analyses the relationship between capital, risk, and efficiency for the latest data set of Bangladeshi banks over the period 2000-2015. Our analysis conveys the ruling of the regulatory hypothesis that higher regulatory capital prevents banks to increase more lending risk and encourage banks to enhance capital during the lending crisis. Possibly it could happen if the banks have a preference for capital as the primary instrument for hedging against future financial risk. But it's quite challenging for the policymakers of banks to issuing new shares in the case of developing countries where market structure is complicated. Even their debt-taking capacities become less opportunistic than a developed financial market.

More interestingly, alike Altunbas *et al.* (2007) the inefficient banks appear to hold more capital and take on less risk. Also, higher efficiency of human lead to increase the capital level. Hence, human capital efficiency should be considered by the policymakers as an inevitable determinant of capital. The main contribution of this study provides a shed light the role of human capital efficiency in determining the bank risk and capital along with other important factors. That creates enthusiasm for the higher skilled labor force to tackling extra-risk and requirement of optimum capital.

One needs to be cautious, however, in comparing the results of developing country's studies that examine capital, risk and efficiency issues as this literature is still in its infancy. Further areas of research should seek to investigate the consistency of our findings applied to a more representative and contemporary sample of developed countries banks. The approach could also be expanded to examine the consistency of results by using alternative accounting and market-based indicators of banking risk, Basel implementation factors and more measures of efficiency.

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Appendix A: Determination of Cost and Human Capital Inefficiency Using Stochastic Frontier Analysis (SFA).

Our stochastic frontier analysis to calculate the efficiency of each bank is based on the stochastic frontier production methodology which was originated by Aigner *et al.* (1977). On this of production frontier model, the stochastic cost frontier model was developed (For details, see Kwan and Eisenbeis (1997); Schmidt and Knox (1979)). According to this methodology, due to inefficiency and random noise the observed cost of a bank is formulated to deviate from cost-efficient frontier (Deelchand and Padgett, 2009).

For the nth Bank,

$$Ln\ TC_n = f(ln\ Q_i, ln P_j) + \varepsilon_n \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (1)$$

Where, TC_n represents total operating cost including financial costs, Q_i indicates two outputs, i.e. Q_1=Loans and advances, Q_2= Other earning assets, Pj stands for three input prices, i.e. P_1= Price of labor which is the personnel expenses, P_2= Price of physical capital, which is non-interest expenses to fixed assets, P_3= Price of fund, which is ratio of total interest expenses to total deposit. ε_n shows the deviation of actual total cost of a bank from the cost-efficient frontier and it has two disturbance terms given as below:

$\varepsilon_n = V_n + U_n$

Where, V_n is the random error term and we assume that this is independent and identically distributed N $(0, \sigma_v^2)$. U_n represents cost inefficiency and assumed to be distributed independently of V_n and a half-normal distribution i.e. N $(0, \sigma_u^2)$.

By using intermediation approach (Sealey and Lindley, 1977) and by following (Deelchand and Padgett, 2009) we have developed the following multiproduct translog cost function to specify the cost function:

$$\text{Ln TC} = \alpha + \sum_i \alpha_i\, lnQ_i + \sum_j \beta_j\, lnP_j + \tfrac{1}{2}\sum_i\sum_k \gamma_{ik}\, lnQ_i lnQ_k + \tfrac{1}{2}\sum_j\sum_h \delta_{jh}\, lnP_j lnP_h + \sum_i\sum_j \lambda_{ij}\, lnQ_i lnP_j + \varepsilon \ldots\ldots\ldots\ldots (2)$$

According to the Jondrow *et al.* (1982) the expected value of U_n, on conditional ε_n, represents the cost-inefficiency of bank n (which is defined as C_n).

$$C_n = E\, U_n / \varepsilon_n = \left[\, \sigma\lambda / (1 + \lambda^2)\right]\left[\varphi(\varepsilon_n\lambda/\sigma)/\phi(\varepsilon_n\lambda/\sigma) + \varepsilon_n\lambda / \sigma\right] \ldots\ldots\ldots\ldots (3)$$

Where λ is the ratio of the standard deviation of U_n to standard deviation of V_n, φ is the cumulative standard normal density function, and ϕ is the standard normal density function. C_n can be estimated by using equation (3).

We also use the alternative Human Capital inefficiency specification, where the dependent variable is the HC_n =Human capital (no. of employees) of all banks in the sample. Q_i indicates two outputs, i.e., Q_1=Loans and advances, Q_2= other earning assets, P_j stands for three input prices, i.e., P_1= Price of labor which is the personnel expenses, P_2= Price of operations, which is other operating expenses, P_3= Price of risk-taking, which is the amount of non-performing loans. The composite error term is now defined as $V_n - U_n$. The general procedure for estimating production inefficiency in equation (3) is to estimate coefficients and the error term $\varepsilon_n = V_n - U_n$ first, and then calculate the efficiency for each observation in the sample. We just alter the error term to $V_n - U_n$ from $V_n + U_n$ to use the equation as production function (Coelli, 1996). And here Un represents human capital inefficiency and assumed to be distributed independently of Vn and a half-normal distribution i.e., N (0,). We use computer software called Frontier Version 4.1 developed by, Coelli (1996) for Stochastic Frontier Production and Cost function estimated by the method of maximum likelihood.

Appendix-B. Pearson's Correlation Coefficients between the variables

	Risk	Capital	INEFF$_C$	INEFF$_{HC}$	Size	OBSTA	LTA	ROA	RWATA	RD	GOVS	LTD	Tax	IRTA	DTA
Risk	1														
Capital	-.540***	1													
INEFF$_C$	.096**	0.036	1												
INEFF$_{HC}$	-.497***	.438***	-0.044	1											
Size	.079*	.207***	.742***	-0.078	1										
OBSTA	-.165***	.099**	-.144***	.302***	-.184***	1									
LTA	-.493***	.366***	-.366***	.298***	-.107**	.211***	1								
ROA	-.395***	.471***	-.262***	.234***	-.269***	.140***	.222***	1							
RWATA	-.481***	.626***	.139***	.420***	.322***	.154***	.471***	.213***	1						
RD	-0.047	.203***	.119**	0.039	0.078	.196***	-.080*	.218***	.216***	1					
GOVS	.291***	-.097**	.722***	-.230***	.613***	-.170***	-.490***	-.226***	-0.072	.117**	1				
LTD	-.362***	.439***	-.337***	.277***	-0.03	.175***	.829***	.206***	.417***	0.033	-.407***	1			
Tax	-.224***	.364***	.339***	-0.06	.621***	-0.067	.177***	0.02	.349***	0.051	.147***	.198***	1		
IRTA	-.688***	.477***	-.260***	.557***	-.147***	0.066	.570***	.293***	.399***	-.096**	-.430***	.432***	.134***	1	
DTA	-.152***	-.260***	-0.013	-0.037	-.158***	0.031	.101**	0	-0.046	-.194***	-0.07	-.455***	-.114**	.120**	1

***, **, *. Pearson's Correlation is significant at 1%, 5% and 10% respectively