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Managerial Skills and Technical Efficiency of Commercial Banks in Kenya

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Abstract
This study analyses the relationship between technical efficiency of commercial banks in Kenya and managerial skill characteristics namely the level of education, years of experience and frequency of training. The study also examined the substitution possibilities between a manager's level of education and years of experience in relation to technical efficiency. The hypotheses of the study were that a positive relationship exists between managerial skill and technical efficiency and that there are substitution possibilities between years of experience and education level. Utilizing a stochastic production frontier technique and regression analysis, it was found that there is a positive relationship between technical efficiency and the level of education, years of experience, and frequency of training. The results also indicated that larger bank size, higher capitalisation and greater profitability are associated with higher technical efficiency. The findings did not suggest any substitution possibilities between a manager's level of education and years of experience in relation to technical efficiency. In light of the results, banks ought to appoint managers with high levels of education and experience, and improve through continuous training, the skills of the managers as these lead to higher technical efficiency. These findings are consistent with previous studies that have recognized managerial skill as a major reason why technical efficiency among firms varies (Jones, 1994; Kirkley et al., 1998; Gallacher, 2001; Ugur, 2004; and Bottazzi et al., 2006). The study however does not support previous literature indicating possible substitution between education and years of experience (Vandenberg, 1980; Kirkley et al., 1998; and Imai, 2003).
Keywords: Productivity, Technical Efficiency, Cost X-efficiency, Managerial Skill, Stochastic Frontier Technique

1. Introduction

A financial institution is an organization that collects funds from the public or other organizations and invests them in financial assets (Berger and Humphrey, 1997). Financial institutions in Kenya comprise commercial banks, development finance institutions, non-bank financial institutions, non-governmental organizations and Government programmes. Financial institutions perform a wide range of functions in the financial system but their primary role is to assist in channelling funds from surplus entities into deficit economic entities (Gondwe, 2005). Efficiency is a key concept for financial institutions (Cinca et al, 2002). Not only does efficiency have important ramifications for the institutions themselves such as profitability, competitiveness and solvency but also in the demands placed upon by the regulatory authorities, and in the provision of low risk financial intermediation. The efficiency of financial institutions has been addressed in literature either in terms of scale and scope or in terms of X-efficiency or both (Sakina, 2006).

According to Limam (2001), scale efficiency addresses the question of whether a firm is operating at the minimum of its long-run average cost curve. On the other hand, scope efficiency is measured by the difference between the cost of joint production and the sum of producing the different outputs individually. Cost X-efficiency refers to how close a firm's actual costs are to the costs of a best-practice firm producing the same outputs. Cost inefficiency may arise because managers use more inputs than would a best practice firm (technical inefficiency) or because they employ an input mix that does not minimize costs for a given input price vector (allocative inefficiency) (Berger, 2000).

This study sought to examine the extent to which technical efficiency among commercial banking firms in Kenya is explained by differences in managerial skill. Technical efficiency measures the extent to which banks could reduce input costs for a given level of output (input orientation) or expand output for a given level of inputs (output orientation). Technical efficiency could be deterministic or stochastic and gives the maximum output that can be attained for a given level of input, or the minimum cost for a given level of output and input prices (Limam, 2001).

In order to measure the technical efficiency of a bank, the stochastic frontier analysis approach was used. The most important advantage of this approach in comparison with deterministic methods is that it takes into account the fact that deviation from the frontier could be due to noise in the data or mis-specification errors and not necessarily to inefficiencies (Limam, 2001). For the purpose of this study, the intermediation approach to bank output and input was considered. According to this approach, banks in their role as financial intermediaries use capital, labour, deposits and other borrowed funds to produce earning assets. Within the framework of financial intermediation, banks are also regarded as optimizers of interest income and other income subject to interest and other operating expenses (Leong et al., 2002).

The concept of productivity is closely linked with the issue of efficiency. If a firm is efficient, it is said to be operating on the production frontier i.e. it is achieving best practice. Rising efficiency would therefore imply rising productivity (Rogers, 1998). Gascon and Adenso-Diaz (1997) pointed out that productivity gains have the potential to contribute to an increase in business profit and proved this by analyzing Spanish commercial banks for the period 1987- 1994. Further, the increased competitiveness, internationalization, sophistication of markets and the increased concern about social and ecological issues make productivity improvement important (Tolentino, 2004).

Researchers have long recognized that entrepreneurial or managerial skill is a major determinant of productivity or the reason why production among firms varies (Kirkley et al, 1998). Typically, managers are responsible for organizing efficiently the transformation of inputs into productive outputs (Dawson and Dobson, 2002). Part of this process requires the manager to monitor and evaluate the inputs as well as motivate labour. The manager's performance may be crucial for the success of the business. If the manager performs well and output is maximized for a given set of inputs, profit maximization will result (Dawson and Dobson, 2002). Given that the financial system in most developing countries is dominated by commercial banks and that the performance of the banking sector has repercussions across the length and breath of the economy (Mohan, 2006), the analysis in this study focused on the commercial banks as the key financial institutions in the financial system.

The rest of the paper is organised as follows. Section 2 reviews the commercial banking industry in Kenya. Section 3 is the literature review. Section 4 discusses the research methodology. Section 5 presents the results of data analysis and their discussion. Lastly, section 6 is the conclusion.

2. The Commercial Banking Industry in Kenya

The banking industry in Kenya has undergone a number of major structural changes since independence whose objective was partly to create leaner but efficient banks. These changes include computerization, branch rationalization and staff retrenchment. One of the major reforms undertaken in the 1990s entailed the liberalization of interest rates and replacing direct controls on lending with open market operations (Cihak and Podpiera, 2005). However, it is not clear whether the liberalization has improved the efficiency of credit allocation in the presence of widespread distortions elsewhere in the economy (Cihak and Podpiera, 2005). According to these authors, efforts to enhance efficiency of intermediation in the Kenyan banking sector have in the past been undermined by the presence of large, weak government- owned banks, which accounted for most of the banking system's non-performing loans.

Following the sector reforms in the 1990s, the banks, at the time 42 in number were growing fast and outpacing the economy. In 2005 and 2004, the industry grew by 11% and 18% while the economy managed 5% and 4.3%. This shows that banking accounted for the increase in national output more than the other sectors collectively (Market Intelligence Banking Survey, 2006). The growth experienced in the sector attracted attention from the big banks on the African continent. Standard Bank of South Africa (Africa's largest bank by asset base), through its Kenyan subsidiary Stanbic Bank, has acquired a controlling interest in the CFC Bank group. Nigeria's Ecobank has also been reportedly sizing a buyout target among the local banks. Increasing competition from banks expanding into new markets as well as from non-bank institutions is putting strong pressure on banks to improve their earnings and efficiency. Banks are therefore re-packaging their services and products in order to satisfy the needs of their customers and retain their market value. In the long run, the success and soundness of the banks and the entire sector depends in part on the achievement of operational efficiency (Central Bank of Kenya Annual Supervision Report, 2006).

In order to enhance efficiency, commercial banks in Kenya have continued to adopt technological innovation, in the form of improvements in communication and data processing. Such improvements are giving the institutions opportunities to raise productive efficiency. Much of the consolidation movement in Kenya is also being spurred by the hope of increasing efficiency. Examples of recent consolidations include the acquisition of First American Bank of Kenya by Commercial Bank of Africa and the East Africa Building Society merger with Akiba Bank. Equity Bank seems to have digested well the commercial banking operations of Industrial Development Bank (Market Intelligence Banking Survey, 2006). Organizations commonly view acquisitions as a way to spread the costs of backroom operations and product development over a large base. Acquisitions also allow the design of more efficient branch delivery systems by eliminating overlapping offices, personnel, and other duplicative resources and services (Spong et al., 1995). All these trends suggest that increased productivity must be a central objective of bankers and that utilizing resources in an efficient and effective manner is of paramount importance to banking success.

A review of the literature on the nature of the relationship between managerial skill and technical efficiency provides contradicting results. Some studies support the existence of a positive relationship between the two variables (Jones, 1994; Kirkley et al., 1998; Gallacher, 2001; Ugur, 2004; and Bottazzi et al., 2006). However, other studies have revealed that no relationship exists between technical efficiency and managerial skill (Campell, 1991; Squires et al., 1998; Viswanathan et al., 2000). The contradicting results from these studies have formed the basis for the debate on the nature of the relationship between managerial skill and technical efficiency. This study contributed to the debate by analyzing commercial banks in Kenya. This was based on the formulation of the following research question: Does managerial skill contribute positively to the technical efficiency of commercial banks in Kenya?

