

An Empirical Investigation on Relationship between Risk, Capital and Efficiency in Banking Sector of Pakistan

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Abstract

In this study, data set of annual figures of 35 Pakistani banks is used over the period 2005-2014 with total 350 observations. Data set composed of four public sector banks fully owned by the state. Twenty three privately owned commercial banks incorporated in Pakistan, six commercial banks incorporated outside the country and four specialized banks. Information for all years of some banks was not available, for this study used an unbalanced panel to make the sample taken reasonable for the investigation. Information regarding banks is taken from Financial Statement Analysis presented by state bank of Pakistan for the period 2005-2009 and 2010-2014. The empirical findings proposed positive association between Z-score and capital level of Pakistani banks. Moreover, other risk indicators provided evidence of significant negative association. The link between risk levels (Loan Loss Provisions to total loans) and “technical efficiencies” found significantly positive. In case of banking factors, large Pakistani banks on the basis of total assets are technically more efficient, on the other hand technical and pure technical efficiencies declines in case of higher liquidity, moreover, liquidity influences level of capitalization positively.

Keywords: Risk, Efficiency, Capital, Three stage Least squares, Pakistani banking sector

1. Introduction

World's financial structure is dominated by most important monetary institutions “banks”. “Bench”, “an exchange” or an “institution” are the terms quoted for banks by Chambers English Dictionary. A dealer that creates credits and works as a financial intermediary termed as bank by Cairncross (1170). The institution which collects funds from the public and provides credits to its customers against securities for financial benefits is named as bank. Briefly, it can be said the institution which has credibility to invest the public funds on the behalf of wealth owners and provide services as custodian of wealth. Wealth maximization is the basic motive of the bank for the stock holders. So bank is an artificial person or a business entity which works as financial intermediary, takes money as deposits from the public provides advances to public for the sake of profit.

Performance of banking sector of rising and emerging economies offers a distinctive prospect to learn the impact of liberalization and regulation. Efficiency of banking sector is influenced by liberalization and regulations in emerging economies. State Bank of Pakistan is the regulating authority for banking sector which rectifies the asymmetries and establish the rules of the game. Transaction costs may increase and inefficiencies can be generated in allocation of resources due to distortions created through changes in regulations frequently. State Bank of Pakistan is trying to stabilize the banking sector by making changes in rules and regulations and also struggling to accomplish the objective of export promotion and price stability in the economy since last ten years.

This study mainly focus on identification of inter-temporal relationship between risk position, level of capitalization and efficiency in banking sector of Pakistan. Risk is the likelihood of economic failure and also refers to the volatility of returns coupled with a given asset. There are two categories of risk on the basis of control. One of them necessarily be controlled consists of liquidity risk, market and credit risk. Second one which can be minimized is risk of operations as quoted in Shinkin Central Bank annual report 2008.

Retained earnings and issue of stock are the main sources of capital for a financial institution. A conceptual misunderstanding prevails that capital and liquidity are the same things which is wrong. A highly capitalized institution can be trapped in illiquidity (Non availability of cash to meet current needs) because it cannot sale its assets promptly so capital and liquidity are two different terms Deelchand & Padgett (2009).

Altunbas et al (2001) reported efficiency of financial institutions on the basis of costs, efficient will be the bank if it has lower operational costs with the same input/output combinations predicted for other bank and no explanation can be given for difference on the base of statistical noise. For measurement of efficiency, two techniques are used as reported in previous studies, first is introduced by Charnes et al. (1978); non-parametric linear programming data envelopment analysis (DEA) and second one is stochastic frontier approach (SFA) a parametric programming reported by Aigner et al.(1977). DEA measures the technical efficiencies; on the other hand SFA computes production, costs and profit efficiencies with the assumption of existence of maximization behavior. In this study; target is to measure the technical efficiencies so DEA is the key to make it resolved.

In context of Pakistan, Scale and technical efficiency of financial institutions computed by using data envelopment approach first time reported by Akmal and Saleem (2008). They suggested that efficiency level of banking sector is improving since 2000, moreover local private banks and public sector banks are less efficient

as compared to foreign banks. They also reported TFP & technology growth in their study.

The factors behind risk taking behavior in association with level of capital and efficiency level is elaborated by number of research studies, in large, belong to European banking industry. In Asian countries very small number of studies elaborated the association of risk, capital and efficiency. After the financial crisis of 2007 in Asia, it has become an important issue to be resolved, which requires a comprehensive empirical investigation on relationship of level of capitalization, risk taking and efficiency of the banking industry of Asian countries, particularly, banking Industry of Pakistan. There is not a single study found in Pakistani context which can explain the gap so this is the first study which explains the inter-temporal association of these three factors.

Pakistani banking industry is in developing stage, so it is important to address the issue of relationship between risk and efficiency. The first goal of this revision is to interrogate the risk-efficiency relationship and the next is to inspect the contact of level of capital ratio on trade-off between risk and efficiency. Banks in with lower level of efficiency in order to boost their earnings will take on higher credit risk which points towards negative relationship between risk and efficiency, on the other side higher credit risk will result in higher level of monitoring costs and administrative efforts which will reduce the technical efficiency of banks.

In order to address these issues in the context of Pakistan, this study comprised of large data set of banks covering the period 2005-2014. Current study investigates the association flanked by risk position, level of capital ratio and efficiency which are the major variables of this research work. This study measures different concepts of efficiency like technical efficiency, pure technical efficiency, scale efficiency and productivity of banks. Capital ratio is termed as the ratio of total equity capital to total assets. Equity capital includes common stock value, premiums, reserves and preferred stocks value. Pyle (1984) defined risk as “state of affairs which causes reduction in charter value of an entity due to unanticipated variations in business surroundings”. Tan & Floros (2013) pointed out that simultaneous increment in level of capitalization and risk produce moral hazard issue. In this study, risk of individual bank is computed by taking fraction of provision against loan losses to total advances of bank. Higher value of fraction shows higher level of risk and vice versa. Rime (2001) suggested an issue that determination of the risk using accounting data is quite problematic as previously proposed by Shrieves and Dahl (1992). They argued that these measures can be a sign of portfolio quality specifically which makes managers to induce towards time discretion in order to reduce costs. Risk computation is become more difficult when banks do not have securities traded publically. So for the confirmation of the results alternative measures are taken into account for risk computations as “Volatility of return on assets”, “Volatility of return on equity” and “Z-Score”. In this study data set of Sample period 2005-2014 used to calculate the volatility of ROE and ROA for each bank and sum of return on assets and ratio of equity to total assets as fraction of standard deviation of ROA is taken as Z-Score. Larger the Value of Volatilities of ROA and ROE represent higher levels of risk while high Z-Score value shows lower risk. Non parametric data envelopment analysis (DEA) used to compute the technical efficiency. CCR model with assumption of constant return to scale employed to measure technical efficiency which is defined as a maximum of ratio of weighted outputs to weighted inputs. DEA (BCC) model is applied to calculate scale and pure technical efficiency and productivity is measured by using input oriented Malamquist productivity index. Moreover, bank and industry specific along with macroeconomic variables are used as controlling factors which have significant impact on variations in risk, capital and efficiency levels.

As it is previously elaborated, current study aims to investigate about inter-temporal analysis of risk, efficiency and capital of Pakistani banking sector. Thus, regarding this point of view agency theory is appropriately theorizing the theoretical grounds of study. Agency theory is presented by Jensen & Meckling, (1976). It stated about agency conflicts between principal and agent. These both individuals are separately concerned with corporate sector with their separate objectives. Principal has objective to maximize the wealth and agent has objective of maximization pursuit of performance. These both objectives are interlinked but their performing agents are separate. Thus, principal’s objectives have separate concern with Pakistani banking sector’s items i-e capital, risk & efficiency. Moreover, other factors are taken into consideration by most researchers which define the risk, capital and efficiency relationships like “Bad Management “practices. According to this hypothesis, less efficient banks face higher levels of costs in order to monitor the credits, further inefficient control on operational costs and other market hurdles along with reputational drawbacks make banks to increase their “risk” level proposed by Berger and De Young(1997), in line with hypothesis suggested by Williams(2004). Further, “Bad Luck Hypothesis” proposes positive impact of risk on technical efficiency. Fact is “increment” in risk causes additional monitoring costs and induces managers to excel at job which leads to technical efficiency proposed by Berger and De Young (1997). Jeitscbko and Jeung (2005) proposed “Moral hazard hypothesis” to explain the association of risk taking behavior with capital level and efficiency level. According to it, less efficient bank’s management induce to take on high risk with lower capital level. This assumption states that moral hazard hurdles arise due to principal-agent conflicts and informational asymmetry which leads to extra risk taking behavior of management in order to boost efficiency level and profits. Contrary to this, management of banks with high capital ratios tries to reduce the increasing costs of holding capital as

well as high level of capitals leave less space for moral hazard benefits. The “Regulatory hypothesis” reported by Peura and Keppo (2006), According to this hypothesis, banks should hold extra capital then minimally required when their risk exposure increases in order to avoid the costs of fund raising through equity issue, and holding higher level of equity than regulatory responded by extra risk of portfolio.

