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EFFECTS OF FINANCIAL LIBERALIZATION ON THE COST EFFICIENCY OF PAKISTANI BANKS
A Stochastic Frontier Approach

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Abstract. This paper provides an analysis of the impact of financial liberalization reforms on the Pakistani banking sector during 1994-2000. Stochastic frontier analysis was applied to a three input-two output translog cost function specification to measure technical efficiency. A U-shaped efficiency trend emerged over the sample period indicating the lagged impact of reforms on bank efficiency. Intra-industry efficiency comparisons based on bank size and ownership were also made. Foreign banks were found to be the most efficient, followed by domestic private banks while state-owned banks appeared to be the least efficient. No significant relationship between bank size and efficiency emerged although large banks were found to be the most inefficient. Inefficiency and number of branches were also found to be positively linked.

I. INTRODUCTION

A large number of industrialized and transition economies have liberalized their banking and financial systems over the past two decades.[1] In a rapidly evolving financial market worldwide, bank regulators, managers and investors are concerned about how efficiently banks transform their expensive inputs into various financial products and services (Hassan, 2002). The primary objective of financial reforms is to enhance the efficiency and performance of banking institutions, enabling them to effectively compete in the excessively competitive global economy. Banking reforms have included measures such as licensing of private domestic banks, eradication of barriers

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[1]See Fanelli and Medhora (1998) for a survey on banking reforms.

to foreign entry, privatization of public financial institutions, removal of interest rate ceilings and the removal of quantitative controls on lending (Hardy *et al.*, 2005).

Given the centrality of the banking sector to the economy, the extent to which the objectives of financial reforms are achieved is fundamental to the well being of the economy as a whole. However, given the rapid changes in the financial services industry efficiency studies have been unable to keep pace with these changes, in terms of both breadth and maturity. The majority of efficiency studies have focused on the impact of deregulation in the US banking industry.[2] Currently there is a serious dearth of empirical research on the banking sectors of developing countries.

In Pakistan, very few studies have been undertaken to analyze the impact of financial reforms on commercial bank efficiency. A majority of these studies have adopted non-parametric approaches to analyze bank inefficiency. For instance, Ataullah *et al.* (2004) and Akhtar (2003) have used the DEA approach to examine technical efficiency of the Pakistani banking sectors in the post financial liberalization period. However, the results of these non-parametric approaches have not been unanimous.

In the Pakistani context only Iimi (2002) has used the stochastic frontier approach to rank state owned Pakistani banks on the basis of efficiency in the post reform period.

In an attempt to fill the gap in research and to reconcile the results of existing studies, this paper evaluates the impact of the reforms on the Pakistani banking sector. A stochastic frontier methodology is employed to calculate the efficiency measure for Pakistani banks over the period 1994-2000.

A seven year (1994-2000) unbalanced panel data is used to derive the inefficiency figures for Pakistani banks. The estimates reveal that Pakistani Banks have on average operated at the 63% level of efficiency across the sample period. This is quite low compared to international and regional standards.

In order to make the analysis relevant for future research and policymaking, the Pakistani banking sector has been categorized on the basis

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[2]According to Hassan (2002), around 70% of banking efficiency studies have examined the US banking industry.

of ownership and size. Through the classification of banks into various categories (state-owned, private, foreign, small, medium and large) intra-industry comparisons of efficiency across time have been made.

The paper is divided into the following sections: section II gives an overview of the developments in the Pakistani banking sector since the 1970s. Section III provides a review of literature regarding efficiency estimation and bank efficiency studies. Section IV elaborates on the data and empirical model, while section V includes a discussion of the empirical results. Finally, section VI concludes the paper and provides policy proposals.

II. AN OVERVIEW OF THE PAKISTANI BANKING SECTOR

Traditionally, the Pakistani Banking sector has been one of the most inefficient sectors of the economy (Iimi, 2002). The nationalization of the banking sector during the 1970s was politically justifiable due to the need to finance state-owned enterprises (SOEs), which suffered from inadequate liquidity and capital (Iimi, 2002). By the 1980s there were only five major public sector banks while the operations of foreign banks were restricted to a few large cities. At the beginning of 1990 the share of public sector assets in total assets was 93.8% (SBP, 2000). Banks during this period were given detailed instructions and regulations on the allocation of credit to specific sectors, moreover the government directed the direction and prices of financial services provided by the banking sector (Ataullah *et al.*, 2004). As a result of the government's discretionary intervention the financial sector, the national commercial banks (NCBs) and development financial institutions (DFIs) accumulated substantial non-performing loans. In the highly regulated environment there was little incentive for banks to operate efficiently (Hardy *et al.*, 2005).

In light of the inefficient performance of the banking sector and the negative consequences on the general well being of the economy, in 1990 the government embarked on a journey to reform the banking sector. The objective of the reform was to create a competitive banking sector based on market-based indirect system of monetary exchange and credit management for better allocation of financial resources. Under such a system the government aimed to strengthen the governance and accountability of the banking sector. The reforms included seven important areas: "financial liberalization, institutional strengthening, domestic debt, monetary management, banking law, foreign exchange and the capital market" (SBP, 2000, p.2).