In Kenya, two studies have covered the subject of efficiency among commercial banks. Sakina (2006) used Stochastic Econometric Cost Frontier Analysis to investigate the X-efficiency of 33 commercial banks in Kenya and found out that the level of X-efficiency in Kenya's commercial banks is 18%. Evidence was found that the average small bank is relatively more inefficient than the average large bank. Mutanu (2002) used the efficient cost frontier approach to investigate the efficiency scores of highly and lowly capitalized banks. Based on a sample of eight quoted commercial banks, it was found that the low capitalized banks were more efficient than highly capitalized banks.

Although previous studies have presented strong evidence that managerial skill is a major determinant of productivity and efficiency differences among firms, there have been a limited number of studies of this relationship from a financial institutions perspective. The previous studies characterizing managerial skill and technical efficiency have focused largely on the agricultural sector (Kirkley et a!, 1998; Viswanathan et a!, 2000; Gallacher, 2001) and the manufacturing sector (Jones, 1994; Ugur, 2004; and Bottazzi et al, 2006). This void in the literature is surprising given that the quality of functioning of the financial institutions can be expected to affect the functioning and productivity of all sectors of the economy. The present study partially sought to fill this void by extending the research to financial institutions, specifically banks.

From a Kenyan perspective, the paper sought to improve on previous research in the subject of efficiency by examining a different efficiency concept i.e. technical efficiency as opposed to X-efficiency investigated by Sakina (2006). In addition to determining the technical efficiency levels, the study went a step further to explain the extent to which managerial skills account for technical efficiency differences among banking firms in Kenya. The first hypothesis of the study was that there exists a positive relationship between managerial skill and technical efficiency. This hypothesis was based on the argument that managerial skill is one of the key inputs in the production process that significantly contributes to variations in technical efficiency of firms. For example, it has been shown that education shortens the time needed to adjust to changes in production options and/or price ratios (Gallacher, 2001). In addition, the positive contribution of management experience to efficiency appears to be consistent with the notion of learning by doing and the idea that workers become more productive as they learn both job-specific and industry-specific skills (Jones, 1994). The second hypothesis was that there exist substitution possibilities between managerial years of experience and technical efficiency (Vandenberg, 1980). This hypothesis is derived from a common corporate recruitment practice supporting the view that a low level of experience could be compensated by higher level of or vice versa. These hypotheses led to the formulation of the following questions: Does managerial skill contribute positively to the technical efficiency of commercial banks in Kenya? Can the level of education be substituted for job experience?

3. Literature Review

This section reviews literature on the relationship between managerial skill and commercial bank technical efficiency.

3.1 Commercial Bank Efficiency

Firm efficiency depends upon the way it produces outputs from inputs. Producing more outputs than competitors for the same amount of inputs or consuming fewer inputs for the same amount of output is a sign of relative efficiency (Gascon and Adenso-Diaz, 1997). According to Rossi and Ruzzier (2000), productive or overall efficiency is the firm's ability to produce an output at a minimum cost. To achieve that minimum cost the firm must produce the maximum output given its inputs (technical efficiency) and choose the appropriate input mix given the relative price of its inputs (allocative efficiency). Thus, productive efficiency requires both technical and allocative efficiency. Related to the decision of what kind of efficiency concept is going to be used is the type of relation that is going to be estimated: A production function or a cost function. A production function displays the produced quantities as a function of the inputs employed and gives information on technical efficiency only, whereas a cost function shows the total cost of production as a function of the level of output/s and the input prices. This allows for the estimation of the overall productive efficiency (Rossi and Ruzzier, 2000).

The study of bank efficiency is of vital importance from both a microeconomic and macroeconomic point of view. From the micro perspective, studies have shown that the most efficient banks have substantial cost and competitive advantages over those with average or low average efficiency (Spong et al., 1995). From the macro perspective, the efficiency of the banking industry influences the cost of financial intermediation and the financial markets, as banks constitute the spinal cord of financial markets (Rossi et al., 2005). Previous studies have examined efficiency and the associated effects on financial institutions' performance from several perspectives. Barr et al (1999) evaluated the productive efficiency and performance of US commercial banks for the period 1984-1988. Using Data Envelopment Analysis model, the authors found out that there is a noticeable tendency for efficiency to be positively correlated with interest income and negatively correlated with interest expense. The level of non- performing loans to total loans was found to be significant and negatively related to the efficiency scores of the banks.

Production in the banking industry involves the use of intermediate inputs, which take part in the production of final or semi-final outputs. For example, the use of deposit funds for the provision of loans or risk taking behaviour of some bankers by channeling deposits and other available funds into the stock market with the aim of making more money (Mlima and Hjalmarsson, 2002).

It has been observed that one of the major inputs in the production process is human capital. Human capital may contribute to growth in a way analogous to any other factor of production such as the amount of labour or physical capital. Therefore, a high level of human capital leads to increased productivity (Serrano et al., 2003). The term human capital covers a wide range of elements including: Knowledge accumulated via education, skills acquired by training, experience gained during employment, ideas and inventions developed in research, or even personal networks established in the workplace (Tang and Tseng, 2004).

The efficiency of banks has been discussed for years. It has been argued that if the financial institutions operate more efficiently, they might expect a greater amount of intermediated funds and an improved profitability (Hung, 2005). Bottazzi et al. (2006) defined profitability as the outcome of a firm's effort to perform economically viable operations by keeping costs relatively low and setting price relatively high. These authors argue that efficient production is obviously of crucial help, especially in keeping costs low, and it is not surprising to observe that profitability increases with productivity.

3.2. The Relationship between Managerial Skill and Technical Efficiency of Firms

Researchers have been curious about factors that influence the efficiency of financial institutions (Berger and Mester, 1997). Campell (1991) used subjective rankings of managerial skill to assess whether or not skill might be an important determinant of productivity and efficiency in the Tasmanian rock lobster fishery. Campell concluded that skill and technology were not important in the inshore fishery but were very important for explaining efficiency and productivity differences in the offshore fishery. Jones (1994) surveyed 200 manufacturing firms in Ghana in 1993 and by utilizing Cobb-Douglas production function that allows the inclusion of variables affecting productivity; it was found that the more experienced workers are in the firm, the higher the level of productivity. Therefore, experience is an important managerial characteristic that affects efficiency. It has been argued in the learning-by-doing literature that management experience can lead to gains in efficiency through better organization and knowledge of the results of experimenting with alternative production techniques (Stefanou and Saxena, 1998). An increase in efficiency may therefore result from more management experience.

Squires et al (1998) found that participation in a skipper training program did not affect the technical efficiency and productivity of an onshore fishery and noted that perhaps in an offshore fishery, such a program might achieve more success. Kirkley et al (1998) used data on output and input levels for 10 Mid-Atlantic scallop dredge vessels operating between 1987 and 1990, to examine the relationship between technical efficiency of the vessels and characteristics of the skipper (fishing vessel captain). Based on an analysis of the stochastic production frontier, the researchers concluded that skipper skill is an important determinant of vessel productivity and technical efficiency. Better captains or those with better managerial skills tend to have higher earnings, production and technical efficiency. Although the authors were not able to determine threshold or essential levels of experience and education, substitution possibilities were found to exist between years of experience and education levels. Additional analysis of efficiency for two captains of the same background and experience revealed that additional characteristics need to be considered in the examination of skipper skill of the good captain hypothesis.

