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EFFECT OF HUMAN CAPITAL EFFICIENCY ON BANK RISK-TAKING BEHAVIOR AND CAPITAL REGULATION: EMPIRICAL EVIDENCE FROM A DEVELOPING COUNTRY

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ABSTRACT

Adopting a new dimension of efficiency named human capital efficiency this study investigates the effect of efficiency on bank risk-taking and capital regulation. Applying production function of stochastic frontier analysis (SFA), we assess the human capital efficiency and examine the effect and reverse effect on risk and regulatory capital of commercial banks of a sample developing country of Asia over the period of 2000-2014. Our empirical results of the generalized method of moments (GMM) estimator identify the significant positive relationship between risk-taking and human capital efficiency of commercial banks. But no significant association found between capital and human capital efficiency. Again we observe the significant impact of risk and capital in the determination of the human capital efficiency of banks of the sample country.

Contribution/ Originality: This study applied production frontier of stochastic frontier analysis (SFA) as a new estimation methodology to determine human capital efficiency in the examination of effect and reverse effect over risk-taking and capital on sample developing country Bangladesh.

1. INTRODUCTION

Commercial banks, the significant part of the financial system, are playing a vital role in the mobilization of funds from surplus to deficit units and in achieving economic prosperity of a country. However, increasing numbers of banks enhance economic growth in one hand and raise intense competition among banks on the contrary. Thus efficiency becomes the relevant consideration in a competitive market. Switching job from one bank to another bank becomes a common phenomenon in the banking industry. This is because of employees of one bank get a better offer from other bank/s and employers offer more because of the perceived efficiency of the employee/s. So the importance of human capital efficiency that prevails in banking industry needs to uncover and examine. Now questions are: why management is more intended to hire productive employees from other banks? Does efficient human capital have a significant impact on managing bank risk and capital? This paper designed to address these questions and contribute to literature through discovering new facts and evidence about the human capital efficiency of the banking industry of Bangladesh.

Global issue of banking also hits in Asia (Sun and Chang, 2011) and as an Asian country, Bangladesh is no exception. The Government of Bangladesh formed four nationalized commercial banks through merging commercial banks that were in operation after liberation in 1971. Although private commercial banks were also allowed to operate after 1975 with economic reform policy of Government, indeed banking in private sector started operations in 1982. Banking industry of Bangladesh now composed of 56 banks (till December'2015)[1]. After commencement of operations increasing numbers of commercial banks enlarge banking sector in one hand and create an intensely competitive environment on the other side. Increased competition also influences banks to take more risk to keep in competition. Again escalations of risk draw the attention to the regulators who try to balance risk-taking behavior through enforcing capital requirements of banks (Altunbas *et al.*, 2007). With increasing number of banks, it is become increasingly difficult to ignore the interrelationship between human capital efficiency, risk, and capital. Non-compliance with regulations has drawn the attention of the government and regulatory authority to strict the banking regulation in Bangladesh (Bangladesh-Bank, 2012-2013). So with the passage of time, it becomes crucial 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). Human capitals are the task force of banking industry. So, it's time demand to explore how human capital efficiency effects in the risk-taking behavior of banks and capital regulation.

The study contributes to the literature in multiple ways. Firstly; this study makes a significant contribution to research by exploring the human capital efficiency in efficiency measurement using SFA. Secondly; empirical evidence of the study shows the significant effect of human capital efficiency in bank risk-taking behavior. And finally, taking into account of human capital efficiency this study examines the effect and reverse effect of efficiency on risk and capital of banks of a sample developing country Bangladesh over recent financial data.

The rest of the study organized in few sections. Review of relevant literature and development of hypotheses of the study are explained in section 2, and Section 3 illustrates the model describing the relationship between risk, capital, and efficiency. Section 4 presents the data and variables, Section 5 explores the empirical results, section 6 shows the test of robustness, and finally, Section 7 summarizes and presents conclusion part of the study.

2. LITERATURE REVIEW AND DEVELOPMENT OF HYPOTHESIS

Unending and counterfactual debates still going on 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, the relevant literature of the survey has been divided into two parts: (1) Literature regarding the relationship between efficiency and risk and (2) Literature relating to the relationship between efficiency and capital regulation. Since no previous study addresses human capital efficiency on risk-taking, in this section, we mention some literature about the relationship between overall efficiency and risk, and the relationship between overall efficiency and capital.