The main objective of the study is to explore the risk, capital and efficiency relationship in Pakistani banking sector. Moreover focus of the study is to explain the variations in bank capital due to efficiency or productivity in relation with risk positions. The purpose of this study is to discover the connection between risk, capital and efficiency of financial institutions as well determinants of risk, capital and efficiency. The majority of studies conducted on this topic in Western countries, is limited in regions. The result of studies that is conducted in the developed country cannot be generalized in Asian countries and may not necessarily have any application in context of Pakistan because economically Pakistan is really different from so many developed countries that is why this research is going to contribute contextually as well. In developing countries like Pakistan market fundamental is different from the developed countries, as well as thinking level of Pakistani managers also vary from developed countries managers.

This study contributes statistically, contextually as well theoretically in existing knowledge. This study gives fresh insight into financial decision making of Pakistani banks according to the regulations of capital levels, the risk exposure faced and their efficiency levels because it involves the latest data from 2005 to 2014. On the other hand, before this study the main focus of the relevant studies was profit efficiency or cost efficiency for developed markets like US and Chinese banking industry.

In the context of Pakistan, it is the first empirical analysis that explores the contact of risk taking behavior, bank’s capital ratio and efficiency/productivity level. It estimates more efficiency concepts like scale, technical, pure technical efficiencies and productivity index, prior suppositions states that position of risk and capital of the banks have same relationship with efficiency and productivity. The additional risk indicators used in this study alternative to loan loss provision to total loans, “volatility of return on assets, z-score and volatility of return on equity” make a significant contribution to existing literature. More over macroeconomic, industry specific and bank-specific variables are used as control variable by using 3SLS estimation framework make this study comprehensive. This study will contribute contextually towards the prediction of risk and capital level to attain certain productivity level.

2. Literatures Reviewed

Many studies conducted to explore the factors affecting the financing decision making. But the relationship of financing decision making with risk level an entity faces and its performance is not clear yet. A small number of studies made in European banking sector to explore the relationship of these three and few empirical studies made in Asian countries. First time, Tan and Floros (2013) studied the association between risk, capital ratio and level of efficiency for Chinese banking sector utilizing three stage least square regression analysis in panel data structure. For efficiency measurement, they used three efficiency indexes and four measures for risk estimation. This empirical study proposed that bank’s efficiency has significant positive impact on risk taking behavior in banking system of China when risk is measured through ratio provision against loan losses to total loans (LLPTL). Moreover, evidence proposed negative association between risk (Z-score) and capital ratio.

Shrieves and Dahl (1992) investigated variations in risk positions of banks due to changing level of capital ratio and vice versa by utilizing a large sample of commercial banks of USA. They used cross sectional data of period 1984 to 1986 in three stage least square framework. This study explored synchronized relationship between level of risk taken by banks and level of capital, and mass of banks increase the asset risk exposure to lessen the effects of increased investment level and vice versa. The results found in line with those banks which have higher capital ratios than regulatory minimum investment standards which indicates that in most banks private incentives of managers/owners are the motives of limiting the overall risk exposure, in undercapitalized banks, partial effect of regulation was found. Concluded that “changes in level of capital” in banks for the period studied are “risk based”.

One of the recent studies on capital requirement and bank behavior in response of regulations conducted by Rime (2001) explored the impact of minimum capital requirement regulations on capital ratio and risk taking behavior of Swiss banks in simultaneous equations framework for the reference period of 1989 to 1995. In this study, banks having capital ratios closer to minimum regulatory requirement induced to increase their capital ratios coupled with no effect of regulatory pressure on risk level.

Demsetz et al. (1996) conducted a study to investigate the risk taking behavior of US banks under the effect of franchise value and capital levels of banks by using different measures of risk. Findings were in line with moral hazard hypothesis, as banks with higher level of capitals take less risk with high franchise value as compared to banks with low franchise value and capital ratio.

Another study to investigate the determinants of bank’s credit and equity risk conducted by Haq and Heaney (2012) in European banking, They argued that as size of bank increases total risk goes higher but credit

risk declines. The study revealed that banks capitalization level has U-shaped association with credit and systematic risk.

Altunbas et al. (2007) examined risk, capital and efficiency relationship in European banking sector over the period of 1992 to 2000. Results did not support the reported evidence from U.S banking system that risk taking behavior is negatively associated with inefficiency of banks. They found that less risk is taken by inefficient banks holding higher level of capital. They reported positive relationship between capitalization (and liquidity) and risk, which probably represents the regulators' partiality for capitalization as a source to limit the risk taking actions of banks. They argued that financially strong entities take less risk as well as hold lower levels of capital. They found almost same association between risk position, equity ratio and banks' efficiency for saving and commercial banks but inverse association found between capital levels and risk taking in co-operative banks. Kwan and Eisenbeis (1997) found positive relationship between efficiency and capitalization. They reported that inefficient banks have low capitalization. Banks' position among most or least efficient operators can change the associations. Festic et al. (2011) studied performance of banking sector of Central and Eastern Europe and reported brisk growth of credits in recent years. They provided the evidence in support of hypothesis indicating increase in credits and available finance might influence negatively performance of banks and can decline the non performing advance dynamics due to economic overheating.

Jeitschko and Jeung (2005) revisited the issue of forces affecting the risk taking behavior of banks in relationship of capitalization level taking three agents' interests into consideration in order to study the accepted claim of low risk taking behavior of well capitalized banks, which is challenged by managers, some academics and regulatory authorities. They suggested that risk level increases or decreases with level of capitalization is associated with incentives of three agents deposit insurer, shareholder and manager. Results suggest that deposit insurer in order to protect funds insured inclined towards low risk taking and on the other hand shareholder get incentive on risk shifting linked with deposit cover financial backing induced towards high risk taking beyond the optimal levels of banks position, while bank managers inclined to be conservative in determination of asset risk in order to protect their personal control incentive in case of economic failure. So, they concluded that relationship between risk and capitalization depends on incentives of three agents in determination of asset risk class and distinctiveness of risk-return profile of banks. Particularly, it revealed that usual insight of low risk taking with decline in capitalization observed whenever incentive of shareholder rules. It also negate the usual perception that asset selected taking high risk high return criteria into consideration induce managers to take high risk with increase in capitalization. They also argued that in these cases, the extent of risk may be over the preferred intensity of risk of authoritarian agency specially deposit insurer.

Another study proposed importance of ownership structure as factor affecting risk taking behavior of the firms carried out by Saunders *et al.* (1990) stated that banks which are controlled by stockholders inclined to take high risk in contrast with firms controlled by managers induced towards conservative policy in risk taking due to non diversifiable human capital.

Berger et al. (2006) conducted an empirical study in order to explore the relationship between capitalization, agency costs and efficiency of firms. Corporate governance theory states that agency costs are affected by level of capital, which has impact on efficiency of the firm. They recommended a new method to examine the supposition utilizing earning efficiency by observing how closely a firm in its earnings to the best performing firm's profits operating under the identical exogenous state of affairs. They were the first, who introduced reverse causality from efficiency to capitalization in a framework of simultaneous equations. Results suggest that the data set of U.S banking sector is in line with the supposition and significance enhanced statistically as well as economically. Agency cost hypothesis state that higher level of capitalization bring down agency costs of external equity financing which contributes positively in value of firm by restricting or allowing managers to proceed for shareholders incentives. But, when capitalization level increases causes increase in anticipated costs of economic failure then monitoring costs of debt crush the reduction in costs of external equity financing which results in higher total monitoring costs. This study provide theoretical support to agency cost hypothesis that level of capitalization is linked negatively with profit efficiency, efficient the lower will be the equity capital ratio. They negated the reverse causality of association when leverage is high although they found marginal impact of equity capital on relationship at very high level of leverage. They proposed two challenging hypothesis in contradiction with respect to predictions regarding causality reversal relationship of profit efficiency and capital structure. Efficiency and risk hypothesis stated that firms which are profit efficient provide elevated returns which render a cover to protect firm from predicted bankruptcy costs as a replacement for equity capital while Franchise-value assumption suggest that higher level of equity holding protects firms expected return inflows from best earning performances. The results show that none of these two hypotheses of reversal of causality from firm performance to equity leads the other over the data sample overall.

Ghosh (2014) investigated the association between capital and risk using data set of 100 GCC banks over the period 1996-2011 by utilizing three stages least square simultaneous equations modeling. Ratio of equity capital is taken into consideration for the calculation of capital and Z-score as the measure of risk. Results

suggested one way irreversible association between capital ratio and risk position by observing that banks respond increase in capital levels as risk level goes on higher side. The empirical evidence provides an insight that this relationship is one sided, banks increase their capital levels in order to absorb the increased level of risk, there is no impact of increased level of capital on risk. Moreover, talking about authoritarian strain results proposed unequal impact on behavior of bank's financing decisions and risk taking, same case with market regulations association with risk taking and capital levels. Additionally, results describes the negative link between income diversification and risk level arguing that banks with high diversified income profiles are exposed to lower levels of risk.