Viswanathan et al. (2000) studied technical efficiency and fishing skill in a developing country context by analyzing a trawler fishery in Malaysia. Using a stochastic frontier analysis, the researchers found that skipper characteristics other than ethnicity did not significantly affect technical efficiency. In light of this, there does not appear to be any readily observed characteristic pertaining to skipper skill to monitor. The control variable for Chinese skippers was found to be positive and statistically significant in the technical efficiency function. Similarly, the number of Malay skippers declined with increases in efficiency whereas the number of Chinese and other ethnic group skippers rose with increases in efficiency. The possible explanation behind differences in technical efficiency arising from ethnicity could be cultural. Viswanathan et al (2000) found that among the Chinese skippers, there was greater networking and sharing of information within the Chinese community as opposed to Malay fishers. The authors also observed that Chinese skippers were generally the first in the trawl and purse seine fisheries and Malays were comparative late corners. The ethnicity or race variable in the Kenyan banking sector may or may not be of relevance among the managers of commercial banks in Kenya. However,

the impact of ethnicity on the technical efficiency of commercial banks in Kenya is not analyzed in this study.
Kebede (2001) used a stochastic frontier analysis in a study of farm household technical efficiency and conducted a survey of 105 farmers from three villages in western development region of Nepal. An analysis of the determinants of technical efficiency indicated that farming experience and education are both significant variables for improving technical efficiency. Kebede concluded that policies designed to educate people through proper agricultural extension services could have a great impact in increasing the level of efficiency and hence agricultural output. Kebede (2001) also found that female-headed households were more efficient demonstrating good management capacity. Female-headed households had better opportunities to carry out frequent follow up and supervision of the farm activities on their plot.
In a study of Master of Business Administration (MBA) program reputation in the US, Jeon et al (2003) pointed out that good management education should produce efficient managers. The researchers argued that efficient management of production requires optimization of resources and that decision making problems parallel production processes, where desirable outcomes of the decision play the role of outputs, while actions or conditions facilitating these outcomes play the role of inputs. Gallacher (2001) stated that efficient input and output combinations are better achieved by more educated managers. Studies on the relationship between technical efficiency and managerial skill have thus provided mixed results. Due to the apparent importance of human capital as revealed in firm efficiency literature, this paper characterizes managerial skill as one of the inputs to the production process and analyzes its contribution to technical efficiency in Kenyan commercial banks.

3.3. Measurement of Technical Efficiency using the Stochastic Frontier Approach (SFA)

The idea of measuring a firm's performance with respect to a best practice frontier goes back at least to the 1950s. Koopmans (1951) defined technical efficiency as the capability of a firm to maximize output for a given inputs and argued that not all producers were technically efficient. This notion did not however offer any guidance concerning the degree of inefficiency. This issue was addressed by Farrell (1957) when he extended the work initiated by Koopmans and suggested measuring inefficiency as the observed deviation from a frontier isoquant.
Farrell (1957) defined technical efficiency as one minus the maximum equip-proportionate reduction in all inputs that still allows continued production of given outputs. A score of unity indicates technical efficiency because no equip-proportionate input reduction is feasible, and a score less than unity indicates technical inefficiency. Farrell pointed out that a technical efficiency measure could be obtained by using input and output quantity without introducing prices of these inputs and outputs. Farrell (1957) was the first to measure productive efficiency empirically. Using data on US agriculture, he defined cost efficiency and decomposed it into its technical and allocative parts using linear programming techniques rather than econometric methods. His work using linear programming eventually led to the Data Envelopment Analysis and this method is widely used in the literature as a non-parametric non-stochastic technique. Farrell's work also led to the development of stochastic frontier analysis which involved estimating deterministic production frontiers, either by means of linear programming techniques or by modification of the least squares techniques.
Following Farrell's work on the measurement of technical efficiency, researchers in the area of firm efficiency argue that the production possibility set that economic theory associates with productive activity is unknown (Hung, 2005). The subsequent research has therefore focused on the best way to identify the frontier of the production possibilities set. Two methodologies are now available. These are parametric methods and non-parametric methods.
The SFA method is also referred to as the econometric frontier approach and specifies a functional form for the cost, profit, or production relationship among inputs, outputs, and environmental factors, and allows for random errors (Berger and Humphrey, 1997). SFA posits a composed error model where inefficiencies are assumed to follow an asymmetric distribution, usually the half-normal, while random errors follow a symmetric distribution, usually the standard normal. The logic is that the inefficiencies must have a truncated distribution because inefficiencies cannot be negative. Both the inefficiencies and the errors are assumed to be orthogonal to the input, output, or environmental variables specified in the estimating equation (Berger and Humphrey, 1997).
Under SFA, the estimated inefficiency for any firm is taken as the conditional mean or mode of the distribution of the inefficiency term, given the observation of the composed error term. The half-normal assumption for the distribution of inefficiencies is relatively inflexible and presumes that most firms are clustered near full efficiency (Berger and Humphrey, 1997). The stochastic frontier is specified with two error terms (Aigner et al., 1977). One term v_i, is assumed to be independently and identically distributed as $N(0, \delta_v^2)$) and captures exogenous shocks beyond the control of firms. A one sided, non-negative error term, u1, is introduced to represent technical inefficiency. The truncated normal distribution $N \sim N(\mu, \delta_\mu^2)$ is considered. If $\mu_i = 0$,

production lies on the stochastic frontier and is technically efficient. If $u_i > 0$, then production lies below the frontier and is technically inefficient.

The stochastic production frontier permits output Y to be specified as a function of inputs X and disturbance term:

$$Y_{it} = f(X_{1it}, X_{2it} ..., X_{Nit}, A)e^{\varepsilon it} \tag{1}$$

Where Y_i is the output of the i^{th} firm, t is the year, X_{ji} is the j^{th} input of firm i, A represents a vector of parameters, e is the exponential operator, and $\varepsilon_{it} = v_{it} - u_{it}$ is the disturbance term. The technical efficiency for the individual firm, $TE = e^{-u_i}$ U, , or as shown by Coelli's (1994) formula laid out in Kirkley et al (1998), equals the algebraic representation of equation (2):

$$TE_i = \frac{E(Y_i^* / U_t, X_i)}{E(Y_i^* / U_i = O, X_i)} \tag{2}$$

Where E is the expectations operator, Y_i^* is the production of the i^{th} firm, and equals Y_i when the dependent variable is in original units and Exp (*Yi*) when production is in logs. The actual calculation of TE requires deriving the conditional expectation of u_{it} conditional on ε_{it} or $v_{it} - u_{it}$. Coelli derived this equation based on a computer program Frontier® Version 4.1 that enables the formulation of stochastic production and cost estimation functions. The estimates for all the parameters of the stochastic frontier production function and technical efficiency can be simultaneously obtained using the program Frontier® Version 4.1.

In general form, Kirkley et al (1998) show that the conditional expected value of u_{it} equals the algebraic representation of equation (3):

$$E(u_i / \varepsilon_i) = \frac{\delta\lambda}{(1+\lambda^2)}\left(\frac{\phi(u*)}{\{1-\varphi(u*)\}} - u*\right) \tag{3}$$

Where

$$u* = \frac{\varepsilon\lambda}{\delta} + \frac{u}{\delta^2}, \lambda = \frac{\delta_u}{\delta}, \delta = \left(\delta_v^2 + \delta_u^2\right)^{1/2};$$

ϕ and φ are the standard and cumulative normal density functions respectively. The value and statistical significance of u_{it} is important in determining the existence of a stochastic frontier: Rejection of the null hypothesis, H0: $\lambda = 0$, implies the existence of a stochastic frontier. If the value of λ is greater than 1 then production is said to be dominated by technical inefficiency. Coelli (1996) as stated in Kirkley et al (1998) recommended that the preferred test should be a one-sided likelihood ratio test of

$$y = \frac{\delta_u^2}{\delta_v^2 + \delta_u^2}.$$

3.4. Measurement of Managerial Skills

In a study characterizing managerial skill and technical efficiency in a fishery, Kirkley et al (1998) measured primary captain characteristics from a survey of the firms sampled. Information obtained included a fishing captain's race, age, years of formal education and years of experience. Age was not included in the data analysis as it was found to be highly collinear with years of experience. According to Kirkley et al (1998), motivation is likely to be a critical characteristic of skill. However, determining a measure of motivation is likely to be extremely complicated. One possible measure would be the value of debt and assets, for example, many of the best captains had substantial investments and because they intend to keep their investments or possessions, they will work extremely hard (Kirkley et al., 1998).