2.1. The Relationship Between Efficiency and Risk

The general expectation between risk and efficiency is that with the increase of efficiency, the risk will be managed substantially. So, a negative relationship is expected to observe in the study, but diversified finding observed in the different literature regarding this. Literature like- Berger and Deyoung (1997); Kwan and Eisenbeis (1997); Deelchand and Padgett (2010); Fiordelisi *et al.* (2011); Miah and Sharmeen (2015) and Nguyen and Nghiem (2015) among others spectacle negative relationship between efficiency and risk. Berger and Deyoung (1997)

[1] see Annual Report Bangladesh Bank 2014-2015

mention efficiency as an essential indicator of non-performing loans and their finding depicts that high cost of monitoring and recovery management reduce the cost efficiency of banks. Kwan and Eisenbeis (1997); Deelchand and Padgett (2010) support the moral hazard hypothesis[2] against the negative relationship between efficiency and risk. Again supporting bad management hypothesis, Fiordelisi *et al.* (2011) opine that banks' risk is subject to the low efficiency of cost and revenue. Investigating on Indian banks, Nguyen and Nghiem (2015) pinpoint the technological advancement behind the cost efficiency of banks.

Whereas positive relationship also observes in the study of Tan and Floros (2013) on China, Isshaq *et al.* (2012) on Ghana. Technical efficiency of banks increase the volume of the loan in banks in one hand but reduce monitoring and screening of loans that in turn increase risk on the contrary (Tan and Floros, 2013). Supporting market competition in increasing efficiency, Isshaq *et al.* (2012) opine that risk-taking and cost efficiency of foreign banks go side by side.

Again, Altunbas *et al.* (2007) opine that there is no significant relationship between inefficiency and risk-taking behavior of commercial banks. To survey the relationship, the relevant hypotheses of the study are:

H_1: There is a significant effect of efficiency on bank risk-taking.

H2: There is a significant effect of bank risk-taking on efficiency.

2.2. The Relationship between Efficiency and Capital Requirement

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 correlation between efficiency and level of capital are Zheng *et al.* (2017); Manlagnit (2015); Pessarossi and Weill (2015); Fiordelisi *et al.* (2011); Chiu *et al.* (2008); Girardone *et al.* (2004); Kwan and Eisenbeis (1997); Lee and Hsieh (2013); Naceur and Omran (2011); Rao (2005); Kwan and Eisenbeis (1997) among others.

Behind the reason of positive association, most of the literature mention cost efficiency and operational efficiency of capitalized banks. Kwan and Eisenbeis (1997) opine that capitalized banks are more cost-efficient than low capitalized banks referring capital as a striking force of operational efficiency. They also prescribe capital as an extenuating risk tool for the regulators and can be used to restrain inefficient bank from taking riskier investment. Supporting cost efficiency (Manlagnit, 2015) also addresses better risk management of capitalized banks. Adjusting agency cost between shareholders and debt holder and strengthening capital buffer, healthy capitalized banks can earn more cost efficiency in banking (Pessarossi and Weill, 2015). On the contrary, some studies report the negative relation between efficiency and capital. For example, Miah and Sharmeen (2015); Deelchand and Padgett (2009); Altunbas *et al.* (2007) among others. Supporting regulatory hypothesis Miah and Sharmeen (2015) opine that regulators may allow operations of more efficient banks with a lower level of capital. Deelchand and Padgett (2009) pinpoint deposit insurance as a motivating factor of taking more risk of inefficient banks.

Again from the empirical study on Chinese banks, Lee and Chih (2013) show a significant impact of capital on the efficiency of large and small banks. But some literature like, Guidara *et al.* (2013) and Zhang *et al.* (2008) reject the significant relationship between capital and efficiency. Guidara *et al.* (2013) opine that capital buffer or maintaining an excess of capital over minimum requirement is the outcome of market discipline and no substantial evidence shows an association of efficiency on profitability and a capital buffer of banks. To investigate the effect of human capital efficiency in the regulatory capital the relevant hypotheses are:

H3: There is a significant impact of efficiency on regulatory capital.

H4: There is a significant impact of regulatory capital on bank efficiency.

[2] Moral hazard hypothesis holds that low capital ratio induces banks to take more risky project resulting increased credit risk in future.