Calem and Rob (1996) have introduced stimulated model using parametric estimations for investigation of capital levels and asset selection changes in banking sector examining the data set over the period of 1984 to 1993. Results revealed risky behavior of banks in response to increase their capital levels which are thinly capitalized, while banks with minimum adequate capital are exposed to lower level of risk, on the other hand risk exposure increased by highly capitalized banks in response to compensate the increased level of risk.

Fiordelisi et al. (2011) have investigated the association between risks taking behavior, capital ratio and efficiency level employing Granger causality estimation in a panel data structure for the European commercial banking system. They investigated different measures of risk, efficiency and equity ratio. They proposed negative Granger-causality between cost and revenue efficiency and risk. Banks with lower level of costs and revenue efficiencies cause increase in level of risk, moreover results describe positive impact of increased level of capital on cost efficiency. They also stated that efficiency improvements make banks to be well-capitalized, moreover capitalization and efficiency levels have positive associations. The results are confirmed through several robust tests. They concluded that to attain the objective of monetary constancy, long period of efficient gains is significant.

What are the driving forces behind the attitude of banks towards risk taking has become the most interested matter of subject for researchers recently. Theoretical literature on this matter prone to state that many factors like deposit insurance mispricing, control structure, agent-principal problem, incentives of management and moral hazard affects the risk taking behavior of banks. Moreover theory states that equity issue on short notice can be expensive for the owners because it gives negative signal to stakeholders about the financial position of the bank, on the other hand moral hazard of deposit insurance supports the argument of increasing risk level with decline in capital level. But work of Duan et al. (1992) negated the evidence of increasing risk exposure with decrease in level of capital in as reported from U.S banking sector; moreover in India study by Nachane et al. (2000) also provided contradictory findings against Moral hazard problem of deposit insurance. So, influential evidence lacks on risk taking behavior of banking as proposed by moral hazard, hence it may be the consequence of ineffectiveness of regulations and behavior of the market which restrains banks from taking risk.

Further, second stream of research work shed light on principal-agent conflicts in the banking sector. It is claimed that bank owners are more risk taking then bank management, Saunders et al. (1990) supported this argument in their study that the banks in which objective of shareholders dominates takes more risk than those banks which are controlled by management. Hughes et al. (1995) associated efficiency level in operations and risk taking behavior of management in his study, provided the different evidence, they found that efficiency and manufacturing functions estimates are made by assuming the neutral effect of risk. They argued that when manager's stake is coupled with the performance of the bank, might be ready to accept low risk low return profile in order to protect his incentive; a risk aversion behavior of management was observed. In this case, credit monitoring and production of high quality advances results in increased level of operational and monitoring costs which consequently reduce the levels of efficiency. The empirical evidence suggested that higher level of capitalization induce banks behavior to take on higher risk, high possibility of breakdown is not as unambiguous as it looks at first sight.

Koehn and Santomero (1980) reported positive association between level of capital and risk taking of banks controlled by managers, they proposed higher capital standards induce banks to increase their risk of asset selection as Kim and Santomero suggested in their study. But, Benston et al (1986) negated the results by arguing that banks are inclined towards reducing capital levels with uplifting level of risk in order to protect the maximization objective of deposit insurance's value. Deposit insurance subsidy which is the gain of owners of the bank is protected by regulatory requirements which restrain banks from increasing portfolio risk.

Furlong and Keeley (1989) pointed out that previous researchers considered anticipated costs of deposits as an invariable. Prior evidence assumed irrelevance of these costs from risk and capital levels, which might be wrong because these costs are paid by agency only in case of bank's failure. Modification in model assuming cost of deposits cause reduction in risk of default made prior results unconvincing. The incentive to shareholders on taking more risk at lower level of capital is greater and reduces with increasing level of capital.

Afterward, Gennotte and Pyle (1991) modified the model by adjusting the costs of deposit insurance as proposed by Keely and Furlong and relaxed anticipated return on assets to decline with the increment in equity

holding. They argued that internal optimal level of size and risk, if present in bank, then increment in equity holding will result in more risk taking behavior which exposes banks to greater default chances.

Levonian (1991) investigated the relationship between risk and capital for bank holding companies, reported positive association between risk and capital which was later on supported by Shreives and Dahl (1992), who studied the U.S commercial banks having assets over than 100 million U.S dollars over the period of 1983 to 1987, their findings also stated positive association between risk and capital.

Extensive literature provided empirical evidence on link between risk position and capital levels but relationship of these two with efficiency is not investigated much empirically. Logically accepted that risk and efficiency are endogenous in estimations so to measure the relationship between these two a framework of simultaneous equations is required which will provide the unbiased results.

Jensen (1986) reported hypothetical reasons to accept that risk position, leverage and efficiency are affected by asymmetry of information and agency costs significantly, which found support in the study by Kwan and Eisenbis, who, reported that inefficient bank holding companies take on more risk at higher level of capitalization.

Most research work, discussed above is employed in developed countries and their findings cannot be generalized to developing countries. Moreover, relationship between position of risk, level of capital and efficiency in context of transition countries may be clear and theoretically supported.

In this context, an effort was made by Deelchand and Padgett (2009) suggested that co-operative banks show decline in capital levels with increase in risk, and inefficiency of these banks force to operate at higher capitalization with greater risk exposure; findings show value maximizing behavior of banks to protect the owners by exploiting the incentive of deposit insurer, results pointed out the existence of moral hazard in banking system. Moreover, they revealed the positive relationship between size and risk for banks holding lower level of equity and negative association with efficiency.

Miah and Sharmeen (2015) suggested that conventional banks are more cost efficient than Islamic banks, whereas bidirectional and negative association between efficiency level and capital ratio found in Islamic banks and reported no association in found case of conventional banks. Further investigations, only for Islamic banks, revealed one-way positive association between risk taking behavior and level of equity ratio.

Mongid et al. (2012) investigated the association of capital level, risk position and inefficiency taking a sample set of data of banks for eight Asian Countries. First stage of the analysis provided regression estimates of inefficiency and suggested that capital level and size of the bank contributes negatively towards inefficiency, astonishingly, risk has no significant impact on inefficiency. Second regression estimated risk determinants, results showed lower level of capitalization forces banks to take on higher risk as well as inefficient banks reduces their risk level.

2.2. Research Hypothesis

Earlier than elaboration of methodological framework employed in current study, hypothesis based on prior literature explaining the links between “risk positioning, capital levels and efficiency” are as follows;

H1; There is a positive and significant association between efficiency and risk level.

H2; Risk positively contribute in technical efficiency.

H3a; Risk has negative impact on productivity of banks.

H3b; Risk has positive association with productivity level of banks.

H4a; Capital has negative association with risk taking.

H4b; Capital has positive link with risk level.

H5; Efficiency contribute positively and significantly towards risk level.

H6; Efficiency has negative and significant impact on capital levels of bank.

H7; Less efficient banks take on more risk, while increase in capital level in response of higher level of risk has positive impact on level of efficiency.

Research Methodology

In this study, data set of annual figures of 35 Pakistani banks is used over the period 2005-2014 with total 350 observations. Data set composed of four public sector banks fully owned by the state. Twenty three privately owned commercial banks incorporated in Pakistan, six commercial banks incorporated outside the country and four specialized banks. Information for all years of some banks was not available, for this study used an unbalanced panel to make the sample taken reasonable for the investigation. Information regarding banks is taken from Financial Statement Analysis presented by state bank of Pakistan for the period 2005-2009 and 2010-2014. The industry specific variable are obtained from the official database of State Bank of Pakistan (<http://www.sbp.org.pk>) and macroeconomic variables are taken from World Bank database

The three stage least square is to be used for the purpose of estimation to investigate the relationship between bank risk, capital and efficiency/productivity as it takes into account both endogeneity and the cross

correlation between the error terms.. The data set will encompass twenty Banks selected for the time period 2005 to 2014. In the first stage for efficiency estimation Data Envelopment Analysis (DEA) employed and for productivity estimations Malmquist productivity index is used. After incorporating the efficiency scores and productivity index to the panel three stages least square (3SLS) method is applied in un-balanced panel data framework to investigate the relationship between risk, capital and efficiency/productivity due to data limitations. The applied method modified by Shreives and Dahl (1992) which consider both endogeneity and cross correlation between the error terms as incorporated by Floquet and Biekpe (2008) and Tan and Floros (2013) in their studies. The econometric model that is to be tested in this study can be written as follows.

$$RISK_{it} = \beta_0 + \beta_1 CAP_{it} + \beta_2 EFF/PROD_{it} + \beta_3 BANK_{it} + \beta_4 INDUSTRY_{it} + \beta_5 MACRO_{it} + \epsilon_{it}$$

$$CAP_{it} = \delta_0 + \delta_1 EFF/PROD_{it} + \delta_2 RISK_{it} + \delta_3 BANK_{it} + \delta_4 INDUSTRY_{it} + \delta_5 MACRO_{it} + \epsilon_{it}$$

$$EFF/PROD_{it} = \gamma_0 + \gamma_1 CAP_{it} + \gamma_2 RISK_{it} + \gamma_3 BANK_{it} + \gamma_4 INDUSTRY_{it} + \gamma_5 MACRO_{it} + \epsilon_{it}$$

Where:

I subscript: Cross-sectional dimension across banks,

T subscript: the time dimension.,

RISK: the variable accounting for bank's risk

CAP: the equity to total assets ratio.