Mathijis and Vranken (2001) argue that human capital matters not only through age and education but also through gender. The authors surveyed the characteristics of firm managers in Bulgaria and Hungary and found that those with a high proportion of women were more efficient. According to Limam (2001), continuous development of human resources through training is necessary in order to keep up with the productivity improving, cost-saving and rapid changes in techniques, financial instruments and technological developments in banking. In addition to education level relating to academic qualifications, Van Passel et al. (2005) point out that there are other indicators of the level of education, for example, extra training, attending workshops, and reading specialist publications.

3.5. Measurement of Bank Inputs and Outputs

Although much attention has been focused on estimating an efficient frontier and measuring the average differences between banks, the major shortcoming of the studies is their failure to define inputs and outputs (Mlima and Hjalmarsson, 2002). This unresolved question has handicapped the research effort when comparing results from different studies. Differences in efficiency estimates are not only blamed on input and output definitions, but also depend on variation in data sources, efficiency concepts and the measurement method used.

For purposes of defining the input-output relationship in financial institutions behaviour, two main approaches have been developed (Leong et al., 2002). First is the production or service provision approach. In this approach, financial institutions are viewed as producers of deposit and loan accounts, defining output as the number of such accounts or transactions (Leong et al., 2002). The second approach is the intermediation approach where banks in their role as financial intermediaries use capital, labor, deposits and other borrowed funds to produce earning assets (Limam, 2001).

According to Leong et al (2002), the principal criticism of the production approach lies in its exclusion of interest costs and an overemphasis on the role of staff costs and rental costs in defining inputs. This appears to neglect the banking sector's traditional function as distributors and perhaps this is why the intermediation approach seems to have dominated empirical research in this area (Leong et al., 2002). The intermediation approach is more inclusive of the total banking cost as it does not exclude interest expenses on deposits and other liabilities. In addition, this approach approximately categorises deposits as inputs and has an edge over other definitions for data quality considerations (Limam, 2001).

Interest income and non-interest income have been widely recognized as outputs of commercial banks (Yao and Han, 2007). However, a fundamental difficulty arises in the treatment of bank deposits (Leong et al., 2002). Considerable debate in the literature surrounds the input-output status of deposits. Traditionally, deposits are regarded as the main ingredients for loan production and the acquisition of other earning assets. On the other hand, high value- added deposit products like integrated savings and checking accounts, investment trusts and foreign currency deposit accounts tend to highlight the output characteristics of deposits (Leong et al., 2002). Outputs are the profits and revenues generated after the provision of bank services (Mlima and Hjalmarsson, 2002).

In the bank production process, risk weighted assets have been considered as better output proxy than just loans due to several reasons. Firstly, risk weighted assets include off balance sheet whose effect on relative efficiency is likely to be significant given the potential economies of scope in the forward books (Leong et al., 2002). Secondly, since risk weighted assets encompass the entire spectrum of a bank's earning assets (e.g. loans, securities. investments and off balance sheet items). Risk weighted assets therefore offer a more realistic abstraction of the bank's production function. Thirdly, using risk weighted assets as an output proxy avoids the problem of variations in product prices across banks (Leong et al., 2002). During the process of transforming deposits into loans, banks will inevitably incur some impaired loans (Yao and Han, 2007). Impaired loans are the cost the banks have to bear and can be dealt with as a resource to gain interest fields from gross loans (Yao and Han, 2007).

3.6 Technical Efficiency of Financial Institutions in Developing Countries

Cook et al (2000) used various DEA models and panel data covering the period 1992-1997 on Tunisian banks to investigate the impact of liberalization on the Tunisian banking industry. The authors found that private banks, in general, are more efficient than public sector banks. Private commercial banks owe this superior performance to the fact that they carry fewer problem loans, record higher foreign equity participation, and are generally smaller. The analysis also revealed that the reforms have been less successful in closing the efficiency gap between public, domestically owned and private, foreign owned banks.

Limam (2001) used a stochastic cost frontier approach to estimate technical efficiency of Kuwait Banks. Using earning assets as the output and fixed assets, labour and financial capital as inputs, he found that except for the largest two banks, there was large room for improving technical efficiency of most of the banks. He showed that larger bank size, higher share of equity capital in assets and greater profitability are associated with better efficiency. In light of this, it is argued that the only way for banks to better meet the challenge of increased competitive pressure from more powerful banks and future foreign entry would be to increase technical efficiency. Limam (2001) also found that banks produce earning assets at constant returns to scale and hence have less to gain from increasing scale of production through merging with other banks, than from reducing their technical inefficiency. Kirkpatrick et al (2002) used a translog stochastic cost and profit frontier approach to measure the degree of X-efficiency in a panel of 89 banks in sub-Saharan Africa, covering the period 1992-1999. Evidence was found that deterioration of asset quality, specifically the bad loans syndrome, contributes to cost X-inefficiency as well as profit X-inefficiency. It was also found that high capital ratios increase costs and reduce profits, suggesting that bank managers in Sub-Saharan Africa tend to maintain high capital ratios, relative to an optimal level, and thus erode the banks' cost and profit efficiency.

Sathye (2003) measured the technical efficiency of banks for the period 1997-1998 in India. The measurement of efficiency was done using Data Envelopment Analysis. The efficiency of private sector commercial banks as a group was found to be paradoxically lower than that of public sector bank and foreign banks. Obehoizer and Van Der Westhuizeri (2004) measured the technical efficiency and profitability of ten regional offices of one of South Africa's larger banks and showed that there is no significant relationship between technical efficiency and the conventional profitability and efficiency measurements. One of the regions had the second highest technical efficiency but what seemed contradictory is that it was also the most unprofitable region. The conclusion was that it is not necessarily a fact that a region that utilizes its inputs efficiently (technical efficiency) will have a high profit or conventional efficiency ratios.

3.7 Technical Efficiency of Commercial Banks in Kenya

In a study aimed at explaining the factors determining interest rate spread for Kenya's banking sector, Ngugi (2001) observed that during the post-liberalization period (mid-1991), interest rate spreads in the sector were expected to narrow to reflect efficiency gains and reduced transaction costs following the removal of distortionary policies and strengthening of the institutional set-up. However, the experience indicates a widening spread in the post- liberalization period because of yet-to-be gained efficiency and high intermediation costs (Ngugi, 2001). Variations in the interest spread are attributable to bank efforts to maintain threatened profit margins. For example, banks that faced increasing credit risk as the proportion of non-performing loans went up responded by charging a high-risk premium on the lending rate (Ngugi, 2001).

Fiscal policy actions saw an increase in Treasury bill rates and high inflationary pressure that called for tightening of monetary policy. As a result, banks increased their lending rates but were reluctant to reduce the lending rate when the Treasury bill rate came down because of declining income from loans. The banks responded by reducing the deposit rate, thus maintaining a wider margin as they left the lending rate at a higher level. Thus, there was an asymmetric response of lending rates to Treasury bill rates. High implicit costs were realized with the tight monetary policy, which was pursued with increased liquidity and cash ratio requirements. Consequently, banks kept a wide interest rate spread even when inflationary pressure came down (Ngugi, 2001).

In Kenya, it has been found that low productivity banks find it costly to evaluate and monitor small-value loans (Blattman et al, 2004). The lack of public credit institutions (such as a rating agency) makes the evaluation of firm credibility very costly for banks, and dissuades them from lending to small enterprises. Moreover, deficiencies in the legal system hinder the enforcement of contracts, especially debt, and result in relatively high collateral requirements that small firms find slightly more difficult to meet. As a result, small firms who are less likely to possess high-value collateral, face dramatically higher costs of lending than larger ones thus making them more inefficient. Smaller firms have been generally observed to report lower use of credit instruments. Such firms are also less likely to apply for a loan because of cost and rejection fear, and are more likely to feel credit constrained (Blattman et al., 2004).

Transactions costs in the Kenyan banking sector are relatively high, and the supply of credit is limited by the legal and institutional structure of the financial sector. High interest rate spreads are driven by low bank productivity, the presence of many small banks, the difficulty of collecting debt contracts, and the relatively high level of non-performing loans. These problems in turn have been traced largely to an inadequate legal and institutional structure, barriers to sector consolidation, and politically motivated interventions (Blattman et al., 2004).