3. METHODOLOGY (MODEL SPECIFICATION)

This study explores the human capital efficiency by adopting the production function of SFA[3]. Taking 'number of employees' as human capital and dependent variable and considering two outputs- loan and advance, other earning assets and three of inputs-price of labor, the price of physical capital and price of the fund, we measure the inefficiency of human capital through SFA. Based on production function of SFA developed by Aigner *et al.* (1977) human capital inefficiency function form as, ln HCn = f (ln Qi, lnPj) + εn. Employees work in banks assume to have banking knowledge and education of banking. And persons who have banking knowledge and ability to apply the knowledge in banking operations treated as human capital for banks. Different literature also addresses educated working force as human capital. For example, Benhabib and Spiegel (1994); Chi (2008); Hakeem and Oluitan (2012); Nik *et al.* (2013) among others refer educated workforce as human capital whereas Gregorio (1996) addresses working generation as human capital. Thus productivity in generating banking assets using relative cost treated as their efficiency in banking. Since in banking industry of Bangladesh, promotion of bankers also tagged with the capacity of mobilizing banking assets (asset mobilization like loan and advances, credit card sales, etc. and liability mobilization like increasing number of deposit accounts), thus treating efficiency of employees by their productivity of generating banking assets is justified. Details of estimation are explained in Appendix A. SFA also used widely in measuring inefficiency in previous studies- Altunbas *et al.* (2007); Altunbas *et al.* (2001); Kwan and Eisenbeis (1997); Girardone *et al.* (2004); Bonin *et al.* (2005) and others. We also opted for simultaneous equations as used by Maji and De (2015); Tan and Floros (2013); Altunbas *et al.* (2007); Deelchand and Padgett (2009); Fiordelisi *et al.* (2011) to examine the effect and reverse effect of human capital efficiency on risk-taking and capital regulation. Since we observe the presence of endogeneity, heteroscedasticity and serial correlations in the sample data of the model, so we apply GMM system panel estimator developed by Arellano and Bover (1995) and Blundell and Bond (2000) to get the best fit result.

The empirical model of the study is as follows:

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 ROA_{i,t} + \sum_{m=3,5,8}^{4,7,10} \beta_m X_{i,m,t} + \varepsilon_{i,t}$$

We avoid the macro the economic variables due to similar effect on all banks as the study based on single country exposure. Regression equations of the model are run separately for risk, capital and inefficiency. The endogenous variable $Y_{i,t}$ represent (1) Non-performing loans to total loan ratio (NPLTL) is used as a proxy for banking risk and main measure of risk and loan loss provision to total loans ratio (LLPTL) is used an alternative measure of risk. (2) Capital-ratio of total eligible capital to total assets is used as a proxy for bank capital regulation, and equity to total assets (ETA) used as an alternative measure of capital. (3) The inefficiency of human capital ($INEFF_{HC}$) is the primary measure of inefficiency and inefficiency of cost ($INEFF_c$) is the alternative measure used in robust check. In the model subscript 'i' denotes the cross-sectional dimension across banks and *t* refers the time dimension in a year (2000……..2014). β refers the parameters of the series to be estimated, and ε_{it} is the error term. One year lagged dependent variable represented by $Y_{i,t-1}$. The $X_{i,m,t}$ present the banks level control variables other than ROA of bank *i* at *t* period. For risk equation *m* = 3 to 4 for each bank *i* at *t* period. Bank level control variables of risk equation are loan to total assets (LTA), and Size. Where deposit to the total asset (DTA), revenue diversification (RD), risk-weighted assets to total assets (RWATA) used as banks' control variables of capital equation denotes by *m* = 5 to 7

[3]See Appendix A for details of estimation of SFA for determining Human capital efficiency.

of bank i at *t* period. Similarly subscript *m* = 8 to 10 refers the bank control variable age of banks (AGE), total liabilities to total asset (Leverage) and off-balance sheet exposure to total assets (OBSTA) of equation inefficiency.

Table-1. Description of variables used in the study

Variables	Acronym	Definition	Variables also used in explaining the relationship between/among risk, capital and efficiency (some references).
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 Hsieh (2013); Tan and Floros (2013); Altunbas *et al.* (2007); Iannotta *et al.* (2007); Sufian and Habibullah (2009); Kwan and Eisenbeis (1997); Hinson and Amidu (2006); Dietrich and Wanzenried (2011); Athanasoglou *et al.* (2008); Sufian (2012).
Inefficiency	INEFF	Inefficiency measured through SFA	Altunbas *et al.* (2007); Altunbas *et al.* (2001); Deelchand and Padgett (2009); Tan and Floros (2013).
Liquidity	LTA	Total loans and advances to total assets	Bougatef and Mgadmi (2016); Tan and Floros (2013); Lee and Hsieh (2013); Altunbas *et al.* (2007); Iannotta *et al.* (2007); Hinson and Amidu (2006)
Size	Size	Logarithm of total assets	Bougatef and Mgadmi (2016); Chaibi and Ftiti (2015); Athanasoglou *et al.* (2008); Deelchand and Padgett (2009).
Non-traditional activity	OBSTA	Total off-balance sheet exposure to total assets	Tan and Floros (2013); Mongid *et al.* (2012); Deelchand and Padgett (2009).
Profitability	ROA	Return on assets	Bougatef and Mgadmi (2016); Kwan and Eisenbeis (1997).
Non-interest income ratio	RD	Non-interest income to total assets	Chaibi and Ftiti (2015)
Ratio of risk-weighted assets	RWATA	Total risk-weighted assets to total assets	Zhang *et al.* (2008)
Ratio of Deposit	DTA	Deposit to total assets	Soedarmono *et al.* (2011)
Leverage	Leverage	Total liability to total assets	Chaibi and Ftiti (2015); Jacques and Nigro (1997)
Experience of banks	Age	No. of years from commencement of operations	Dietrich and Wanzenried (2011)