Under the privatization policy, Muslim Commercial Bank and Allied Bank of Pakistan were sold to the private sector. Other nonproductive and inefficient state owned banks were also downsized and restructured to compete with the fast emerging private banks. In order to enhance the transparency of financial institutions under the Banking Companies Ordinance, 1962, the loan recovery process was streamlined through greater reporting requirements. Moreover, the State Bank through the Credit Information Bureau, acted as a supervisory board which could hold the commercial banks accountable for their performance (SBP, 2003, pp. 26-28).

III. LITERATURE REVIEW

APPROACHES TO FRONTIER ESTIMATION

The use of frontier techniques for cost efficiency studies of the banking industry is probably the most controversial area of research. The underlying controversy stems from at least two sources: the general debate in the empirical production analysis literature (for example, estimating methods and the meaning of estimates) and the peculiarities of the banking firm (for example, modeling the firm with the production or intermediation approach (Kaparakis *et al.*, 1994).

The basic framework for studying inefficiency as introduced by Farell (1957), defines inefficiency as deviations from the "optimum behavior". Under this approach a best practice frontier is created to serve as a benchmark for optimum behavior, deviations from this optimum serve as measures of inefficiency Frontier analysis provides an efficient method of numerically ranking firms on the basis of technical and allocative efficiency. Two types of frontier analysis have been used namely stochastic and deterministic.[3] These approaches differ in the shape imposed on the frontier and the restrictions on the random error term.

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[3]Deterministic Frontiers can be either non-parametric (*e.g.*, Farrell, 1957) or parametric, and in the latter case, can be either non-statistical (*e.g.*, Aigner and Chu, 1968; Timmer, 1971) or statistical (*e.g.*, Afriat, 1972; Richmond, 1974). Stochastic frontiers are either parametric (*e.g.*, Aigner, Lovell and Schmidt, 1977; Meeusen and Van den Broek, 1977) or non-parametric (*e.g.*, Banker and Maindiratta, 1992). Schmidt (1985-86), Forsund, Lovell and Schmidt (1980) and Bauer (1990) review this literature with a discussion of the technical and conceptual problems associated with the estimation of frontiers and the difficulties of measuring efficiency relative to the frontier benchmark (Kaparakis *et al.*, 1994).

Deterministic frontiers by their very nature are fixated in the relevant space and encompass all sample observations; due to this only a small subset of the data supports the frontier, making it prone to sampling, outlier and statistical noise problems, greatly undermining the efficiency of the estimates (Kaparakis *et al.*, 1994).

Stochastic frontiers avoid the problems associated with the deterministic approach as they explicitly consider the stochastic properties of the data, and distinguish through a composite error term between firm-specific effects and random shocks or statistical noise. Within the stochastic frontier analysis, there are parametric and non-parametric approaches to estimation. Non-parametric approaches lag in several respects; firstly there is no random error when the frontier is created, hence the non-parametric approach does not take into account any random effects in measuring efficiency/inefficiency. This implies that estimated efficiency or inefficiency may give an inflated value making the results uncertain (Grabowski *et al.*, 1994).

The parametric approach to frontier analysis takes into account the random effects and is therefore superior to non-parametric approaches. The three main parametric approaches are: stochastic frontier approach (SFA), distribution-free approach (DFA) and the thick frontier approach (TFA). The stochastic frontier approach posits a composed error term where inefficiencies are assumed to follow an asymmetric distribution, usually the half normal, while random errors follow a symmetric distribution (Berger and Humphrey, 1998). One problem with the parametric stochastic frontier approach is regarding the appropriateness of the explicit production or cost function (Kaparakis *et al.*, 1994). Secondly, in cross-sectional studies strong distributional assumptions must be imposed on the error term. Such arbitrary assumptions regarding the distribution of the error term can result in serious distortions in inefficiency estimates (Greene, 1993).

STUDIES OF BANK EFFICIENCY

The impact of financial liberalization has been the subject of considerable academic research. Studies have shown mixed results regarding the impact of deregulation on the efficiency and performance of the banking sector. The deregulated and competitive environment in the post reform period often poses a challenge to the efficiency of commercial banks. Research based on the financial reforms of the US deregulation reveal mixed effects on the efficiency of the institutions in the pre and post reform period. Berger (2001) in his study of the US banking sector during 1991-97 revealed that cost productivity declined as a result of deregulation. On the other hand,

Grabowski *et al.* (1994) using the stochastic frontier approach concluded that financial reforms of the 1980s had minimal impact on the efficiency of the US banking sector. Isik and Hassan (2002) have used the DEA to analyze the technical efficiency of the Turkish banking sector in the post deregulation period. Their results suggested that the performance of the banking sector improved as a result of financial liberalization. In contrast, Yildirim (2002) in his analysis of the Turkish banking industry over 1988-1999 using the non-parametric DEA approach found no sustained efficiency gains. Thus, there exists no unanimous consensus on the impact of financial reforms on the efficiency of the banking sector.

IV. METHODOLOGY

THE FRAMEWORK

This paper has used the Stochastic Frontier Approach, developed independently by Aigner *et al.* (1977) and Meeusen and Broeck (1977), to estimate the technical efficiency of commercial banks. Technical efficiency in our context implies the ability of banks to produce maximum output using minimum inputs. Following Kaparakis (1994), we have assumed the banking firm to be an intermediary, utilizing multiplicative input output technology. Maximum output occurs when the firm employs the optimum mix of discretionary inputs given their price vector and the best configuration of observable, non-discretionary firm specific inputs. Banking firms producing on the cost frontier are technically efficient, while banks lying above the cost frontier are technically inefficient.