According to Cihak and Podpiera (2005) the overhead costs in East African banks i.e. Kenya, Uganda and Tanzania are by far the most important component of the interest rate spreads, accounting for about 6-8% percentage points of the spread. The high overhead costs are related to the low productivity and overstaffing of East African banks compared to banks in other sub-Saharan African countries and other emerging market countries. East African banks seem to be overstaffed and their employees less productive (Cihak and Podpiera, 2005). The banks have more than three times as many employees for a given amount of assets, loans and deposits than other banks in emerging market countries. In Kenya, state-owned banks are significantly overstaffed and less productive compared to private domestic banks, which are in turn overstaffed and less productive than foreign-owned banks. This indicates a significant potential for productivity improvements (Cihak and Podpiera, 2005).

Efforts to increase productivity and efficiency in the commercial banking sector in Kenya are evident from the strategies the sector continues to undertake. The very few banks that have not yet completed the decentralization of branches in order to offer 'branches' banking' are close to doing so. No bank worth its salt now wants to be caught without an ATM network, and VISA or MasterCard branded cards. Offering Internet banking is a done thing and does not make news any more. SMS banking is also routine. Banks are naturally asking the question of what next (Market Intelligence Banking Survey, 2006). It has been shown that the very best banks in Kenya have the best balance in terms of assets size, asset quality, profitability and efficiency (Market Intelligence Banking Survey 2006). Banking is increasingly becoming a game of scale, size and scope so the bigger banks over the years have dominated the upper end of the rankings (Market Intelligence Banking Survey 2006).

According to Mutanu (2002), low capitalized banks in Kenya are more efficient than highly capitalized banks.

The low capitalized banks by taking more risks increase their efficiency while the highly capitalized banks feel that taking more risks would be too much risk for their capital and this increases their inefficiency (Mutanu, 2002). The large banks are therefore not utilizing their resources well (Mutanu, 2002). Sakina (2006) found that the level of efficiency was increasing with time which means that the banks are operating further from the efficient cost frontier than before.

In summary, a review of the literature on the nature of the relationship between managerial skill and technical efficiency provides results that support the existence of a positive relationship between the two variables (Jones, 1994; Kirkley et al., 1998; Gallacher, 2001; Ugur, 2004; and Bottazzi et al., 2006). However, other studies have revealed that no relationship exists between technical efficiency and managerial skill (Campell, 1991; Squires et al., 1998; Viswanathan et al., 2000). This study sought to extend studies of technical efficiency in developing countries by measuring the contribution of human capital elements to technical efficiency among Kenyan commercial banks. The first hypothesis of this study envisages a positive relationship between managerial skill and technical efficiency. The second hypothesis was that there exist substitution possibilities between managerial years of experience and technical efficiency.

4. Research Methodology

This section presents the research methodology used in this study. It describes the population and sample respectively. It also discusses the data, the conceptual and analytical models. Lastly, it presents the diagnostic tests applied.

4.1 Research Design

This study employed a descriptive research design. This type of research design aims at explaining relationships between variables. The study examined the relationship between managerial skill and technical efficiency of commercial banks in Kenya. Therefore, the descriptive research design was the most appropriate design for this study.

4.2. The Population

As at October 2007 when the data for this study was collected, the commercial banking sector was comprised of 42 banks. These banks formed the population of the study.

4.3. The Sample and the Sample Period

The sample was made up of 39 commercial banks for which data was available for all the years covered by the study. The sample period was January 2002 to December 2006. Among the three excluded banks, two had been in operation for less than three years while one had been put under statutory management.

4.4. Data and Data Collection Instruments

The data was made up of both secondary and primary data. Secondary data was obtained from the audited financial statements of the commercial banks. The financial statements were sourced from the Bank Supervision Department of the Central Bank of Kenya (CBK). Data on labour which refers to bank personnel and the management expertise necessary for the provision of bank services was captured in the form of staff expenses (SE), while data on borrowed funds and deposits (FDE) was the funds collected on the liabilities side of the balance sheet comprising customer deposits and borrowed funds such as lines of credit.

Investment in physical capital was captured as fixed assets (FA) on the asset side of the balance sheet as measured by investments in offices, branches and hardware (Kosak and Zajc, 2004). Additional input data captured included interest expenses (IE) and operating expenses (OE). The output variables were captured as risk weighted assets (RWA) and trading income (TI). Data on RWA was obtained from the notes to the banks' financial statements while total income was computed as the sum of interest income and other income.

Primary data for bank managers was obtained through a survey of the human resource managers of the banks using a questionnaire. The human resource managers were targeted as the respondents because they are the custodians of human resource information for their organisations. Maximum effort was made to get the managers or their representatives to complete the questionnaires. This included day to day follow up and revisits to the respondents where cases of incomplete questionnaires were detected. The questionnaire contained closed questions, where the respondent's answers to the questions were selected from a given set of possible responses. The data obtained for the bank managers included: years of experience (EX), level of education (ED), frequency of training (TR) and gender (GE). The data for each of these variables was obtained for each financial year under study. Experience was measured by an index of years of managerial experience. Education level was determined by asking how many managers possessed a given level of academic qualifications, for example, doctor of philosophy degree, masters' degree, bachelors' degree, diploma or certificate. Data on the gender of the managers was obtained by asking how many managers in a particular year were female or male, thus making it possible to determine the proportion of female managers in each bank. Due to the difficulties in measuring manager motivation requiring data on the managers' debt, assets or wealth, we restricted our characterization of managerial skill to the relationship between technical efficiency and primary manager attributes.

4.5. Research Models
The conceptual and analytical models are discussed below.
4.5.1. Conceptual Model
The conceptual model defines the relationship between the dependent variable and the independent variables. The dependent variable is technical efficiency while the independent variables are the managerial skills characteristics namely: Level of education, years of experience and frequency of training. The expected signs of the education and experience variables in the model should be positive (Kebede, 2001). The frequency of training variable should also have a positive sign (Limam, 2001). In addition to the managerial skill characteristics, four control variables were included. The first control variable GE relates to the proportion of female managers which was included to test the suggestion that the higher the proportion of female managers the higher the technical efficiency. The expected sign of this variable should be positive (Mathijis and Vranken, 2001). The inclusion of total assets (*ASSETS*) as the second control variable is intended to test the validity of the claim frequently found in the literature that larger banks tend to be more efficient (Fedhi and Duygun, 2000; and Limam, 2001). It is therefore expected that the sign of the total assets variable is positive. The third control variable is the degree of capitalization measured by total value of capital (*CAP*) whose expected sign is negative (Mutanu, 2002). The fourth control variable was the level of profitability measured by the value of profit before tax whose expected sign should be positive (Limam, 2001).
Equation (15) below presents the conceptual model for this relationship.

$$TE = f(ED, EX, TR, GE, ASSETS, CAP, PBT) \tag{4}$$

Where *TE* = technical efficiency, *ED* = managerial level of education, *EX* = years of managerial experience, *TR* = frequency of managerial training programs and job related conferences, *GE* = the proportion of female managers to total number of managers, *ASSETS* = total value of assets, *CAP* = total capital, and *PBT* = profit before tax.
4.5.2. The Analytical Models
A multiple regression model of technical efficiency versus manager characteristics was applied to examine the relationship between the variables. The translog flexible functional form was chosen for the stochastic frontier (Kirkley et al., 1998). This form permits a limited determination of the underlying technology and accommodates the inclusion of a one sided error term to allow estimation of technical efficiency for each observation. In order to determine the technical efficiency of each bank in a given financial year, a balance sheet oriented production function referred to as Model A was formulated where FA, as follows:

$$\begin{aligned} Ln(RWA)_{it} &= \beta_0 + \beta_1 Ln(FDE)_{it} + \beta_2 Ln(SE)_{it} + \beta_3 Ln(FA)_{it} + \beta_{11} Ln(FDE)_{it})^2 + \\ &\beta_{22} Ln(SE)_{it})^2 + \beta_{33} Ln(FA)_{it})^2 + \beta_{12}\{Ln(FDE)_{it})[Ln(SE)_{it}]\} + \\ &\beta_{13}\{Ln(FDE)_{it})[Ln(FA)_{it}]\} + \beta_{14}\{[Ln(SE)_{it}][Ln(FA)_{it}]\} + \varepsilon_{it} \end{aligned} \tag{5}$$