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

Table-2. Descriptive statistics of all variables (all figures are in BDT. Million except ratios)

	Minimum	Maximum	Mean	Std. Deviation
Risk	0.0000	0.4459	0.0736	0.0838
Capital	-0.1303	0.1478	0.0762	0.0302
INEFF	0.0896	0.8991	0.7489	0.1598
Size	8.5707	13.7486	11.0405	1.0180
OBSTA	0.0000	0.6751	0.3045	0.1168
RD	0.0034	0.1011	0.0292	0.0106
LTA	0.0744	0.8375	0.6590	0.0871
Leverage	0.0464	1.1294	0.9267	0.0686
DTA	0.4600	0.9354	0.8114	0.0560
Age	2.0000	43.0000	16.9783	9.7647
RWATA	0.0000	1.2726	0.6768	0.2257
ROA %	-13.5200	6.0500	1.4103	1.3399

Source: Authors' calculation by using SPSS-20

4. DATA AND VARIABLE DESCRIPTION

According to the annual report of Bangladesh Bank (2014-2015) at the end of 2015 banking industry of Bangladesh consists of 56 banks. Although initially all commercial banks were targeted to cover in the study, due to nonavailability of data and missing information of required variables, finally 32 commercial banks have been taken into consideration for the subject study. The scope of the research covers from the year 2000 to 2014 and all selected banks are listed under DSE[4] except all public commercial banks. In choosing sample data, we consider at least five years continuous data for the reliability of relationship drafting. In total, the study covers 28 private commercial banks and four state-owned commercial banks of Bangladesh. To avoid outlier effect, we exclude one commercial bank's information (ICB Commercial Bank). We adopt unbalanced panel data not to lose degrees of freedom. All information collected from audited annual reports and source of annual reports is DSE library, and some information gathered from banks scope database (www.bvdinfo.com) and individual bank's web page, especially data that were not available in DSE library.

Table 1 represents the detail of variables used in the study and Table 2 presents the descriptive statistics of all variables. The mean of Risk (NPLTL-Nonperforming loans to total loans and advances) is 7.36% which refers that risk of banks in Bangladesh yet to improve. Again the mean of capital (Total eligible capital to total assets) is about 7.62%, but minimum value is negative in the studied period. That means sample bank/banks failed to maintain minimum capital requirements over the studied period. Average value of inefficiency is about 0.7489. The standard deviation of human capital inefficiency is 0.1598. Maximum and minimum values of inefficiency are 0.8991 and 0.0896 respectively. Although, the minimum value of inefficiency is quite satisfactory but maximum and mean value of inefficiency still need to improve to a large extent.

Among the independent variables, no correlation value[5] shows above 0.70 except Age and Size. Since these two independent variables do not use in the same equation, so our models are free from significant multicollinearity problem.

5. EMPIRICAL RESULTS

The estimated results from GMM estimator of the model present in Table 3-5.

5.1. Examining the Effect of Efficiency on Risk

Table 3 reports the summarized results for the estimation of risk equation using GMM for the year 2000-2014. Nonperforming loans to total loan used to measure risk as the dependent variable.