The SFA is useful for our purposes as it separates random noise from firm controlled inefficiency components, through the composed error structure for the disturbance term. The composed error term helps in the differentiation of technical efficiency from statistical noise, random shocks and external events outside the banking firm's control.

Our analysis proceeds in two steps. First, we have used a cost function to establish a relation between inputs and outputs, in general form the cost function that we have used can be represented as

$$TC_i = C(y_i, w_i)e^{\varepsilon_i} \tag{1}$$

where TC_i is the observed total cost, y_i is a vector of outputs, w_i is a vector of input prices and ε_i is the composed error term specified as

$$\varepsilon_i = v_i + u_i, u_i \geq 0 \tag{2}$$

where v_i is independently and identically distributed (i.i.d.), $v_i \sim N(0,\sigma^2)$, while u_i follows an asymmetric half normal distribution. v_i and u_i are independent of each other and the input and output vectors. Under this composed error term model, the symmetric v_i, captures random effects while the truncated u_i captures the deviations emanating from factors internal to the banking firm. Hence, u_i gives us a measure of technical inefficiency.

Since the error emanating from inefficiencies cannot be negative their distribution is asymmetric or truncated. Both the inefficiencies and the errors are assumed to be orthogonal to the input, output or environmental variables specified in the estimating equation.[4] Through the composed error term we can determine whether a firm lies above the cost frontier due to external shocks or due to internal inefficiency.

Second, we evaluate the role of non-discretionary observable inputs (*e.g.* managerial quality). This has been accomplished through the use of ordinary least square approach to regress the inefficiency index onto a set of non-discretionary inputs or their proxies.[5]

THE MODEL

We estimate a translog cost function with a composite error term that can be written as follows:

$$\begin{aligned} \ln TC \;=\; & \alpha_0 + \sum_{i=1}^{m}\alpha_i \ln p_i + \left(\frac{1}{2}\right)\sum_{i=1}^{m}\sum_{j=1}^{m}\gamma_{ij}\ln p_i \ln p_j \\ & + \sum_{k=1}^{n}\beta_k \ln q_k + \sum_{k=1}^{n}\sum_{l=1}^{n}\beta_{kl}\ln q_k \ln q_l \\ & + \sum_{i=1}^{m}\sum_{k=1}^{n}\rho_{ik}\ln p_i \ln q_k + \varepsilon, \end{aligned} \tag{3}$$

where

$\ln TC$ = the natural logarithm of total cost

$\ln p_i$ = the natural logarithm of the i^{th} input price ($i = 1, \ldots, m$)

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[4]For detailed discussion on the composed error term, *see* Jondrow *et al.* (1982) and Berger and Humphrey (1998).

[5]For details on the two step procedure, *see* Kaparakis *et al.* (1994).

$\ln q_k$ = the natural logarithm of the k^{th} output ($k = 1, \ldots, n$)

ε = $v + u$ with $v \approx N(0, \sigma_v^2)$ and $u \approx$ truncated normal; and $\alpha, \beta, \gamma, \rho$ are coefficients to be estimated.

In theory, the duality condition implies that the cost function must be monotonically increasing in input prices and outputs and concave in input prices. To ensure the monotonicity[6] requirement, two standard properties of the cost function – symmetry and linear homogeneity in input prices – are imposed before estimation. The symmetry condition requires:

$$\gamma_{ij} = \gamma_{ji}$$

$$\beta_{kl} = \beta_{lk}$$

The linear homogeneity condition, on the other hand, requires:

$$\sum_{j=1}^{2} \alpha_j = 1, \sum_{j=1}^{2} \gamma_j = 0, \sum_{k=1}^{2} \beta_k, \sum_{l=1}^{2} \beta_l = 0$$

For linear homogeneity, we can rewrite total cost and input prices using one of the input prices as a numeraire.

We assume a normal distribution for v_i and a half-normal distribution for u_i. The joint density function $f(\varepsilon_i)$ for a half-normal distribution is written as

$$f(\varepsilon_i) = \frac{2}{\sigma} f^*\left(\frac{\varepsilon}{\sigma}\right)\left[1 - F^*\left(\varepsilon_i \lambda \sigma^{-1}\right)\right] \tag{4}$$

where

$$\sigma^2 = \sigma_v^2 + \sigma_u^2, \lambda = \frac{\sigma_u}{\sigma_v},$$

f^* and F^* are standard normal density and standard normal cumulative distribution function, respectively. Moreover, σ_u and σ_v are the standard deviations of one-sided error and the symmetric error, respectively.

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[6]Due, to the flexible nature of the translog cost function it does not globally satisfy the theoretical properties of monotonocity and concavity in factor prices, these properties have therefore been verified locally.