Where *i* indexed individual banks and *t* indexed financial years. The dependent variable is risk weighted assets (RWA_{it}) by the ith bank on the t^{th} financial year, while the independent variables are borrowed funds and deposits (FDE_{it}), staff expenses (SE_{it}), and fixed assets (FA_{it}). $\varepsilon_{it} = v_{it} - u_{it}$ is the disturbance term.
According to Leong et al (2002), technical efficiency scores may vary due to the variables used in the definition of a production function and therefore, for comparison purposes, the study included Model B based on income and expense items whose relationship is expressed as follows:

$$\begin{aligned} Ln(TI)_{it} &= \beta_0 + \beta_1 Ln(IE)_{it} + \beta_2 Ln(OE)_{it} + \beta_3 Ln(FA)_{it} + \beta_{11} Ln(FDE)_{it})^2 + \\ &\beta_{12}\{[Ln(IE)_{it})][Ln(OE)_{it})\} + \varepsilon_{it} \end{aligned} \tag{6}$$

Where *i* indexed individual banks and *t* indexed the financial years. The dependent variable is total income (TI_{it}) by the i^{th} bank in the t^{th} financial year, while the independent variables are interest expenses (IE_{it}) and operating expenses (OE_{it}), $\varepsilon_{it} = v_{it} - u_{it}$ is the disturbance term.
Kirkley et al (1998) specified inefficiency u as a function of control variables representing random variables assumed to account for technical efficiency in production. The independent variables are further assumed to be independently distributed as truncations at zero of the normal $N(\mu_{it}, \delta_\mu^2)$ distribution. $\mu_{it} = Z_{it}\delta.\ Z_{it}$ is a 1 x *p* vector of control variables which are thought to possibly influence the efficiency of commercial banks and δ is a *p* x 1 vector of unknown parameters to be estimated.
In this study, it was assumed that each bank operates on the constant returns to scale production frontier and hence there is a one-to-one, linear relationship between inputs and outputs. For example, if a 10% increase in inputs yields a 10% increase in outputs, the bank is operating at constant returns to scale. This assumption was

important since variable returns to scale requires the decomposition of technical efficiency into pure technical efficiency and scale efficiency. Such an analysis is supported by the DEA methodology (Cummings, 1997) as opposed to the Stochastic Frontier Analysis which was applied in this study.
The technical efficiency function, comprising the vector variables was specified by the equation (18):

$$TE_{it} = a + b_1(ED)_{it} + b_2(EX)_{it} + b_3(TR)_{it} + b_4(GE)_{it} + b_5(ASSETS)_{it} + b_6(CAP)_{it} + +b_7(PBT)_{it} + \varepsilon_{it} \quad (7)$$

Where TE_{it} is the bank level technical efficiency measure for financial year *t*, *a* is a constant, *ED* is the level of education for financial year *t*, *EX* is the number of years of managerial experience for financial year *t*, *TR* is the frequency of training acquired by attending job related courses and conferences in financial year *t*, *GE* is the proportion of female managers to total number of managers for financial year *t*, *ASSETS* are represented by the value of total assets for financial year *t*, *CAP* is total capital for financial year *t* and *PBT* is profit before tax for financial year *t*. The partial coefficients for *ED, EX, TR, GE, ASSETS, CAP* and *PBT* are denoted as b_1, b_2, b_3, b_4, b_5, b_6, and b_7 respectively, while ε_{it} is the error term which is defined by the truncation of the normal distribution with zero mean and variance δ_V^2 The possibility of substitution between the level of education and the years of experience was computed by determining whether a positive linear relationship exists between the two variables and hence the substitution possibilities.

4.6. Diagnostic Tests

In order to test the overall significance of the regression model, *F*-test and *LR* tests were used to estimate if all the individual coefficients together were statistically different from zero at the 95% significance level. To establish the significance of individual variables in each of the models, *t*-test was applied at both 95% and 99% levels of confidence.

5. Results of Data Analysis

5.1Summary Statistics

Table 1 presents the descriptive statistics of technical efficiency scores. The average efficiency scores for Model A (15%) are seen to differ significantly from model B (86%). This may be explained by the differences in the structure of the models. Model A is based on balance sheet variables, which differs significantly from the income and expense variables used in Model B. This indicates that the derived efficiency rankings are sensitive to variable changes.

Table 1 Descriptive Statistics of Technical Efficiency Estimates of Commercial Banks in Kenya (2002 – 2006)

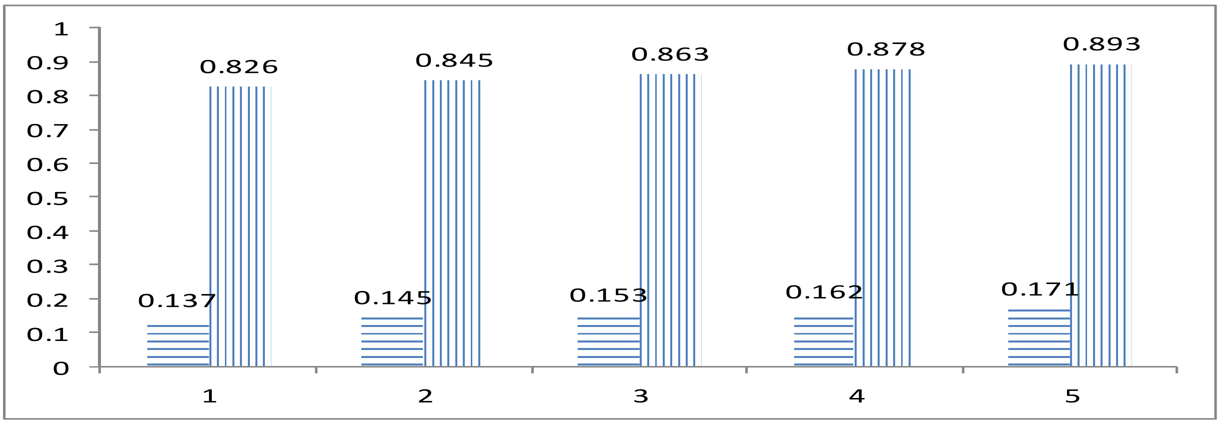
MODEL A		MODEL B	
Statistic	**Efficiency score**	**Statistic**	**Efficiency score**
Minimum	0.0132	Minimum	0.2944
Maximum	0.9144	Maximum	0.9606
Mean	0.1537 (0.0131)	Mean	0.8610 (0.0069)
Standard Deviation	01826	Standard Deviation	0.0965
Skewness	2.4320 (0.1741)	Skewness	-3.2809 (0.1741)
Kurtosis	6.2542 (0.3465)	Kurtosis	14.0749 (0.3465)
N	195	N	195

Note: Figures in brackets are the standard errors.

Model A is a production oriented model where banks transform borrowed funds, deposits and physical capital into assets such as loans and investment securities. The findings indicate that on average, the banks were only able to generate 15% outputs (risk weighted assets) from the input variables (borrowed funds, deposits and fixed assets). While the banks have been very successful in deposit mobilization as evidenced by the high liquidity levels and huge customer funds on their balance sheets, the utilization of these deposit funds to produce loans has not yielded proportionate loan output. This could partly be attributed to the capital to risk weighted assets ratio which could be restricting commercial banks in their lending operations. As the banking industry is characterized by many small banks with relatively low levels of capitalization, this poses a challenge to the banks' ability to expand their loan book despite having a healthy deposit base. A skewness value of 2.4 for this model indicates that the distribution of technical efficiency was not symmetric about the mean. A majority of the observations were clustered below the mean technical efficiency score of 15%. A kurtosis value of 6.3 indicates that the distribution was highly peaked. This is attributed to the high scores of technical efficiency reported by

the top 5 banks in relation to the overall sample.
Model B results which measure the ability to maximise income from loans and advances, investment securities and other assets while minimizing interest expenses and operating expenses, yielded a higher level of technical efficiency compared to Model A. On average, the banks were able to achieve a high ratio of total income to interest and operating expenses (86%). The possible explanation of the high level of efficiency lies in the high cost of financial intermediation characteristic of the banking industry in Kenya. While deposits are poorly remunerated, the interest charged on loans and advances has remained high thus yielding high interest margins for the banks. A skewness value of -3.28 for this model indicates that the distribution of technical efficiency was not symmetric about the mean. A majority of the observations were clustered above the mean score. A kurtosis value of 14.07 indicates that the distribution was highly peaked. This is attributed to the high scores of technical efficiency over 90% reported by the top 12 banks.
Based on the average technical efficiency scores computed over the period of study, Model A reported that 26 out of 39 or 67% of the banks generated a lower proportion of risk weighted assets (below the average of 15%) compared to the inputs of borrowed funds and deposits. Under Model B, 14 out of the 39 or 35% of the banks achieved a technical efficiency level of below the average score of 86%.
Figure 1 illustrates the distribution of mean technical efficiency scores for the sample banks for each of the years, from 2002 to 2006. The findings under model A indicate that the average productivity of risk-weighted assets improved by 3 percentage points from 14% in 2002 to 17% in 2006 as indicated by the horizontal patterns in Figure 1. On the other hand, the findings under model B indicate that the average growth in the efficiency of generating income improved by 6 percentage points from 83% in 2002 to 89% in 2006 as shown by the vertical patterns in Figure1.