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

[5] See Appendix C (Pearson's Correlation Coefficients between the variables)

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

Variable	Coefficient (t-statistic)
Capital	0.405*(1.913)
$INEF_{HC}$	-0.089***(-2.681)
LTA	-0.157***(-4.913)
SIZE	-0.009**(-2.087)
ROA	-0.012***(-3.625)
RISK(-1)	0.634***(15.366)
Constant	0.286***(3.80)
Adjusted R-squared	0.797
Hausman test, F(p-value)	67.273(0.000)
Serial correlation LM test (p-value)	0.000
Serial correlation LM test (t-value), RESID(-1)	14.164***(0.000)
Serial correlation LM test (t-value), RESID(-2)	-0.130(0.897)
Sargan test (p-value)	0.372
Panel Fixed/Random effect (p-value)	1.00
Observations	415
Number of banks	32

Notes: The table shows the empirical results from GMM panel estimator. The risk is dependent variable measured as the ratio of NPLTL; ***, **, and * indicate significance at the 1%, 5%, and 10% respectively. For Hausman test and serial correlation, LM-test p-values are in parentheses. T-Statistics are shown in parentheses.

In Table 3, we see that coefficient of inefficiency is significant and adverse. It refers that with the increase of efficiency of employees' nonperforming loan ratio to total loan increases. On the other way, it expounds that banks with less efficient human capital are taking less risk and have a low ratio of non-performing loans. But more significant risk-taking behavior also dictates banks expectation of improved risk management. Thus it supports the hypothesis that human capital efficiency significantly affects the risk-taking behavior of banks. This result also confirms the previous study of Tan and Floros (2013) on China and Isshaq *et al.* (2012) on Ghana shows a positive association between risk and bank efficiency.

The coefficient of Capital is significant and positively related to risk. It refers that more capitalized banks are taking more risk than low capitalized banks in Bangladesh. This result also supports previous studies showed positive relations between risk and capital. For example, the finding of Ghosh (2014); Ahmad *et al.* (2009); Altunbas *et al.* (2007); Lin *et al.* (2005); Blum (1999) and Shrieves and Dahl (1992) among others.

In the explanation of control variables, we see in the table that LTA, SIZE and ROA have a significant negative association with risk and risk is persistently followed from the one year to the next year.

5.2. Examining the Effect of Efficiency on Capital

Table 4 presents the empirical results for Equation capital, examines the effect of risk and inefficiency of human capital on banks' capital. The coefficient of inefficiency shows no significant relationship with capital. It means that human capital efficiency does not have any significant impact on the regulatory capital of banks. The result is somehow logical as regulatory capital is the compliance issue of banks and employees productivity are not related to the regulations of banks and compliance issue.

The empirical results also show that there is a negative and significant relationship between risk (NPLTL) and capital, which implies that banks with lower risk hold more capital than highly risk-taking banks. Similar findings of negative association between risk and capital found in the study of 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 (2009); Zhang *et al.* (2008); Agusman *et al.* (2008); Iwatsubo (2007); Jacques and Nigro (1997) and Karels *et al.* (1989).

Table-4. Bank capital (Capital as dependent variable- a ratio of total eligible capital to TA)

Variable	Coefficient
RISK	-0.100**(-2.34)
$INEFF_{HC}$	-1.80E-02(-1.161)
ROA	0.0067***(4.638)
RWATA	0.0185(1.638)
RD	0.041(0.569)
DTA	-0.104***(-3.654)
Capital(-1)	0.528***(6.139)
Constant	0.120***(3.827)
Adjusted R-squared	0.747
Hausman test, F(p-value)	79.780(0.000)
Serial correlation LM test (p-value)	0.000
Serial correlation LM test (t-value), RESID(-1)	10.767***(0.000)
Serial correlation LM test (t-value), RESID(-2)	0.0974(0.923)
Sargan test (p-value)	0.119
Panel Fixed/Random effect (p-value)	1.000
Observations	415
Number of banks	32

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

We see there is a significant positive relationship between ROA and capital, such that banks with a high level of profitability ratio also tend to operate with a high level of capital. Banks are rarely tried to increase their level of capital for enhancing profitability as capital is the costly source of financing. Rather the finding refers the positive effect capital over the profitability of banks. Significant negative relation of DTA with capital refers that bank with a low amount of deposit ratio to asset holding more capital than those banks with high deposit ratio. This finding dictates that banks with the efficient mobilization of deposit to assets have less tension and dependence on regulatory capital. The coefficient of Capital (-1) depicts that capital of last year positively affect capital of present year. RWATA and RD have found no significant impact on capital.

5.3. Examining the Effect of Risk and Capital on Efficiency

Table 5 presents the results of the inefficiency of human capital. The dependent variable is the inefficiency of human capital of banks (INEFF) derived from SFA. The coefficient of RISK is negative and significant, meaning that banks are taking more risk with efficient human capital. Differently, it can be said that with the increase of risk of banks the productivity of employees enhances. A possible reason for such behavior may be with more efficient human capital banks rely more on their employees in monitoring and recovering loans. Regulatory capital (Capital) of banks also show a negative association with banks' inefficiency of human capital.