A decomposition suggested by Jondrow *et al.* (1982), of the composed error term ε_i from the cost frontier is used to obtain bank-specific estimates of efficiency. Bank-level measures of inefficiency are usually given by the mean and mode of the conditional distribution of u_i given ε_i. Inefficiency measures can be derived as follows:

$$E(u_i \mid \varepsilon_i) = \sigma^* \left[\frac{f^*\left(\frac{\varepsilon_i \lambda}{\sigma}\right)}{1 - F^*\left(\frac{\varepsilon_i \lambda}{\sigma}\right)} + \frac{\varepsilon_i \lambda}{\sigma} \right] \quad (5)$$

where $\sigma^* = \sqrt{\sigma_u^2 \sigma_v^2 / \sigma^2}$, and f^* and F^* are standard normal density and standard normal cumulative distribution function, respectively.

One problem with the parametric stochastic frontier approach is regarding the appropriateness of the explicit production or cost function (Kaparakis *et al.*, 1994). To alleviate this theoretical drawback the flexible translog functional[7] form has been used. The translog cost function is appropriate in our study as it imposes no restrictions on the first and second order effects and it represents a second-order logarithmic approximation to an arbitrary continuous transformation surface (Kaparakis *et al.*, 1994). Also, the duality property of the translog cost function avoids the problem of multicollinearity inherent in the direct approach. These problems become more severe when excluded inputs are unobservable to the researcher, but observable to the producer. This situation influences the input mix and causes the explanatory variable matrix to be correlated with the error vector (Fuss *et al.*, 1978).

Share equations have been deliberately omitted from our analysis to avoid the restrictive assumptions that they impose while decomposing the overall (cost) inefficiency into technical and allocative components (Kaparakis *et al.*, 1994).

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[7]Despite the flexibility of the translog cost function recent studies have favored the Fourier flexible form due to its global property which has proved useful for banking where scale and product mix are often far from the mean. When using the translog cost function, one holds the maintained hypothesis that the banking industry's true cost function has the translog form. If this maintained hypothesis is false misspecification error occurs (Kasman, 2002).

DATA AND VARIABLE DESCRIPTION

Our data set consists of information from the annual reports of individual banks which include their balance sheets and income statements for the years 1994 to 2000.[8] Unbalanced panel data were used to assess efficiency across the industry and over time. In 2000, there were 37 commercial banks; this figure has not been constant throughout the sample period as new banks started operations and some private banks closed down. For the purpose of meaningful analysis the commercial banks in the panel were classified into three categories: foreign, state-owned and private domestic banks. In 2000, the Pakistani banking industry included a few large state owned banks with assets exceeding Rs. 150 billion (Habib Bank, National Bank of Pakistan, United Bank Limited and Muslim Commercial Bank). 33 Banks had assets less than Rs. 50 billion. Clearly, the Pakistani Banking sector in 2000 was dominated by small and medium sized banks. Table A in the Appendix provides the descriptive statistics for the input and output variables and total assets for 2000.

In order to make the results comparable across time all prices have been normalized by the GDP deflator, taking 2000 as the base year.

Banks like any other firm utilize inputs to produce certain outputs. There is no unanimous consent on the appropriate inputs and outputs for the banking sector. According to the literature on the theory of banking there are two distinct approaches of classifying inputs and outputs the 'production' and 'intermediation approach' (Sealey and Lindley, 1977). We have used the "intermediation approach" as opposed to the "production approach"[9] to determine the inputs and outputs of the Pakistani banking industry. According to Berger and Humphrey, (1997) in the absence of a perfect approach for defining inputs and outputs the intermediation approach is more suitable as it takes into account interest costs which represents two thirds of the costs of financial institutions (Kasman, 2002). Under the intermediation approach banks are viewed as intermediators of financial services; whereby

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[8]Since a relatively long period of time is needed for developments in the market place and regulatory environment to exert their influence on the banking technology (Hassan, 2002), our data set begins from 1994, four years after the reforms were implemented.

[9]Under the production approach, banks are viewed as producers of loans and deposit account services using capital and labor. Under the production approach, the total costs are exclusive of interest expense, and the outputs are measured by the number of accounts services as opposed to dollar values (Grabowski *et al.*, 1994, p. 44).

banks collect deposits and other funds which are converted into earning assets such as loans and investment securities with the help of labor and capital (Kasman, 2002). Total costs under this approach comprise of both interest and other production costs including wages and the cost of capital (Grabowski *et al.*, 1994). The total costs are a proxy for the sum of labor, capital and loanable funds expenditure incurred by Pakistani commercial banks in the production of financial outputs valued in rupees.

Our model includes two outputs and three inputs. Table B in the Appendix gives a detailed illustration of the inputs, outputs and input prices that constitute our model.

IV. EMPIRICAL RESULTS

The parameters of the translog cost frontier and the density functions of v_i and u_i are estimated by numerically maximizing the likelihood function for normal-half normal distribution. The model is estimated by using the maximum likelihood method, which gives consistent and asymptotically efficient estimates (Greene, 1982). Symmetry and linear homogeneity conditions were imposed on the translog cost function while the monotonicity and curvature conditions were verified after estimation. The parameter estimates of translog cost function are illustrated in Table 1. The estimated value of 1.826 for λ indicates that technical inefficiency due to internal sources is relatively more important. The bank specific efficiency[10] is obtained by $E(u_i \mid \varepsilon_{i_i})$, given in equation (5).