EFF/PROD: The technical, pure technical, scale efficiencies or Malmquist productivity index.

BANK: bank-specific

INDUSTRY: industry-specific factors

MACRO: Macroeconomic factors influencing the efficiency/productivity–capital–risk relationship and

ϵ_{it} : Random error term.

Empirical Results and discussion

Table 4 provides the “descriptive statistic” which includes all variables of the study. The mean value of risk measure LLPTL is 0.14 (14%), a high figure but not much, indication of reforms in Pakistani banking sector, but further efforts and effective regulations are required to increase the ability to manage the risk. It points towards higher level of provisions against loan losses which are accumulated not written off by Banks. Whereas, lower level of risk on average, indicated by mean values of VROA (volatility of return on assets) and Z-score, 0.0071 (less than one percent) and 136.11 respectively. A large difference present between higher and lower values of Z-score. The mean value of Capital is 0.012 shows higher level of capitalization in Pakistani banking sector, moreover, there is not much room between max (0.788) and min(-7.20) values. There is a noteworthy difference between values of standard deviation in case of productivity and Efficiency. The problem of correlation among variables is typically insignificant because model utilized in this study rarely experience Multicollinearity hurdles.

Table 4

Descriptive statistics of all variables

Variables	Mean	Std. Dev.	Minimum	Maximum
LLPTL	0.140374	0.21284	0	0.999913
VROA	0.007135	0.012951	0.004	0.126855
VROE	0.193103	0.996547	0.13	10.38033
ZSCORE	136.1153	556.6949	-1428.521	7424.621
TECRS	0.929146	0.130879	0	1
PROD	0.955269	0.635132	0	9.031
CAP	0.012849	0.914941	-7.209585	0.788
ROA	0.000961	0.026203	-0.2217	0.0865
SZ	18.09966	1.876882	0.76	21.3476
LIQ	0.41606	0.153325	0.072	0.7211
TAXATION	0.411422	0.767596	-2.196061	11.17492
OBSOTA	0.568453	1.098624	0.00034	14.1105
LP	5362.647	11624.13	-14.26	199996.8
CONC	0.125801	0.003694	0.117017	0.13088
BSD	0.462817	0.053938	0.393089	0.559685
SMD	0.229441	0.074867	0.142642	0.377844
IR	10.88811	3.933092	7.191671	20.28612
GDPG	4.017846	1.839672	1.606692	7.667304

Estimations resulted from three stage least squares taking technical efficiency as dependent variable with four risk measures Z-core, LLPTL, Return on assets' volatility (VROA on above) and return on equity's volatility (VROE on above). Findings declared the positive association between Z-Score and capital ratio. This

result suggests that default risk of banking firms reduces with increasing capital level. The fact that support this finding is that, banks which are thinly capitalized (High equity holding) are capable to absorb more risk. Banks with higher equity ratios can soak up the losses due to bad debts, which causes decline in overall risk of the banks. Meanwhile, higher level of capital is required to compensate the sufferings from non performing advances which bring down the capital level for banks with higher risk exposure.

Table 4.1

Three stage least square estimation for the relationship between bank capital, technical efficiency and risk taking in Pakistani banking

Model where risk=Z-Score									
Variable	Eq (1)			Eq (2)			Eq (3)		
	Y=ZScore			Y=Capital			Y=Efficiency		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	1439.96	18.661	0.000				0.3126	1.576	0.083
Efficiency	-4659.75	-1.637	0.107	-14.3736	1.576	0.084			
Risk				0.0033	18.6611	0.000	-0.0002	-1.637	0.106
BSD	476.70	0.429	0.668	-2.2117	-2.4170	0.016	-0.1263	-0.493	0.623
CONC	-35388.00	-0.240	0.196	52.2347	1.6023	0.114	-2.8099	-1.963	0.095
GDPG	79.76	1.197	0.143	-0.2686	-1.2332	0.376	0.0181	1.302	0.105
IR	42.99	4.166	0.000	-0.1405	-1.2171	0.143	0.0096	0.024	0.269
LIQ	3138.04	1.265	0.097	-1.9687	-2.146	0.018	-0.6781	-12.542	0.000
LP	-0.01	-4.251	0.000	0.0005	1.3680	0.072	-0.0000	-1.267	0.089
OBSOTA	236.43	1.503	0.078	0.3211	1.3999	0.089	0.0514	0.605	0.113
ROA	-4099.41	-1.011	0.133	-2.8414	-0.2295	0.391	0.9059	4.381	0.000
SMD	-1130.48	-1.778	0.076	-0.5191	-0.8966	0.371	-0.2285	-1.578	0.116
SZ	-79.27	-4.594	0.000	-0.2736	-1.5944	0.084	0.0173	5.460	0.000
TAXATION	162.36	0.744	0.0860	-0.1296	-1.2089	0.089	-0.0827	-5.472	0.000
C	-3529.83	-1.504	0.231	-1.1960	-1.2567	0.210	0.7939	3.587	0.000
R-squared			0.553			0.911			0.584
Adjusted R-squared			0.536			0.907			0.568
F-statistic			32.033			263.931			36.246
Prob(F-statistic)			0.000			0.000			0.000
Durbin-Watson stat			1.158			1.468			1.405

Notes:

Statistical significance at 5% (Prob=0.05)

statistical significance at 1% (Prob=0.01)

Table 4.2
Three stage least square estimation for the relationship between bank capital, technical efficiency and risk taking in Pakistani banking

Variable	Model where risk=LLPTL								
	Eq (1) Y=LLPTL			Eq (2) Y=Capital			Eq (3) Y=Efficiency		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	-0.32	-0.432	0.197				0.1021	1.550	0.103
Efficiency	0.22	2.102	0.036	3.2953	1.550	0.103			
Risk				-7.8414	-0.432	0.197	0.1648	2.102	0.036
BSD	0.15	1.041	0.299	1.0290	0.9227	0.872	-0.1823	-3.543	0.001
CONC	2.70	3.160	0.002	8.2964	2.3823	0.043	-2.8109	-3.681	0.004
GDPG	-0.01	-2.524	0.012	-0.0578	-1.4790	0.468	0.0016	1.897	0.094
IR	-0.01	-3.908	0.000	0.0324	9.1591	0.000	0.0034	1.108	0.269
LIQ	0.05	2.058	0.040	-2.8957	-1.6859	0.237	-0.6781	-2.268	0.004
LP	-0.00	-0.174	0.862	-0.3130	-1.1454	0.468	-0.0005	-0.058	0.749
OBSOTA	-0.02	-0.438	0.643	0.0054	0.6256	0.532	0.0199	0.304	0.241
ROA	-3.31	-26.539	0.000	-18.1023	-29.8175	0.000	0.1286	0.394	0.694
SMD	0.08	0.994	0.321	-0.1824	-0.9555	0.340	-0.2823	-1.512	0.132
SZ	-143.00	-2.113	0.067	-1.3150	-4.9280	0.001	0.0173	3.304	0.001
TAXATION	0.0052	2.309	0.003	-0.1519	-1.6048	0.179	-0.0817	-1.948	0.013
C	-0.20	-1.590	0.113	-6.7615	-2.8110	0.047	0.8039	2.349	0.041
R-squared		0.950				0.993			0.249
Adjusted R-squared		0.948				0.993			0.220
F-statistic		489.800				363.443			8.592
Prob(F-statistic)		0.000				0.000			0.000
Durbin-Watson stat		0.994				1.722			0.977

Notes:
Statistical significance at 5% (Prob=0.05)
statistical significance at 1% (Prob=0.01)

Table 4.3
Three stage least square estimation for the relationship between bank capital, technical efficiency and risk taking in Pakistani banking

Variable	Model where risk=VROA								
	Eq (1) Y=VROA			Eq (2) Y=Capital			Eq (3) Y=Efficiency		
	Coefficient	tStatistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	0.0365	1.283	0.596				0.4619	0.2056	0.834
Efficiency	0.0006	0.033	0.974	32.8678	0.2056	0.834			
Risk				0.9797	1.283	0.596	1.1234	0.033	0.974
BSD	-0.0878	-0.808	0.405	7.0314	1.9376	0.049	-0.3507	-1.336	0.183
CONC	-0.1154	-0.670	0.504	9.7989	2.9495	0.000	-2.820	-4.831	0.000
GDPG	0.0069	0.556	0.246	-0.1020	-1.1072	0.183	0.0014	0.171	0.453
IR	0.0045	0.048	0.403	0.1440	0.0470	0.374	-0.0031	-1.238	0.217
LIQ	-0.0664	-1.601	0.093	-3.2122	-1.54	0.351	-0.6781	-2.730	0.000
LP	0.0003	1.663	0.097	-0.0000	-4.84	0.000	-0.0000	-7.316	0.000
OBSOTA	0.0072	6.259	0.000	0.4773	0.7733	0.547	0.0661	0.681	0.376
ROA	0.3020	4.783	0.000	-17.1926	-0.4262	0.843	-1.6056	-0.621	0.940
SMD	-0.0303	-1.770	0.178	-8.6108	-54.8	0.428	-0.6119	-1.277	0.246
SZ	-0.0056	-2.807	0.042	-0.4877	-6.43	0.000	0.0173	3.809	0.000
TAXATION	-0.0046	-1.628	0.590	-0.2863	-0.3896	0.864	-0.0817	-4.007	0.000
C	0.0331	1.169	0.243	-14.0508	-2.8846	0.043	0.7574	-3.459	0.001
R-squared			0.491			1.000			0.715
Adjusted R-squared			0.471			1.000			0.704
F-statistic			24.943			65.023			64.855
Prob(F-statistic)			0.000			0.000			0.000
Durbin-Watson stat			1.531			1.017			1.537