In the context of Bangladeshi banking industry, the finding explains that more capitalized banks are capable of holding more efficient human capital than low capitalized banks. Again employees productivity (Human capital efficiency) act a decisive role in risk-taking of banks. Positive coefficient of ROA presents that productivity of employees of less profitable banks is greater than the profitable counterparts. The coefficient off-balance sheet exposure to total assets (OBSTA) is negatively related to the inefficiency of human capital. It explains that banks with active involvement in non-traditional activities hold more efficient human capital. From coefficient of AGE, we can say that old banks are holding more efficient human capital than new banks in the industry. The relationship depicts that experience in the banking industry acts the positive role in employees productivity of banks. The efficiency of human capital of Bangladeshi banks also significantly depends on previous years' efficiency levels. Leverage has found no significant impact on the efficiency of human capital.

Table-5. Inefficiency of Human Capital ($Ineff_{HC}$ as dependent variable derived from SFA)

Variable	Coefficient
RISK	-0.001***(-3.371)
Capital	-2.14E-03***(-3.460)
ROA	1.82E-05**(2.525)
LEVERAGE	3.06E-05(0.689)
OBSTA	-1.86E-04**(-2.567)
AGE	-6.90E-06**(-2.188)
$INEFF_{HC}$(-1)	0.9998***(1780.751)
Constant	0.003***(8.652)
Adjusted R-squared	0.999
Hausman test, F(p-value)	78.453(0.000)
Serial correlation LM test (p-value)	0.000
Serial correlation LM test (t-value), RESID(-1)	16.603***(0.000)
Serial correlation LM test (t-value), RESID(-2)	0.736(0.462)
Sargan test (p-value)	0.544
Panel Fixed/Random effect (p-value)	1.000
Observations	415
Number of banks	32

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

In Table 3-5, the Hausman test implies that the capital and inefficiency are endogenous variables in risk equation, risk and efficiency 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 we have valid instruments in all models. From the p-value of serial correlation test, we do not have 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 79.72 %, in Capital equation is 74.68 % and in INEFF equation is 99.99% respectively.

6. TEST OF ROBUSTNESS

We conduct robustness checks to validate the empirical result of GMM estimators. In Table 6 we perform GMM estimator using ETA (Equity to total assets) instead of Capital as independent variable in risk equation

Table-6. Equation Risk

Variable	Coefficient (t-statistics)
ETA	0.349*(1.657)
$INEFF_{HC}$	-0.075**(-2.565)
LTA	-0.138***(-5.183)
SIZE	-0.008*(-1.874)
ROA	-0.013***(-3.926)
RISK(-1)	0.644***(16.596)
Constant	0.257***(3.889)
Adjusted R-squared	0.7996
Hausman test, F(p-value)	72.164(0.000)
Serial correlation LM test (p-value)	0.000
Serial correlation LM test (t-value), RESID(-1)	14.241***(0.000)
Serial correlation LM test (t-value), RESID(-2)	-0.0254(.980)
Sargan test (p-value)	0.296
Panel Fixed/Random effect (p-value)	1.000
Observations	415
Number of banks	32

Notes: The table shows the empirical results from GMM panel estimator. The risk is dependent variable measured as the ratio of NPLTL. ETA is used as an alternative measure of capital. ***, **, and * indicate significance at the 1%, 5%, and 10% respectively. For Hausman test and serial correlation, LM-test p-values are in parentheses. T-Statistics are shown in parentheses.

Both models show the similar results and consistent with Table 3 in association with the relationships between dependent and independent variables. In the level of significance of all variables, we also find similarities, but size is considered significant in baseline model at 5% level whereas in the robust model it is found at 10% level of significance.

Table-7. Equation Capital

Variable	Coefficient
RISK	-0.081***(-3.078)
$INEFF_C$	0.0287***(2.828)
ROA	0.008***(4.999)
RWATA	0.0181*(1.699)
RD	-0.008(-0.130)
DTA	-0.114***(-3.850)
Capital(-1)	0.486***(5.436)
C (Constant)	0.111***(3.827)
Adjusted R-squared	0.750
Hausman test, F(p-value)	89.244(0.000)
Serial correlation LM test (p-value)	0.000
Serial correlation LM test (t-value), RESID(-1)	10.714***(0.000)
Serial correlation LM test (t-value), RESID(-2)	0.073(0.9421)
Sargan test (p-value)	0.297
Panel Fixed/Random effect (p-value)	1.000
Observations	415
Number of banks	32

Notes: The table shows the empirical results from GMM panel estimator. Capital is the dependent variable measured as the ratio of total eligible capital to total assets. The inefficiency of Cost ($INEFF_C$) measured through SFA is used as an alternative measure of efficiency (Inefficiency of human capital). ***, **, and * indicate significance at the 1%, 5%, and 10% respectively. For Hausman test and serial correlation, LM-test p-values are in parentheses. T-Statistics are shown in parentheses.