Table 2 shows the estimated efficiency results; the implication of the results is discussed based upon average values of the efficiency scores obtained in our sample. The average estimated efficiency scores for the sample period have remained within the 50-70% range, with the lowest cost efficiency being 57% and the highest being 70% with an average of 63%.

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[10]The relationship between efficiency (E) and inefficiency (IE) is E = 1 / (1 + IE) or IE = (1 – E) / E. 78% efficiency implies 28% inefficiency not 22%. The % efficiency figure means that the average bank in the sample could have produced the same level of output using only 78% of the resources actually employed, if it were producing on the frontier rather than at its current location. On the other hand, 28% inefficiency figure means that the average bank needs 28% more resources to produce the same output as the average efficient bank (Hassan, 2002). However, Table 4 has reported an average of the efficiency and inefficiency estimates which have been calculated using the above procedure.

This implies that on average over the six-year period, technical inefficiency raises costs of an average bank by 37%, which could have been saved had the bank been technically efficient.[11]

TABLE 1

Maximum Likelihood Parameter Estimates and Test Statistics

Parameters		Estimate	Standard Error	t-statistic	P-value
α_0		–3.655	7.736	–0.472	[0.637]
α_1	$\ln p_1$	–0.066	0.376	–0.177	[0.860]
α_2	$\ln p_2$	–0.104	0.686	–0.152	[0.879]
β_1	$\ln q_1$	–0.821	0.746	–1.100	[0.271]
β_2	$\ln q_2$	1.072	0.906	1.183	[0.237]
γ_{11}	$\ln p_1 \ln p_1$	–0.151***	0.031	–4.898**	[0.000]
γ_{12}	$\ln p_1 \ln p_2$	0.185***	0.038	4.856**	[0.000]
γ_{22}	$\ln p_2 \ln p_2$	–0.082	0.061	–1.343	[0.179]
β_{11}	$\ln q_1 \ln q_1$	0.214***	0.041	5.274**	[0.000]
β_{12}	$\ln q_1 \ln q_2$	–0.170***	0.040	–4.251**	[0.000]
β_{22}	$\ln q_2 \ln q_2$	0.231***	0.061	3.759**	[0.000]
ρ_{12}	$\ln p_1 \ln q_1$	–0.059*	0.035	–1.698	[0.089]
ρ_{12}	$\ln p_1 \ln q_2$	0.092***	0.034	2.681**	[0.007]
ρ_{21}	$\ln p_2 \ln q_1$	0.032	0.045	0.715	[0.475]
ρ_{22}	$\ln p_2 \ln q_2$	0.048	0.055	0.873	[0.383]
σ^{-1}		1.535***	0.086	17.883	[0.000]
λ		1.826***	0.404	4.523	[0.000]
Log-likelihood		–173.393			
N		272			

Note: Convergence for the log-likelihood function was achieved after 232 iterations at 0.001 tolerance level.
*, ** and *** denote significance level at 10%, 5% and 1% respectively.

[11]The average efficiency estimates for Pakistan are much lower than the annual efficiency averages in US. Bauer *et al.* (1993) reported 85% while Drake and Howcraft (1997) reported 93% for UK. Even Indian banking sector efficiency estimates made by Bhattacharyya *et al.* (1997) were around 79%. For more details, *see* Berger and Humphrey (1997).

TABLE 2

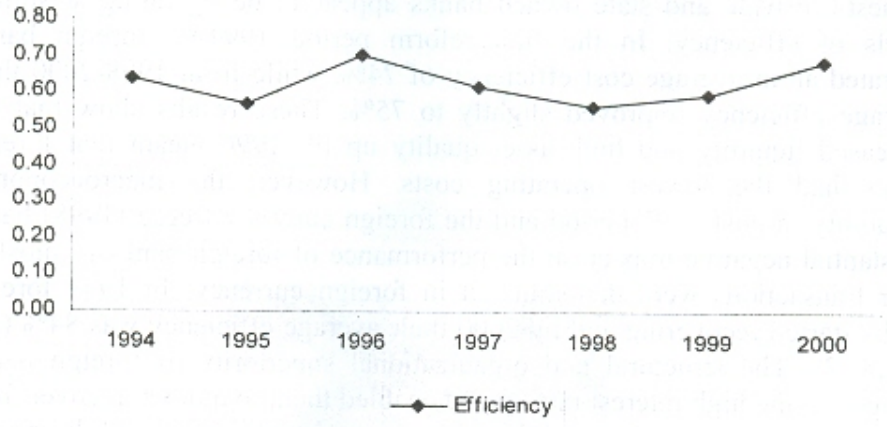
Average Cost Efficiency

Year	Inefficiency	Efficiency
1994	0.69	0.64
1995	0.85	0.57
1996	0.68	0.70
1997	0.78	0.62
1998	0.98	0.56
1999	1.00	0.59
2000	0.73	0.69
Average	0.82	0.63

For the purpose of analysis we have divided our sample into two sections 1994-1997 and 1997-2000. 1997 was crucial for the Pakistani Banking industry as the SBP implemented the second stage of reforms by imposing strict reporting regulations requiring greater transparency, additionally massive restructuring of the banking sector was undertaken.