Notes:
Statistical significance at 5% (Prob=0.05)
statistical significance at 1% (Prob=0.01)

Table 4.4
Three stage least square estimation for the relationship between bank capital, technical efficiency and risk taking in Pakistani banking

Model where risk=VROE									
Variable	Eq (1)			Eq (2)			Eq (3)		
	Y=VROE			Y=Capital			Y=Efficiency		
	Coefficient	T-Stat	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	-0.37	-1.259	0.209				0.6607	1.4967	0.437
Efficiency	6.38	1.167	0.202	31.7878	1.4967	0.437			
Risk				-0.2773	-1.259	0.209	0.0993	1.167	0.192
BSD	1.61	0.576	0.565	-6.6418	-2.2547	0.048	-0.3277	-1.597	0.163
CONC	24.65	1.417	0.158	11.7000	1.7352	0.093	-2.831	-4.934	0.000
GDPG	-0.03	-0.500	0.617	0.0982	4.3119	0.000	0.0024	3.507	0.001
IR	0.01	0.472	0.637	0.1445	0.9831	0.127	-0.0021	-1.066	0.132
LIQ	-1.29	-1.641	0.102	-3.3699	-1.2063	0.640	-0.6781	-3.676	0.000
LP	0.00	1.476	0.141	0.0000	0.4141	0.603	-0.00894	-1.962	0.093
OBSOTA	0.01	0.116	0.908	0.4704	0.8276	0.957	0.0880	0.466	0.187
ROA	-13.59	-0.076	0.947	-14.5011	-1.8420	0.134	-1.5683	-1.763	0.315
SMD	1.55	0.945	0.345	-8.2590	-1.8021	0.203	-0.8016	-0.504	0.526
SZ	0.10	0.258	0.725	-1.4709	-5.2480	0.000	0.0174	7.772	0.000
TAXATION	0.05	0.692	0.489	-0.2651	-1.5322	0.468	-0.0818	-2.285	0.003
C	-0.56	-0.219	0.827	-14.4847	-2.4479	0.043	0.7823	1.580	0.237
R-squared		0.120			0.9764			0.996	
Adjusted R-squared		0.086			0.9755			0.996	
F-statistic		3.512			1068.8090			6627.223	
Prob(F-statistic)		0.000			0.0000			0.000	
Durbin-Watson stat		1.005			1.0168			0.975	

Notes:

Statistical significance at 5% (Prob=0.05)
statistical significance at 1% (Prob=0.01)

Table 4.5
Three stage least square estimation for the relationship between bank capital, pure technical efficiency and risk taking in Pakistani banking

Model where risk=Z-Score									
Variable	Eq (1)			Eq (2)			Eq (3)		
	Y=Z-Score			Y=Capital			Y=Efficiency		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	1081.53	4.653	0.000				0.2440	0.782	0.467
Efficiency	-4828.09	-1.106	0.204	16.7574	0.7817	0.467			
Risk				0.0023	4.653	0.000	-0.0002	-1.106	0.204
BSD	1083.81	4.828	0.008	5.2331	0.3162	0.654	-0.3160	-0.766	0.178
CONC	-19811.83	-1.573	0.161	10.1294	1.2542	0.135	-3.8802	-2.555	0.039
GDPG	69.50	1.314	0.193	-0.1723	-4.9884	0.000	0.0106	2.350	0.019
IR	38.54	3.381	0.001	-0.1100	-14.8083	0.000	0.0067	1.019	0.147
LIQ	2618.32	-1.078	0.148	-3.1871	-3.8912	0.000	-0.5984	-2.179	0.046
LP	-0.00034	-2.247	0.005	0.0032	1.1474	0.246	-0.0004	-1.821	0.042
OBSOTA	191.17	1.681	0.193	0.3194	1.7945	0.264	0.0412	1.539	0.173
ROA	-2636.41	-0.441	0.515	-4.0902	-1.2102	0.157	0.5999	1.250	0.239
SMD	-718.48	-1.009	0.314	-1.5515	-0.9288	0.114	-0.2266	-0.245	0.152
SZ	-125.53	-5.414	0.000	-0.4341	-1.0904	0.078	0.0248	8.212	0.000
TAXATION	115.85	1.673	0.346	-0.1268	-1.4633	0.261	-0.0271	-0.132	0.161
C	-2570.08	-1.331	0.220	-1.0345	-1.1924	0.234	0.4955	3.240	0.001
R-squared			0.427			0.917			0.749
Adjusted R-squared			0.405			0.914			0.739
F-statistic			19.278			285.360			77.191
Prob(F-statistic)			0.000			0.000			0.000
Durbin-Watson stat			1.291			1.649			1.577

Notes:

Statistical significance at 5% (Prob=0.05)
statistical significance at 1% (Prob=0.01)

Table 4.6
Three stage least square estimation for the relationship between bank capital, pure technical efficiency and risk taking in Pakistani banking

Model where risk=LLPTL									
Variable	Eq (1)			Eq (2)			Eq (3)		
	Y=LLPTL			Y=Capital			Y=Efficiency		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	-0.3020	-1.739	0.346				0.1050	9.419	0.000
Efficiency	0.3167	2.562	0.011	5.0921	9.4188	0.000			
Risk				-7.1619	-1.7387	0.346	0.1549	2.562	0.011
BSD	0.0267	0.137	0.891	1.1626	1.9405	0.047	-0.5108	-0.972	0.419
CONC	1.7998	4.598	0.001	12.2353	2.0588	0.034	-0.5011	-5.320	0.001
GDPG	-0.0090	-2.035	0.043	-0.0587	-8.6612	0.000	0.0008	0.127	0.899
IR	-0.0051	-1.037	0.103	0.0263	0.2090	0.348	-0.0023	-0.968	0.334
LIQ	-0.0346	-4.986	0.002	-2.0994	-1.4586	0.350	-0.2179	-4.344	0.000
LP	-0.0000	-0.254	0.800	0.0000	-1.8988	0.283	-0.0000	-1.484	0.139
OBSOTA	-0.0201	-0.512	0.364	0.0334	1.4350	0.431	0.0196	1.217	0.167
ROA	-3.1866	-1.956	0.032	-15.8296	-0.9656	0.235	0.1788	0.713	0.476
SMD	-0.0816	-0.772	0.441	-0.2246	-1.0700	0.285	-0.2530	-1.758	0.180
SZ	0.0017	2.475	0.046	-0.0877	-1.3945	0.243	-0.0223	-6.945	0.000
TAXATION	0.0019	2.407	0.034	-0.1276	-1.5060	0.173	-0.0094	-3.434	0.015
C	-0.2910	1.801	0.073	-6.8165	1.2523	0.138	0.3315	1.507	0.133
R-squared		0.915			0.990			0.451	
Adjusted R-squared		0.912			0.990			0.430	
F-statistic		277.565			2550.880			21.243	
Prob(F-statistic)		0.000			0.000			0.000	
Durbin-Watson stat		1.043			1.080			1.007	

Notes:

Statistical significance at 5% (Prob=0.05)
statistical significance at 1% (Prob=0.01)

Table 4.7
Three stage least square estimation for the relationship between bank capital, pure technical efficiency and risk taking in Pakistani banking

Model where risk=VROA									
Variable	Eq (1)			Eq (2)			Eq (3)		
	Y=VROA			Y=Capital			Y=Efficiency		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	0.0205	1.6033	0.113				0.3286	0.6276	0.436
Efficiency	0.0093	0.460	0.646	23.0643	0.6276	0.436			
Risk				100.7047	1.6033	0.113	0.6499	0.460	0.646
BSD	-0.0811	-0.539	0.112	19.8297	0.1238	0.231	-0.6242	-0.729	0.152
CONC	-0.0986	-0.531	0.596	69.3967	2.8005	0.034	-3.4646	-3.529	0.001
GDPG	0.0030	1.115	0.137	-0.2783	-0.9199	0.182	0.0021	0.397	0.692
IR	0.0008	1.729	0.327	0.0021	0.2101	0.834	-0.0024	-1.531	0.127
LIQ	-0.0376	-5.305	0.000	-3.3409	-1.3219	0.159	-0.8138	-6.672	0.000
LP	0.0002	0.974	0.331	0.0003	1.1918	0.213	-0.0001	-1.871	0.079
OBSOTA	0.0026	2.110	0.039	0.3591	4.1215	0.000	0.0493	10.325	0.000
ROA	0.2450	1.333	0.260	-6.3675	-1.1099	0.202	0.9836	1.816	0.143
SMD	-0.0212	-1.222	0.223	-5.7837	-1.3647	0.341	-0.4695	-1.405	0.261
SZ	-0.0005	-2.877	0.041	-0.4768	-7.1898	0.000	0.0208	11.324	0.000
TAXATION	-0.0017	-1.173	0.231	-0.1352	-1.6212	0.328	-0.0384	-11.420	0.000
C	0.0078	0.294	0.769	-14.4858	-41.8646	0.000	0.4349	3.149	0.002
R-squared		0.387			1.000			0.859	
Adjusted R-squared		0.363			1.000			0.854	
F-statistic		16.302			53747.220			157.462	
Prob(F-statistic)		0.000			0.000			0.000	
Durbin-Watson stat		1.642			1.550			1.653	