Figure 1 Mean Plots for Average Technical Efficiency Scores of Commercial Banks in Kenya (2002 - 2006)



Note: Horizontal patterns indicate the average productivity of risk-weighted assets. Vertical patterns indicate average technical efficiency in generating income.

5.2. Ordinary Least Squares (OLS) Estimation of Technical Efficiency of Commercial Banks in Kenya

Ordinary least squares (OLS) estimates of the input parameters were computed for the translog functional form (model A) and the findings presented in Table 2.

Table 2 OLS Estimates of Parameters Derived using Translog Functional Form (Model A)

$$Ln(RWA)_{it} = \beta_0 + \beta_1 Ln(FDE)_{it} + \beta_2 Ln(SE)_{it} + \beta_3 Ln(FA)_{it} + \beta_{11} Ln(FDE)_{it})^2 + \beta_{22} Ln(SE)_{it})^2 + \beta_{33} Ln(FA)_{it})^2 + \beta_{12}\{Ln(FDE)_{it})[Ln(SE)_{it}]\} + \beta_{13}\{Ln(FDE)_{it})[Ln(FA)_{it}]\} + \beta_{14}\{Ln(SE)_{it}][Ln(FA)_{it}]\} + \varepsilon_{it}$$

Parameters	Coefficients	*r* ratios	*p* values	Decision
β_0	31.529	6.050**	0.000000	Reject H_0
β_1	-3.169	-5.601**	0.000000	Reject H_0
β_2	0.566	0.860	0.391000	Accept H_0
β_3	1.123	2.223*	0.027000	Reject H_0
β_{11}	0.086	6.412**	0.000000	Reject H_0
β_{22}	-4.461	-2.718**	0.000000	Reject H_0
β_{33}	-0.016	-0.642	0.521000	Reject H_0
β_{12}	-12.203	4.574**	0.000009	Reject H_0
β_{13}	7.108	3.667**	0.000320	Accept H_0
β_{14}	-0.022	-0.619	0.537000	Reject H_0

Note: Adjusted R^2 = 0.937; ($F_{(6,187)}$ = 481 .702, *p*-value <0.01) ; * denotes significance at 5% level (*p*-values < 0.05); Critical values = 1.96 (at 5%); ** denotes significance at 1% level (*p*-values < 0.01); Critical values = 2.57 (at 1%)

With the adjusted R^2 value of 0.937, the inputs of model A were able to explain 94% of the variations in the output proxy variable of risk weighted assets, *RWA*. The *t*-statistics (alongside their corresponding *p*-values) were used to determine the significance of each variable in the model. Table 4.1 indicates that the coefficients of funds and deposits (*FDE*) and fixed assets (*FA*) are statistically significant. Staff expenses (*SE*) were found to be insignificant in the production process. Since SE was individually insignificant in the model, a *t*-test was performed on the linear restriction of the parameter β_2 under the null hypothesis H_0: $\beta_2 = 0$. A *t*-statistic of 0.860 was obtained and since it is less than 1.96 (critical value of t-test at 5% level), the null hypothesis was accepted. Therefore, analyses using Model A only FDE and FA were used as the explanatory variables.

Similarly, Table 3 indicates the Ordinary least squares (OLS) estimates of the input parameters that were computed for the translog functional form (model B). With the adjusted R^2 value of 0.938, the inputs of model B (interest expenses and operating expenses were able to explain 94% of the variations in the output proxy variable which is total income (*TI*). The findings indicate that the explanatory variables (IE and OE) were jointly significant in the ($_{(4,190)}$ 736.976, *p*-value < 0.01). Therefore, in subsequent analyses using model B both explanatory variables were used.

F

Table 3 Estimated Parameters using Translog Functional Form for Commercial Banks in Kenya (2002-2006)

Model B

$$Ln(TI)_{it} = \beta_0 + \beta_1 Ln(IE)_{it} + \beta_2 Ln(OE)_{it} + \beta_{11} Ln(FDE)_{it})^2 + \beta_{22}\{[Ln(OE)_{it})^2] + \beta_{12}\{[Ln(IE)_{it}][Ln(OE)_{it}]\} + \varepsilon_{it}$$

Parameters	Coefficients	*r* ratios	*p* values	Decision
β_0	29.208	5.333**	0.0000	Reject H_0
β_1	-0.705	2.059*	0.0410	Reject H_0
β_2	-1.197	2.539*	0.0120	Reject H_0
β_{11}	-0.022	-1.310	0.1920	Accept H_0
β_{22}	1.202	1.006	0.3160	Accept H_0
β_{12}	0.096	3.949**	0.0001	Reject H_0

Note: Adjusted $R^2 = 0.938$; ($F(4, 190) = 736.976$, p-value < 0.01) * denotes significance at 5% level (P-values < 0.05); Critical values = 1.96 (at 5%) ** denotes significance at 1% level (P-values < 0.01); Critical values = 2.57 (at 1%)

5.3 Estimation of Technical Efficiency of Commercial Banks in Kenya

5.3.1. Results of test of Appropriateness of the Stochastic Frontier Analysis Technique

Generalized likelihood ratio tests were performed to establish whether the production frontier is appropriate for the sample of data (H_0: $\gamma = 0$). The null hypotheses were that technical inefficiency effects are absent. The value of γ calculated as follows:

$$\gamma = \frac{\sigma_u^2}{\sigma_v^2 + \sigma_u^2}$$

It lies between 0 and 1. Where σ_u^2 the variance of the non-negative technical efficiency component of the error is term (u_i) and σ_v^2 is the variance of the two-sided "noise" component of the error term (v_i). By testing for $\gamma=0$, the test indirectly tests whether or not $\sigma_u^2 = 0$. Acceptance of the null hypothesis $y = 0$ indicates that the u term is absent in the production function's error term. It also implies that the stochastic production frontier should be rejected in favour of ordinary least squares estimation. The LR statistics were computed for models A and B using the Frontier® Version 4.1 following the methodology outlined by Coelli (1996). The findings are presented in Table 4 below and indicate that the null hypotheses were rejected in both cases. Therefore, further analysis applied the stochastic estimation approach.

Table 4 Results of the Generalized Likelihood Ratio Tests of the Stochastic Frontier Production Function

Model	Null Hypothesis	Likelihood Ratio	d.f.	Decision
Model A	$\gamma = 0$	175.2517**	3	Reject H_0
Model B	$\gamma = 0$	26.5291 **	3	Reject H_0

Note: Tests for H_0: $\gamma = 0$ follows a mixed chi-square distribution. Degrees of freedom are defined by the number of restrictions imposed; * denotes significance at 5% level; Critical values = 5.138 (at 5%) ; ** denotes significance at 1% level; Critical values = 2.57 (at 1%).

5.3.2. The Maximum Likelihood Estimates (MLEs)

The Maximum Likelihood Estimates (MLEs) of the stochastic frontier production model with assumption of the half-normal were generated and the findings for both models are presented in Table 5. The results indicate that model A yielded a γ value of 0.94503, (which is the ratio of the variance of the bank-specific technical efficiency to the total variance of the output). This implies that more than 94% of the variations in the technical efficiency scores reported under model A were due to variations in the level of input variables across banks. On the other hand, model B yielded a γ value of 0.7944. This implies that more than 79% of the variations in the technical efficiency scores reported under model B were due to variations in the level of input variables across banks.