We conduct robustness check of the capital equation by changing inefficiency of human capital as the inefficiency of cost (Inefficiency of cost derived from SFA[6] using cost function). Table 7 presents the robustness test of Equation capital. This table also shows the consistent result with Table 4 holding few exceptions. RWATA report as insignificant in Table 4 but found significant in Table 7 at 10% level of significance. Again inefficiency of human capital is negatively related to capital, and insignificant is baseline model. But inefficiency of the cost is found significant and positively related to capital.

Table-8. Equation inefficiency

Variable	Coefficient
RISK	-0.0004***(-2.658)
ETA	-2.68E-03***(-3.091)
ROA	2.90E-05**(2.444)
LEVERAGE	-7.22E-05(-0.708)
OBSTA	-1.76E-04**(-2.33)
AGE	-0.000008*(-1.750)
$INEFF_{HC}$(-1)	1.001***(900.960)
Constant)	0.003***(3.306)
Adjusted R-squared	0.999
Hausman test, F(p-value)	77.815(0.000)
Serial correlation LM test (p-value)	0.000
Serial correlation LM test (t-value), RESID(-1)	16.514***(0.000)
Serial correlation LM test (t-value), RESID(-2)	0.805(0.422)
Sargan test (p-value)	0.635
Panel Fixed/Random effect (p-value)	1.000
Observations	415
Number of banks	32

Notes: The table shows the empirical results from GMM panel estimator. The inefficiency of human capital is the dependent variable measures through SFA.ETA is used as an alternative measure of capital. ***, **, and * indicate significance at the 1%, 5%, and 10% respectively. For Hausman test and serial correlation, LM-test p-values are in parentheses. T-Statistics are shown in parentheses.

[6] See Appendix B for details of estimation of SFA for cost efficiency

As the assumption and measurement techniques of human capital efficiency (use production function of SFA) and cost efficiency (use cost function of SFA) are different, so the inverse directional relationship is justified. Although RD is observed insignificant in both model, unfortunately, it is positively related in baseline result whereas inversely related to the robust test.

We check the robustness of the model inefficiency equation by taking ETA (equity to total assets) instead of Capital as a proxy measure of regulatory capital. In inefficiency equation, we found similar results in table 5 and table 8 except the level of significance of variable AGE. In Table 5 AGE is found significant at 5% level whereas it is significant at 10% level in Table 8.

Regarding dependent variables and control variables of risk, capital and inefficiency we find the similar result in the same direction except for very few exceptions. So in robustness test, we see similar patterns of results as derived from the original model considering few exceptions.

7. CONCLUSION

We delve the effect of human capital efficiency on risk-taking and capital adequacy of banks for a sample developing country-Bangladesh. Using simultaneous equation modeling, we examine the effect of efficiency through examining the relationship between human capital efficiency, risk and capital. Risk, capital and human capital efficiency are modeled as dependent variables. In this study, we find human capital efficiency has a positive effect on bank risk-taking. And in capital concern, capitalized banks are holding more efficient human capital than low capitalized banks. With the increase of human capital efficiency, risk-taking behavior of banks increases. A possible reason for such behavior may be more reliability on the efficient workforce, sufficient loan monitoring, and recovery initiative, etc. That means with efficient human capital banks' risk-taking tendency increases due to banks expectation of improved risk management and employees' productivity. Thus in the risk-taking behavior of banks, efficient human capital plays a significant positive role. In inefficiency equation, we find that healthy capitalized banks are more capable of enhancing the productivity of human capital than the low capitalized counterpart. This finding also confirms a positive relationship between capital and efficiency of a previous study of Fiordelisi *et al.* (2011) on European banks. Again old banks show more productivity of employees than comparatively new entrances in the industry. Thus empirical evidence of the study validate the hypothesis, human capital efficiency has a significant impact on bank risk-taking behavior and pinpoint one of the possible reasons for the high demand of hiring efficient employees in the banking industry. Like previous findings of the literature, we have found a significant effect of cost efficiency on regulatory capital on the robust check, but we don't find any significant impact of human capital efficiency on capital requirements of banks.