FIGURE 1

Average Efficiency across Time



As can be observed from Figure 2 efficiency was at its lowest in 1995, peaked in 1996 and thereafter exhibited a U-shaped pattern. After the decline in efficiency in 1997-1998 the performance of the banking sector has been

gradually improving. The impact of deregulation has been significant in explaining the efficiency trend from 1994-2000.

The growth in the banking sector's assets (deposits) following the first phase of reforms in 1990-91 resulted in increased profitability and efficiency up till 1997. However, after the second phase of reforms, in the post 1997 period the average growth rate of deposits fell from 17.9% to 7% (SBP, 2000, p. 3). Since the slow growth rate of deposits indirectly impacted the interest cost, the total costs of the banks increased in the period 1997-2000. Hence the decline in efficiency can be attributed to external circumstances which increased the internal costs of commercial banks.

The limitation of the above analysis is that the industry average does not depict the performance of individual banks which may differ on the basis of ownership or size. Therefore the above averages may represent an over or under estimation of the true efficiency of individual banks. Thus, we also analyze efficiency in the Pakistani banking sector by classifying banks according to their ownership and assets size.

BANK OWNERSHIP AND EFFICIENCY ACROSS TIME

Performance of commercial banks across the three categories foreign, state-owned and private banks has been significantly varied as a consequence of financial reforms. Throughout our sample period foreign banks have been the most efficient as their average efficiency has been the highest, while domestic private and state owned banks appear to be operating at similar levels of efficiency. In the first reform period 1994-97 foreign banks operated at an average cost efficiency of 74%, while from 1998-2000 their average efficiency improved slightly to 75%. These results show that the increased liquidity and high asset quality up till 1996 meant that foreign banks had the lowest operating costs. However, the macroeconomic instability in post 1997 period and the foreign currency freeze (1998) had a substantial negative impact on the performance of foreign banks as most of their transactions were denominated in foreign currency. In 1999 foreign banks started recovering and by 2000 their average efficiency was 84% (*see* Figure 2). The structural and organizational superiority of foreign banks along with the high interest rate spread enabled them to quickly recover from the macro economic crisis and their efficiency actually improved during the second phase of reforms (SBP, 2000).

In sharp contrast, state owned banks have consistently reported the lowest level of efficiency throughout the sample period. This can be attributed to the fact that state-owned banks had poor quality assets as they

mostly lent to state owned enterprises (SOEs), since profit maximization was not their primary objective. In the second reform period (1997-2000) the efficiency of state owned banks declined from 50% to 46%, the highest decline amongst the three categories (*see* Table 3). When the economic conditions deteriorated state owned banks accumulated a large amount of

FIGURE 2

Mean Annual Efficiency of Banks by Ownership

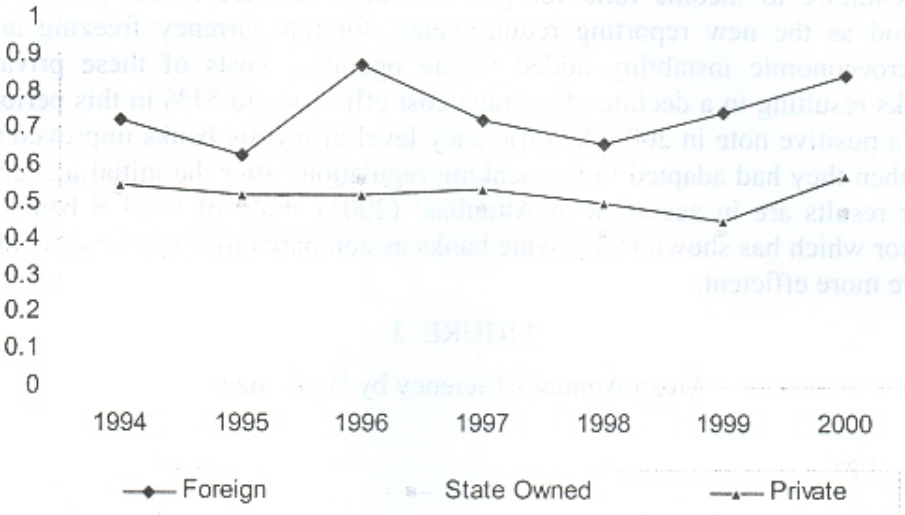


TABLE 3

Average Efficiency by Type of Bank in the two reform periods

Reform Period	Foreign		State-Owned		Domestic Private	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
First: 1994-1997	0.74	0.28	0.50	0.15	0.53	0.11
Second: 1998-2000	0.75	0.38	0.44	0.10	0.51	0.15

Note: The table gives efficiency index values.