Notes:

Statistical significance at 5% (Prob=0.05)
statistical significance at 1% (Prob=0.01)

Table 4.8
Three stage least square estimation for the relationship between bank capital, pure technical efficiency and risk taking in Pakistani banking

Model where risk=VROE									
Variable	Eq (1) Y=VROE			Eq (2) Y=Capital			Eq (3) Y=Efficiency		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	-0.2555	-1.153	0.250			0.000	0.4054	1.1823	0.182
Efficiency	-1.4985	-0.797	0.426	29.1023	1.1823	0.182			
Risk				-0.1834	-1.1531	0.250	-0.0150	-0.797	0.426
BSD	1.1021	0.369	0.713	15.5938	6.9391	0.000	-0.5916	-1.521	0.217
CONC	23.1957	1.328	0.185	32.8014	9.2092	0.000	-5.5113	-9.880	0.000
GDPG	-0.0134	-0.198	0.843	0.0188	5.9478	0.000	0.0002	0.471	0.638
IR	0.0111	0.429	0.668	0.0974	0.6936	0.344	-0.0026	-1.597	0.381
LIQ	-1.0940	-1.566	0.118	-4.8809	-1.3206	0.238	-0.9810	-6.889	0.000
LP	0.0000	0.478	0.633	-0.0046	-1.0311	0.157	-0.0002	-1.603	0.093
OBSOTA	0.0331	0.542	0.588	0.4134	1.0254	0.158	0.0581	6.244	0.000
ROA	-9.7403	-3.912	0.000	-11.7800	-1.0904	0.183	1.1145	0.379	0.623
SMD	0.4333	0.266	0.790	-6.6649	-1.3224	0.286	-0.5344	-0.866	0.146
SZ	0.0410	0.732	0.465	-0.6783	-7.4620	0.000	-0.0206	-8.325	0.000
TAXATION	0.0354	0.483	0.630	-0.2010	-0.3218	0.479	-0.0478	-6.117	0.000
C	-2.3280	-0.927	0.355	-11.7332	-2.2285	0.036	0.7558	7.968	0.000
R-squared		0.090			0.999			0.997	
Adjusted R-squared		0.055			0.998			0.997	
F-statistic		2.557			17498.900			9990.576	
Prob(F-statistic)		0.002			0.000			0.000	
Durbin-Watson stat		1.016			1.020			1.010	

Notes:

Statistical significance at 5% (Prob=0.05)
statistical significance at 1% (Prob=0.01)

Table 4.9
Three stage least square estimation for the relationship between bank capital, scale efficiency and risk taking in Pakistani banking

Model where risk=Z-Score									
Variable	Eq (1) Y=Z-Score			Eq (2) Y=Capital			Eq (3) Y=Efficiency		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	2935.47	6.442	0.000				0.0073	0.3113	0.756
Efficiency	-4982.32	-1.039	0.191	0.8219	0.3113	0.756			
Risk				0.0069	6.442	0.000	-0.0001	-1.039	0.191
BSD	2048.00	7.407	0.000	11.3381	1.2321	0.204	0.3309	1.409	0.160
CONC	-6567.20	-4.265	0.000	89.9563	1.9427	0.012	-2.4348	-1.628	0.105
GDPG	54.07	1.487	0.164	-0.4735	-0.0995	0.183	0.0060	1.002	0.317
IR	21.73	-4.721	0.000	-0.1646	-0.4010	0.737	0.0027	1.223	0.222
LIQ	5750.14	2.653	0.000	-0.6564	-2.0842	0.038	0.1227	2.003	0.046
LP	-0.01	-8.603	0.000	0.0037	-3.6849	0.000	0.0045	0.860	0.390
OBSOTA	383.54	1.806	0.094	0.2188	1.6585	0.281	-0.0062	-1.261	0.208
ROA	-15523.77	-0.729	0.373	-9.4548	-10.8329	0.000	-0.4131	-1.995	0.047
SMD	-1496.27	-2.392	0.000	-7.0183	-6.7629	0.000	-0.0589	-0.444	0.658
SZ	-48.82	-2.786	0.006	-0.1377	-4.9939	0.000	0.0122	4.226	0.000
TAXATION	304.45	1.552	0.276	-0.0110	-1.0735	0.284	0.0005	0.084	0.933
C	-6471.64	-0.738	0.347	-14.3605	-1.0761	0.217	0.5585	1.607	0.247
R-squared		0.999732			0.980			0.134	
Adjusted R-squared		0.999722			0.979			0.100	
F-statistic		96547.06			1243.860			3.987	
Prob(F-statistic)		0.000			0.000			0.000	
Durbin-Watson stat		1.306			1.290			1.289	

Notes:

Statistical significance at 5% (Prob=0.05)
statistical significance at 1% (Prob=0.01)

Table 4.10
Three stage least square estimation for the relationship between bank capital, scale efficiency and risk taking in Pakistani banking

Variable	Model where risk=LLPTL								
	Eq (1)			Eq (2)			Eq (3)		
	Y=LLPTL			Y=Capital			Y=Efficiency		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	-0.3328	-1.1075	0.183				0.0214	-1.0533	0.121
Efficiency	0.5490	0.418	0.641	-1.6942	-1.0533	0.121			
Risk				-8.5922	-1.1075	0.183	0.1790	0.418	0.641
BSD	0.1036	2.014	0.045	2.6186	4.0755	0.000	-0.1211	-0.533	0.594
CONC	2.2462	6.289	0.000	8.7592	3.5448	0.000	-1.3521	-0.986	0.325
GDPG	-0.0087	-7.965	0.000	0.0729	0.0285	0.983	0.0004	0.069	0.945
IR	-0.0063	-1.777	0.324	0.0517	1.3445	0.241	0.0013	0.620	0.536
LIQ	0.1398	8.832	0.000	-3.2976	-7.2090	0.000	-0.0451	-1.026	0.306
LP	-0.0002	-1.414	0.261	0.00007	-1.3002	0.289	0.0000	1.554	0.121
OBSOTA	-0.0185	-1.465	0.232	0.0514	1.9801	0.031	-0.0048	-1.167	0.244
ROA	-3.3495	-2.599	0.004	-21.2813	-2.0350	0.003	-0.1475	-0.670	0.504
SMD	0.0122	0.453	0.651	-1.2261	-1.7644	0.217	-0.0774	-0.614	0.540
SZ	-0.0116	-6.734	0.000	-0.0546	-5.6830	0.000	0.0110	3.916	0.000
TAXATION	0.0006	4.458	0.005	-0.1990	-0.9264	0.781	0.0056	0.973	0.331
C	-0.3690	-0.024	0.203	-4.5391	-1.4278	0.283	0.6428	1.336	0.244
R-squared		0.995			0.981			0.141	
Adjusted R-squared		0.995			0.980			0.108	
F-statistic		5109.006			1330.027			4.242	
Prob(F-statistic)		0.000			0.000			0.000	
Durbin-Watson stat		1.283			1.288			1.302	

Notes:
Statistical significance at 5% (Prob=0.05)
statistical significance at 1% (Prob=0.01)

Table 4.11
Three stage least square estimation for the relationship between bank capital, scale efficiency and risk taking in Pakistani banking

Variable	Model where risk=VROA								
	Eq (1)			Eq (2)			Eq (3)		
	Y=VROA			Y=Capital			Y=Efficiency		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	0.0781	0.6018	0.548				-0.1232	-1.3290	0.185
Efficiency	0.3062	1.932	0.271	-13.9957	-1.3290	0.185			
Risk				0.3553	0.6018	0.548	1.0166	1.932	0.271
BSD	-0.1328	-1.526	0.173	2.4015	2.7964	0.046	-0.0696	-0.701	0.342
CONC	-0.5279	-0.355	0.408	-0.1863	-0.0094	0.993	2.8878	1.507	0.167
GDPG	0.0028	0.743	0.483	0.0126	0.2049	0.838	0.0045	1.001	0.141
IR	-0.0009	-37.476	0.000	-0.0041	-0.1841	0.854	-0.0007	-26.923	0.000
LIQ	-0.2009	-2.242	0.004	-3.8595	-3.0120	0.003	-0.1490	-6.266	0.000
LP	0.0000	4.236	0.000	0.0000	-0.4409	0.660	0.0000	164.078	0.000
OBSOTA	0.0082	6.700	0.000	0.0648	1.0865	0.278	-0.0187	-9.771	0.000
ROA	0.4171	1.796	0.321	-0.2617	-0.0697	0.945	-1.0283	-0.073	0.746
SMD	-0.0490	-1.384	0.148	-0.0458	-0.0306	0.976	-0.1562	-1.892	0.096
SZ	-0.0043	-9.423	0.000	-0.1507	-4.3454	0.009	0.0087	1.149	0.237
TAXATION	-0.0073	-0.381	0.700	-0.0853	-1.3598	0.175	0.0142	1.411	0.197
C	0.3975	-0.010	0.374	-13.5567	-1.6360	0.103	0.4685	0.192	0.208
R-squared			0.995			0.153		1.000	
Adjusted R-squared			0.995			0.120		1.000	
F-statistic			5717.050			4.655		179539.200	
Prob(F-statistic)			0.000			0.000		0.000	
Durbin-Watson stat			1.201			0.422		0.466	