The empirical results also show that there is a negative and significant relationship between capital and risk, which implies that banks with lower risk, holding more capital than highly risk-taking banks. But with the increase of regulatory capital risk-taking tendency of banks also increases observed in the examination of the reverse effect of capital on risk.

The findings of the study provide a new understanding of the role of human capital efficiency in examining the relationship between risk, capital, and efficiency of banks. Since banks are the lenders of lending money so confirming the efficiency of human capital is a necessary concern in risk-taking behavior. Again since human capital efficiency affects the risk-taking behavior of banks and capital also have significant impact on efficiency of human capital, so more study required for further evidence in developed and other developing countries to contribute to the literature.

Finally, further study could be done covering all banks including specialized banks and foreign commercial banks to delve the effect of human capital on risk and capital in Bangladeshi banks and other commercial banks of Asia. Scope the study can also be extended through covering non-bank financial institutions to explore the

relationship and adopting new inputs and output in the measurement of employees' productivity through SFA and other efficiency measures.

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Appendix A: Stochastic Frontier Analysis (SFA) for determining Human capital efficiency

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). For the nth Bank,

$$\ln HC_n = f(\ln Q_i, \ln P_j) + \varepsilon_n \quad \ldots\ldots (1)$$

Where HC_n represents a total number of human capital. That is total number of employees of bank$_n$, 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 physical capital which is the ratio of other non-interest expenditure and physical capital, P_3= Price of fund, which is ratio of total interest expenses to total deposit. Here, Other earning assets= Total assets - Total loans – Fixed assets – cash–reserve, and Physical capital = Total fixed assets. ε_n shows the deviation of the actual human capital of a bank from the human capital-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 human capital 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) we developed the following multiproduct translog production function to specify the Human Capital function:

$$\ln HC = \alpha + \sum_i \alpha_i \ln Q_i + \sum_j \beta_j \ln P_j + \tfrac{1}{2} \sum_i \sum_k \gamma_{ik} \ln Q_i \ln Q_k + \tfrac{1}{2} \sum_j \sum_h \delta_{jh} \ln P_j \ln P_h + \sum_i \sum_j \lambda_{ij} \ln Q_i \ln P_j + \varepsilon \quad \ldots\ldots (2)$$

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

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

Where λ is the ratio of the standard deviation of U_n to the 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 use computer software called Frontier Version 4.1 developed by, Coelli (1996) for Stochastic Frontier Production function estimated by the method of maximum likelihood.

Appendix B: Stochastic Frontier Analysis (SFA) for determining cost efficiency

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,

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

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 the 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:

$$\text{Ln } TC = \alpha + \sum_i \alpha_i \ln Q_i + \sum_j \beta_j \ln P_j + \tfrac{1}{2} \sum_i \sum_k \gamma_{ik} \ln Q_i \ln Q_k + \tfrac{1}{2} \sum_j \sum_h \delta_{jh} \ln P_j \ln P_h + \sum_i \sum_j \lambda_{ij} \ln Q_i \ln P_j + \varepsilon \ldots\ldots (2)$$

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).

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

Where λ is the ratio of the standard deviation of U_n to the 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 use computer software called Frontier Version 4.1 developed by, Coelli (1996) for Stochastic Frontier Cost function estimated by the method of maximum likelihood.

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

Correlations												
	Risk	**Capital**	**INEFF**	**Size**	**OBSTA**	**RD**	**LTA**	**Leverage**	**AGE**	**DTA**	**RWATA**	**ROA**
Risk	1											
Capital	-.538***	1										
INEFF	-.559***	.384***	1									
Size	.086*	.208***	-.464***	1								
OBSTA	-.171***	.099**	.296***	-.158***	1							
RD	-0.079	.213***	.102**	.099**	.187***	1						
LTA	-.479***	.350***	.349***	-.097**	.233***	0.005	1					
Leverage	.253***	-.436***	-.193***	-.090*	-0.04	-.182***	-.156***	1				
AGE	.445***	-.155***	-.680***	.711***	-.128***	.098**	-.335***	0.08	1			
DTA	-.161***	-.240***	0.032	-.146***	0.027	-.183***	.083*	0.075	-.175***	1		
RWATA	-.479***	.614***	.286***	.340***	.147***	.223***	.462***	-.316***	0.032	-0.026	1	
ROA	-.401***	.481***	.381***	-.251***	.132***	.223***	.221***	-.399***	-.345***	-0.021	.214***	1

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