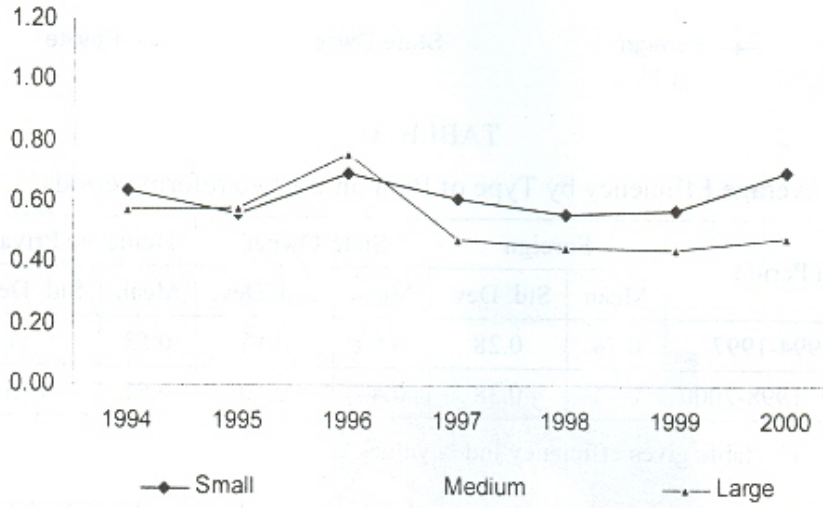
non-performing loans. Under the new banking regulations these had to be reported as losses. Secondly, the restructuring of these banks under schemes like 'Golden Handshake' resulted in extraordinary expenditure which added to the inefficiency. Even the high interest rate spread did not help these banks to recover from the foreign currency freeze of 1998 (SBP, 2000).

However, in 2000 the performance of state owned banks did show signs of improvement and efficiency statistics rose. This shows that the restructuring of the banks after the two-year lag was showing signs of improved efficiency.

Private Banks performed slightly better than state owned banks in almost all years except 1996. After the first reform period these banks benefited from the high interest rate spread and increased liquidity. However, over the sample period the efficiency of private banks steadily declined. The expenditure to income ratio for private banks declined in the post 1997 period as the new reporting requirements, foreign currency freezing and macroeconomic instability added to the operating costs of these private banks resulting in a decline of average cost efficiency to 51% in this period. On a positive note in 2000 the efficiency level of private banks improved as by then they had adapted to the banking regulations after the initial hiccups. Our results are in accord with Altunbas' (2001) study of the US banking sector which has shown that private banks as compared to state owned banks were more efficient.

FIGURE 3

Mean Annual Efficiency by Bank Size



BANK SIZE AND AVERAGE EFFICIENCY

The evidence on the relationship between size and (pure technical) efficiency is mixed. For example, in the case of Singaporean Banks, Leong and Dollery

(2002) find that large banks are more inefficient, due to the complexity of their operations. In contrast, Yildrim (2002) found a positive relationship between size and technical efficiency of Turkish banks. This positive link was attributed to the larger banks' market power and their ability to diversify credit risk in an uncertain macroeconomics environment. Berger and Humphrey (1997) also find a positive relationship between size and efficiency for the US banking sector.

We examined cost efficiency in the Pakistani Banking Industry by dividing banks into three classes (small, medium and large) with respect to their total assets. The assets were taken as a proxy for the bank size. Figure 3 looks at the efficiency trend in these banks over the sample period 1994-2000.

The results suggest that the large banks were the least, while the medium sized banks were the most efficient throughout the given period. However, there was no clear relationship between bank size and efficiency. The large banks also exhibited a falling efficiency trend. The smaller banks seem to be catching up with the medium sized (most efficient) banks over the years. The increased efficiency of smaller banks could be due to their higher flexibility, which allowed them to adapt to changes in the banking industry brought about by the financial liberalization programs. In contrast, the declining efficiency of the largest banks, which primarily constitute the public sector banks, could be due to their large and complex bureaucratic organizational structure, which impeded their ability to keep up with the smaller private domestic and foreign banks. The smaller banks would also have found it easier to adopt modern financial technology (*e.g.* Automatic Teller Machines) and introduce new financial products (*e.g.* car financing and credit cards).

INEFFICIENCY INDEX: ECONOMETRIC ANALYSIS

Having calculated inefficiency measures for banks, we also considered intra-industry variables that could account for inefficiency in the banking sector. We used the ordinary least square approach to regress the inefficiency index on total assets, number of branches, capital labor ratio and the ratio of borrowed funds to total loanable funds. The estimates and their asymptotic t-statistics are shown in Table 4.

The variable of total assets has been employed as a proxy for bank size. Since the estimate for total assets is negative and statistically significant this implies that large banks have a negative impact on inefficiency. However, due to the extremely small value of the estimate it could be argued that the

impact of asset size on the level of efficiency is almost negligible for the Pakistani banking industry.

TABLE 4
Regression Results for Inefficiency Index

Variable	Estimated Coefficient	Standard Error	t-statistic	P-value
C	0.906	0.563	1.609	[0.126]
Assets	–7.13E-12	2.38E-12	–2.997	[0.008]
No. of Branches	1.00E-03	4.00E-04	2.218	[0.040]
Capital/Labour Ratio	0.525	0.571	0.919	[0.371]
Borrowed funds/ Total deposits	0.334	0.474	0.705	[0.491]

Note: Loanable funds include total deposits and borrowing from other banks.

The number of branches was incorporated in our analysis as the operation of a branch network, whether foreign or domestic, contributes to higher cost inefficiency. While at the same time it could be argued that the higher the number of branches the lower is the cost inefficiency (Kaparakis *et al.*, 1994). Our results suggest a positive relationship between cost inefficiency and number of branches. Thus, banks with large branch networks are relatively less efficient than banks with smaller branch networks.