Notes:
Statistical significance at 5% (Prob=0.05)
statistical significance at 1% (Prob=0.01)

Table 4.12
Three stage least square estimation for the relationship between bank capital, scale efficiency and risk taking in Pakistani banking
Model where risk=VROE

Variable	Eq (1) Y=VROE			Eq (2) Y=Capital			Eq (3) Y=Efficiency		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	-14.397	-11.799	0.000				-0.2393	-2.032	0.043
Efficiency	241.232	27.944	0.000	-28.1482	-2.0321	0.043			
Risk				-11.2878	-11.7986	0.000	1.6078	27.944	0.000
BSD	40.235	1.716	0.241	0.8506	2.2767	0.078	-0.3488	-1.736	0.247
CONC	79.410	2.542	0.012	359.9698	10.1424	0.000	-45.9407	-15.715	0.000
GDPG	-0.231	-1.717	0.246	0.0988	1.8244	0.069	0.0179	0.812	0.394
IR	0.047	1.608	0.263	0.1771	3.2226	0.002	0.0257	1.486	0.357
LIQ	-60.902	-4.621	0.005	-12.9051	-7.4007	0.000	-1.7029	-6.523	0.000
LP	0.000	7.484	0.000	-0.0021	-5.0308	0.000	0.0000	7.370	0.000
OBSOTA	0.796	4.457	0.000	0.2085	3.0846	0.002	-0.0530	-3.750	0.000
ROA	-1.661	-0.204	0.839	-82.3991	-1.4198	0.920	-13.1064	-0.012	0.934
SMD	1.844	1.272	0.204	-4.4897	-3.1778	0.002	-0.3985	-3.301	0.001
SZ	2.577	0.384	0.781	-0.3374	-2.3447	0.020	0.0180	10.165	0.000
TAXATION	1.113	7.752	0.000	-0.5839	-7.5500	0.000	0.0682	4.957	0.000
C	-22.011	-1.057	0.210	-18.3925	-1.6136	0.108	4.6332	0.514	0.364
R-squared		0.989			0.404			0.740	
Adjusted R-squared		0.988			0.381			0.730	
F-statistic		2298.799			17.553			73.536	
Prob(Fstatistic)		0.000			0.000			0.000	
Durbin-Watson stat		0.674			0.689			0.719	

Notes:
Statistical significance at 5% (Prob=0.05)
statistical significance at 1% (Prob=0.01)

Table 4.13
Three stage least square estimation for the relationship between bank capital, productivity and risk taking in Pakistani banking
Model where risk=Z-Score

Variable	Eq (1) Y=Z-Score			Eq (2) Y=Capital			Eq (3) Y=Productivity		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	2683.07	52.956	0.000				-0.6631	-6.503	0.000
Productivity	589.68	1.743	0.082	-3.1919	-6.5026	0.000			
Risk				0.0063	52.9565	0.000	0.0003	1.743	0.082
BSD	-707.91	-0.562	0.574	0.6084	0.3276	0.743	2.9914	2.765	0.006
CONC	41950.66	1.749	0.240	5.3830	0.4113	0.681	-9.8068	-1.432	0.153
GDPG	-102.76	-1.086	0.278	0.4544	3.1550	0.002	0.2594	9.381	0.000
IR	-26.95	-0.965	0.335	-0.1103	-2.5850	0.010	0.0752	7.403	0.000
LIQ	5521.50	27.539	0.000	-0.4507	-2.4361	0.015	0.9976	0.683	0.349
LP	-0.03	-2.380	0.018	0.0001	6.2045	0.000	0.0003	21.516	0.000
OBSOTA	-323.05	-2.214	0.000	0.1474	12.8972	0.000	-0.0645	-2.897	0.004
ROA	-135.44	-4.716	0.000	11.4621	0.1029	0.217	-4.0433	-4.314	0.000
SMD	1149.38	3.761	0.000	-5.6560	-0.9935	0.127	-0.4208	-2.688	0.002
SZ	-9.40	-2.093	0.005	0.1689	26.0118	0.000	0.0171	1.282	0.201
TAXATION	274.11	1.328	0.244	0.0219	2.7784	0.006	-0.0733	-1.649	0.191
C	7077.43	0.247	0.783	-0.5586	-0.2478	0.805	-1.7442	-1.783	0.076
R-squared		0.896			0.993			0.689	
Adjusted R-squared		0.892			0.992			0.677	
F-statistic		223.120			3545.200			57.276	
Prob(F-statistic)		0.000			0.000			0.000	
Durbin-Watson stat		2.245			2.119			2.204	

Notes:
Statistical significance at 5% (Prob=0.05)
statistical significance at 1% (Prob=0.01)

Table 4.14
Three stage least square estimation for the relationship between bank capital, productivity and risk taking in Pakistani banking

Variable	Model where risk=LLPTL								
	Eq (1)			Eq (2)			Eq (3)		
	Y=LLPTL			Y=Capital			Y=Productivity		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	0.3090	0.2960	0.450				0.0827	1.716	0.087
Productivity	0.2026	1.500	0.247	0.2916	1.7159	0.087			
Risk				8.2238	0.2960	0.450	1.5298	1.500	0.247
BSD	0.8786	0.838	0.379	2.7875	1.6983	0.102	3.7236	3.575	0.000
CONC	7.3950	10.508	0.000	1.3599	2.2383	0.008	-21.2902	-3.383	0.001
GDPG	-0.0469	-1.387	0.280	-0.0090	-0.1825	0.855	0.2642	10.514	0.000
IR	-0.0103	-1.019	0.000	-0.0255	-1.7188	0.087	0.0723	7.690	0.000
LIQ	0.1075	1.353	0.240	-3.1276	-23.0839	0.000	0.4154	2.080	0.038
LP	0.0003	-6.577	0.000	-0.0004	-2.7667	0.006	0.0008	21.803	0.000
OBSOTA	0.0215	32.508	0.000	0.0324	2.6326	0.009	0.0008	0.041	0.967
ROA	-3.2401	-57.389	0.000	20.8191	6.0771	0.000	-2.6070	-2.590	0.010
SMD	0.0206	0.892	0.373	1.1135	1.9113	0.204	-0.4925	-3.851	0.004
SZ	-0.0091	-1.835	0.098	-0.0408	-1.5636	0.209	0.0223	1.729	0.085
TAXATION	-0.0037	-1.163	0.212	0.1855	1.6315	0.324	-0.0524	-2.002	0.046
C	-0.7264	-1.065	0.216	-4.2400	-4.8478	0.000	-2.8568	-3.236	0.001
R-squared		0.997			0.937			0.694	
Adjusted R-squared		0.996			0.934			0.682	
F-statistic		7518.843			381.513			58.603	
Prob(F-statistic)		0.000			0.000			0.000	
Durbin-Watson stat		2.027			2.188			2.117	

Notes:
Statistical significance at 5% (Prob=0.05)
statistical significance at 1% (Prob=0.01)

Table 4.15
Three stage least square estimation for the relationship between bank capital, productivity and risk taking in Pakistani banking

Variable	Model where risk=VROA								
	Eq (1)			Eq (2)			Eq (3)		
	Y=VROA			Y=Capital			Y=Productivity		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	0.0728	0.412	0.487			0.000	1.1281	1.620	0.243
Productivity	0.0050	0.509	0.611	1.620	0.243				
Risk				387.7229	0.412	0.487	5.3703	0.509	0.611
BSD	-0.0662	-1.838	0.067	47.3746	3.8793	0.004	3.1279	2.466	0.014
CONC	-0.9316	-3.787	0.000	284.2444	5.3167	0.000	-2.5305	-0.332	0.741
GDPG	0.0018	0.645	0.520	-2.6778	-0.9086	0.377	0.2650	6.761	0.000
IR	-0.0004	-0.541	0.589	-0.7489	-1.7142	0.089	0.0784	6.509	0.000
LIQ	-0.1555	-27.817	0.000	-3.5487	-19.5378	0.000	2.1433	1.599	0.121
LP	0.0001	0.121	0.904	-0.0002	-8.2845	0.000	0.0046	23.347	0.000
OBSOTA	0.0089	24.807	0.000	0.0517	3.9870	0.000	-0.1155	-0.912	0.841
ROA	0.4836	8.282	0.000	70.3532	6.9587	0.000	-5.1118	-2.538	0.012
SMD	-0.0603	-1.124	0.231	3.0963	1.7286	0.091	-1.1054	-1.949	0.052
SZ	-0.0012	-5.124	0.000	-0.1463	-0.8360	0.426	0.0112	0.799	0.425
TAXATION	0.0072	7.245	0.000	0.0628	6.1015	0.000	-0.1309	-1.648	0.103
C	0.1693	1.070	0.194	-44.7132	-1.7093	0.239	-0.5555	-0.511	0.610
R-squared		0.860			0.999			0.716	
Adjusted R-squared		0.854			0.999			0.705	
F-statistic		158.177			40502.170			65.245	
Prob(F-statistic)		0.000			0.000			0.000	
Durbin-Watson stat		2.052			2.220			2.069	

Notes:
Statistical significance at 5% (Prob=0.05)
statistical significance at 1% (Prob=0.01)

Table 4.16

Three stage least square estimation for the relationship between bank capital, productivity and risk taking in Pakistani banking.