The ratio of borrowed funds to total loanable funds was used to examine the impact of aggressive management behavior on efficiency. In our study the estimate for the ratio of borrowed funds to total loanable funds was statistically insignificant implying that management aggressiveness towards profit maximization had no bearing on efficiency.

Lastly, the capital labor ratio was employed as a measure of managerial discretion in the use of different intensities. A significant coefficient reflects sub-optimal use given relative prices (Kaparakis *et al.*, 1994). Our estimate for the capital labor ratio is again statistically insignificant, implying that management discretion in the use of inputs has not impacted the efficiency of the banking firm.

These results have important policy implications. The more branches that a bank operates the more inefficient it becomes thus there should be

regulation restricting the number of branches. Also banks with lower levels of assets tend to be more inefficient. Thus, the state should support larger banks with fewer branches. These results appear to be in contradiction to our previous analysis, according to which large state owned banks were the least efficient while small and medium sized banks were relatively more efficient. This discrepancy in results could be attributed to the fact that our regression may suffer from omitted variable bias as several important portfolio variables like the ratio of non-accrual total loans and total equity have been omitted due to the unavailability of data.

IV. CONCLUSION

Over the last two decades financial market liberalization and deregulation has transformed the banking systems of a large number of developing countries. The Pakistani banking industry since 1990 has underwent substantial structural changes. The main objective of the financial liberalization program was to promote financial market development through deregulation and create a competitive and efficient banking sector. The program either eliminated or relaxed most restrictions on interest rate and market entry. This paper examined the performance of the Pakistani banks after the deregulation of the banking sector.

A stochastic frontier methodology was used to measure the cost efficiency of the Pakistani banks. Using an unbalanced panel data over the sample period 1994-2000, the translog cost function was employed to calculate measures of bank-level efficiency.

Our findings indicated a U-shaped pattern of efficiency against time was observed, thus implying that deregulation reforms lead to a fall and then an increase in the efficiency level. Hence, in the context of Pakistani banking sector, the financial reforms have been significant in altering the efficiency of commercial banks. However the positive impact seems to manifest itself after a certain time lag.

Bank level efficiency was also examined by looking at the relationship between ownership of banks (foreign, state-owned or private) and inefficiency. Foreign banks were found to be the most efficient while the state owned banks were the least efficient. Asset quality, managerial efficiency, organizational structure and the percentage of non-performing loans in the banks' portfolio were identified as the main factors responsible for this difference.

Furthermore, when banks were classified by asset size, both small and large-scale banks appeared to be inefficient relative to medium sized banks.

However, when inefficiency was regressed over asset size inefficiency appeared to decrease with bank size. Thus, our results were unable to identify any significant link between size and inefficiency.

Lastly, we observed a positive relation between inefficiency and the size of the branch network, while management behavior appeared to have no significant impact on banking efficiency.

Our analysis suggests that there is considerable need for improvement in the efficiency of banks in Pakistan. Incentives should be given for setting up small and medium sized banks since these were generally the more efficient than large banks. Finally, as noted by Attaullah *et al.* (2004), the accumulation of non performing loans is not solely due to the ineffectiveness of bank mangers, rather external factors such as economic recessions, political pressure to provide loans to noncredit worthy clients, or the weakness of the legal system to support the recovery of non-performing loans can explain inefficiency to a large extent. A step forward for the liberalization program could be to concentrate on the strengthening of the institutional structure to support good practices in the banking industry, apart from the deregulation of interest rates and enhancing the level of competition.

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APPENDIX

TABLE A

Summary Statistics of Data for 2000

Variable	Mean	Standard Deviation	Minimum	Maximum
Total Assets	41.15	81.88	0.61	370.75
Price of Labor	394039.35	226931.59	91499.18	1023505.63
Price of Capital	0.22	0.20	0.03	0.89
Price of Funds	0.42	0.80	0.05	4.52
Branches	172.65	449.42	1.00	1705.00
Securities	9.07	18.12	0.02	80.37
Loans	20.93	41.61	0.11	203.55
Total cost	3.10	6.12	0.04	26.27

Note: Assets, costs and loans are in billions of dollars.

TABLE B

Definition of Inputs, Outputs and Input Prices

Variable	Variable Name	Description
C	Total cost	Sum of all costs: wage bill + depreciation on and repair to bank property + operating cost + interest paid on deposit an borrowings
Outputs		
q_1	Loans and Advances	The value of loans and advances, which include loans, cash credits, overdrafts and bills discounted and purchased
q_2	Investments	The amount of investment made by the bank consisting of government securities, treasury bills, shares fully paid-up, debentures, bonds and other
Inputs		
x_1	Financial Capital	Total deposits + borrowing from other banks and agents
x_2	Physical Capital	Includes book value of fixed assets, premises, furniture and fixtures
Inputs Prices[12]		
p_1	Interest on Deposits and Borrowing	Total interest paid on deposits and borrowing divided by financial capital
p_2	Cost of Fixed Assets and Premises	Equal to the depreciations on and repairs of bank property divided by total book value of physical capital
p_3	Wage paid to employees	Total wage bill divided by the total number of employees

[12]The input prices are endogenously determined in our model, a few authors have suggested that such prices can be problematic and should be substituted with local market area input prices (Kaparakis *et al.*, 1994).