Variable	Model where risk=VROE			Eq (2)			Eq (3)		
	Eq (1)			Y=Capital			Y=Productivity		
	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.	Coefficient	t-Statistic	Prob.
CAP	-2.020	-1.3377	0.241				3.2043	0.2065	0.417
Productivity	16.600	1.143	0.193	16.2439	0.2065	0.417			
Risk				-1.5802	-1.3377	0.241	2.5618	1.143	0.193
BSD	56.091	1.680	0.104	54.4164	1.3403	0.158	4.6553	23.117	0.000
CONC	404.354	4.645	0.000	422.5186	8.0157	0.000	-108.3646	-3.985	0.004
GDPG	4.585	1.537	0.139	-4.5247	-1.1507	0.186	0.2576	8.476	0.000
IR	-1.364	-1.626	0.141	-1.2962	-1.0950	0.193	0.1264	4.616	0.000
LIQ	-12.121	-1.033	0.191	-3.5500	-6.0679	0.000	5.0468	0.653	0.324
LP	0.001	1.433	0.162	-0.0006	-1.8989	0.043	0.0001	1.365	0.114
OBSOTA	0.567	0.241	0.413	0.1547	4.4747	0.000	-0.3186	-13.935	0.000
ROA	-2.833	-0.820	0.413	30.3479	0.1894	0.291	-4.2750	-1.166	0.144
SMD	2.262	1.776	0.077	3.7517	0.9732	0.000	-3.6443	-26.170	0.000
SZ	0.290	0.628	0.314	-0.2524	-0.1849	0.264	0.0021	0.696	0.487
TAXATION	-0.038	-0.456	0.648	0.1343	0.7169	0.297	-0.4970	-1.042	0.197
C	10.339	1.518	0.134	-7.8513	-19.0371	0.000	-14.8451	-1.837	0.083
R-squared		0.522			0.638			0.989	
Adjusted R-squared		0.504			0.624			0.988	
F-statistic		28.249			45.490			2296.045	
Prob(F-statistic)		0.000			0.000			0.000	
Durbin-Watson stat		0.789			0.882			0.846	

Notes:

Statistical significance at 5% (Prob=0.05)

statistical significance at 1% (Prob=0.01)

Table 4.2 reported the significant positive association between risk taking (LLPTL) and technical efficiency. Pakistani banks try to produce maximum outputs with the help of minimum level of inputs which leads to increase in technical efficiency. Lower level of costs are assigned to monitor the credit, moreover no strict credit checks, all this make the risk level to go up. Consequently, little credit screening and monitoring of advances boost the production of credits, this provide the incentive of large scale production to banks, a higher level of technical efficiency achieved in this way.

Talking about bank specific factors, "Bank size" significantly influences technical efficiency in same direction. State owned banking firms of Pakistan are of large size on the basis of total assets, developed branch network throughout the country make them to approach more economic entities and engaged in number of business activities more than other commercial banks make them able to get the benefits of large scale production. Due to scale economy state owned banks reduce their cost level of production which incorporates the higher level of technical efficiency. Findings of this study proposed negative and significant impact of liquidity on the level of bank's efficiency, because to fulfill the daily cash requirements to manage the current account transactions, banks offer higher interest rates on deposits which make "inputs" more costly, consequently, banks with large volume of advances face cost inefficiency which result in technical inefficiency. Taxation also has negative impact on efficiency level, higher level of tax payments causes increase in costs of operations, and managers of such banks have not much room to reduce the level of costs so all this results in declining technical efficiency level. Another factor, productivity of labour (LP), negative association with technical efficiency, and significant relationship proposed by results, the fact behind the screen is the increasing cost of inputs. Productive labour demands higher level of wages, increase in wage and salary increase the cost which negatively affect technical efficiency in Pakistani banking sector.

Talking about industry specific factors, concentration found negatively associated with efficiency level, highly concentrated banking sector do not provide much room to managers to do something better for improvement of technical efficiency of the bank. The findings suggest that large size banking firms more often willing to set lower position of capital when risk is estimated by measures except Z-Score. Results reported negative association of size of the bank and capital level. Banking sector development has positive and significant link with capital position reported in table 4.1 to 4.4. Banks operating in developed market usually have better capital positions. High level of capitalization provides a ground to managers to compensate the higher costs of funds which causing technical inefficiency.

The link of pure technical efficiency with all risk measures (Z-Score, LLPTL, VROA, and VROE) and capital level found same as revealed in table 4.1 to 4.4. The incorporation of pure technical efficiency in the model reported in table 4.5 to table 4.8. Comparing the findings reported in table 4.5 to table 4.8 with results of

technical efficiency most of the results found consistent. Table 4.9 to table 4.12 reported the estimations of scale efficiency with capital ratio and all risk measures. Results revealed the significant negative link between liquidity and capital ratio. Liquidity significantly brings down the level of capital ratio and makes bank highly capitalized. The number of non performing advances is high, specifically in public sector commercial banks because majority of advances made to public sector firms which are inefficient and very low capability to repay the advances, it creates the illiquidity in banking firms which reduces the level of capitalization, an increase in capital ratio which works as cushion to soak up the loan losses, finally more credit formation higher will be the illiquidity and lower will be the level of capitalization. Banking sector development and concentration of market positively influence level of banks capital, as results reported in table 4.10 to 4.12.

Lastly, the connection between risk and level of capital incorporating productivity index estimated. Table 4.13 to table 4.16 provides examined results of productivity association with level of capital and bank's risk position. Empirical findings are consistent with suggested relationship by Altunbas et al. (2007) and Tan and Floros (2013), results suggested that liquidity is positively associated with level of capital which is in line with previous estimations. Talking about industry related factors, as Pakistani banking sector is not much concentrated but still there is a lack of competition due to high concentrated market which causes significant positive impact on level of capital; except in case of risk measure Z-score. Fiordelisi et al. (2011) reported the same link between level of capital and concentration in case of European countries. Pakistani banking industry is in developing phase, still not much developed, but positively contributing towards productivity improvements. Pakistani banking sector in comparison with stock market is developing more rapidly, which provide a platform to customers to raise funds, so increased number of customers positively influence the productivity level of banks. Improvements in stock market development attracts customers which reduces the opportunities for banks to retain customers, consequently, reduction in number of customer reduces the productivity of the banks. In case of macroeconomic forces inflation rate has positive impact on Pakistani banks, same case with GDP growth ratio. Technological developments are making a significant positive contribution in productivity levels of the banks. The increased productivity due to inflation can be justified with the fact that higher level of inflation causes reduction in value of funds, and for this reason deposit level of banks goes down, so to make banks productive and to earn substantial profits, managers make more efforts which results in improved productivity.

5. Conclusion and Future Recommendations

In this research work, empirical investigation conducted to find out the association of risk taking behavior with level of capital and productivity or efficiency of banking sector of Pakistan, a deeply investigation made by including four risk measures and three efficiency explanatory indexes and one productivity index. This study examined the data of Pakistani banks over the period 2005 to 2014 which includes the effects of financial crisis of Asia (2007). During this period, the main concern for the banking sector was to improve the efficiency level and making the environment more competitive.

The empirical findings proposed positive association between Z-score and capital level of Pakistani banks. Moreover, other risk indicators provided evidence of significant negative association. The link between risk levels (Loan Loss Provisions to total loans) and "technical efficiencies" found significantly positive. In case of banking factors, large Pakistani banks on total assets basis are technically more efficient, on the other hand technical and pure technical efficiencies declines in case of higher liquidity. Liquidity also influences level of capitalization positively. Finally, positive association of GDP growth rate and inflation with productivity of Pakistani banks is suggested by the findings.

In this study, due to time and data limitations Islamic banks and Microfinance banks are not taken into consideration. An empirical investigation is required to investigate the same relationship as elaborated in this study, further a comprehensive comparative empirical study on Islamic, Microfinance and other private commercial banks in context of risk taking behavior in relation with efficiency and capital levels is required to fill the gap. It is believed that current study might be helpful for regulatory authority of Pakistani banking system, investors, and policy makers of banks. As well as, it will provide the base contextually for further studies and a contribution to empirical literature.

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