Table 5 Maximum Likelihood Estimates of the Half-Normal Model of the Stochastic Frontier Production

$Ln(RWA)_{it} = \beta_0 + \beta_1 Ln(FDE)_{it} + \beta_2 Ln(FA)_{it} + \varepsilon$ Model A				$Ln(TI)_{it} = \beta_0 + \beta_1 Ln(IE)_{it} + \beta_2 Ln(OE)_{it} + \varepsilon$ Model B			
Variable	**Parameter**	**Coefficient**	***t* ratios**	**Variable**	**Paramete r**	**Coefficient**	***t* ratios**
Constant	β_0	19.3411 (417)	18.566**	Constant	β_0	1.3404 (04114)	3.2576**
FDE	β_1	0.0466 (0.0110)	4.223**	*IE*	β_1	0.2474 (0.0288)	85974**
FA	β_2	0.2179 (0.0453)	4.8034**	*CE*	β_2	0.7410 (00313)	23.6975**
	σ^2	1.0416 (0.1014)	10.2705**		σ^2	Q4397	3.4977**
	Y	0.94503 (0.0118)	79.9259**		*Y*	(01257)	12.8480**
	LR	-0.9226			*LR*	0.7944	
	N	195			N	-0.5653	

Note: * denotes significance at 5% level (*p*-values <0.05); Critical values = 1.96 (at 5%) ** denotes significance at 1% level (*p*-values < 0.01); Critical values = 2.57 (at 1%). Figures in brackets are the standard errors. *LR* = Log likelihood ratio.

5.4. Linking Technical Efficiency to Managerial Skills
5.4.1. Correlation Analysis
Pearson's correlation coefficient measure of linear association was used to examine the relationship between technical efficiency scores, managerial skills and four control variables (Proportion of female managers, assets, capital, and profitability). Two variables can be perfectly related, but if the relationship is not linear, Pearson's correlation coefficient is not an appropriate statistic for measuring their association. Pearson correlation test conducted and the findings presented in Table 6. The null hypothesis was the non-existence of correlation between technical efficiency and managerial skills (H_0: $\rho = 0$).
5.4.2. Regression Analysis
The model represented by equation (7) was first subjected to *F*-test to establish whether the variables were jointly significant. The *t*-tests were further computed for the individual variables coefficients to determine their significance in the respective models. Using the technical efficiency scores derived from model A as the dependent variables, the *F*-test yielded $F_{(7, 187)}$ 394.858; (*p*-value < 0.01) and an adjusted R^2 value of 0.934. This implies that 93.4% of variations in the efficiency scores could be explained jointly by managerial skill characteristics and the control variables. Using the technical efficiency scores derived from model B as the dependent variables, the *F*-test yielded $F_{(7, 187)} = 7.811$; (*p*-value < 0.01) and an adjusted *R* value of 0.820 implying that 82% of variations in the efficiency scores could be explained h. the mix of managerial skill characteristics and the control variables. The values of *F*-statistics were found to be statistically significant implying the existence of linear relationships in both cases. The results of the *t*-tests are presented in Table 6 and Table 7.

The findings presented on Table 7 indicate that the technical efficiency scores under model A were positively correlated at both 95% and 99% levels of confidence to the level of education, years of experience and the frequency of training. In addition, three control variables namely bank size, level of capitalisation and profitability were all found to be positively correlated to technical efficiency. On the contrary, the fourth control variable which is the proportion of female managers to total number of managers was found to be negatively correlated to technical efficiency.

Table 6 Relationship between Technical Efficiency and Managerial Skills in Commercial Banks in Kenya

$$TE_{it} = a + b_1(ED)_{it} + b_2(EX)_{it} + +b_3(TR)_{it} + b_4(GE)_{it} + b_5(ASSETS)_{it} + b_6(CAP)_{it} + b_7(PBT)_{it} + \varepsilon_{it}$$

Model A			Model B		
Variable	ρ	Decision	Variable	ρ	Decision
Education	0.158*	Reject H_0	Education	0.308**	Reject H_0
Experience	0.240**	Reject H_0	Experience	0.062	Accept H_0
Training	0.210**	Reject H_0	Training	0.157*	Reject H_0
Female Managers	0.132*	Reject H_0	Gender	0.115	Accept H_0
Total assets	0.965**	Reject H_0	Total Assets	0.255**	Reject H_0
Total capital	0.954	Reject H_0	Total Capital	0.252**	Reject H_0
Profit before tax	0.790**	Reject H_0	Profit Before Tax	0.255**	Reject H_0
N	195		N	195	Reject H_0

Note: H_0: p =0 (No significant correlation between TE and MS) . * denotes significance at 5% level (*p*-values < 0.05); ** denotes significance at 1% level (*p*-values < 0.01); Variables in italics represent control variables. **ρ** = Pearson Correlation coefficient.

Table 7 Parameter Estimates of the Relationship between Technical Efficiency and Managerial Skills

Model A

$$TE_{it} = a + b_1(ED)_{it} + b_2(EX)_{it} + b_3(TR)_{it} + b_4(GE)_{it} + b_5(ASSETS)_{it} + b_6(CAP)_{it} + b_7(PBT)_{it} + \varepsilon_{it}$$

Parameters	Coefficients	t ratios	p-values	*Results*
a	-0.0103	-0.2360	0.81 30	Accept H_0
b_2	0.1430	2.1340*	0.0258	Reject H_0
b_3	1.4783	11.504**	0.0000	Reject H_0
b_4	0.1660	13.744	0.0000	Reject H_0
b_5	-1.3537	2.3390*	0.0295	Reject H_0
b_6	0.6150	8.2840 **	0.0000	Reject H_0
b_7	0.0213	3.0550 **	0.0026	Reject H_0

Note: * denotes significance at 5% level (*p*-values < 0.05); Critical values = 1.96 (at 5%) ** denotes significance at 1% level (p-values < 0.01); Critical values = 2.57 (at 1%). Dependent Variable = Technical Efficiency scores derived from Model A.

Model B findings on Table 8 are consistent with those of Model A. The findings indicate that the technical efficiency under Model B is positively correlated to the level of education, years of experience and the frequency of training at the 95% and 99% confidence level. Positive correlation between technical efficiency and the size of the bank, capitalization level, and level of profitability was also reported. The results of Table 7 and Table 8 therefore support the Pearson correlation analysis results reported in Table 6. The regression results of model A indicated a significant (negative) relationship between technical efficiency and the proportion of female managers (Table 7). To the contrary, the results of model B (Table 8) showed that there is no significant relationship between technical efficiency and the proportion of female managers. A negative coefficient under the results of model A implies that commercial banks with high proportions of female managers are likely to report reduced productivity in loans and other risk-weighted assets. The results of model B imply that the proportion of female managers in managerial positions has no significant effect on the bank's ability to generate income by incurring interest and operating expenses.

The findings did not suggest possibilities of substitution between a manager's level of education and years of experience in relation to technical efficiency. This was arrived at after applying F-test to establish whether or not there exists a linear relationship between the two variables. The null hypothesis of the test was that there exists no linear relationship between the manager's level of education and the years of experience. The value of F-statistic obtained was $F_{(1, 193)} = 0.672$, p value > 0.05 and hence the null hypothesis was accepted. Therefore, in the Kenyan banking sector, the manager's level of education cannot be substituted for years of experience in relation to technical efficiency.

Table 8 Parameter Estimates of the Relationship between Technical Efficiency and Managerial Skills

Model B

$$TE_{it} = a + b_1(ED)_{it} + b_2(EX)_{it} + b_3(TR)_{it} + b_4(GE)_{it} + b_5(ASSETS)_{it} + b_6(CAP)_{it} + b_7(PBT)_{it} + \varepsilon_{it}$$

Parameters	Coefficients	t ratios	p values	Decision
a	0.3990	4.9360**	0.000002	Reject H_0
b_2	0.1210	5.2060**	0.000000	Reject H_0
b_3	0.0015	0.8303	0.407400	Accept H_0
b_4	0.0044	1.9840*	0.048700	Reject H_0
b_5	0.0830	1.1182	0.354700	Accept H_0
b_6	0.1640	4.2290 **	0.000000	Reject H_0
b_7	0.3540	2.7477**	0.000697	Reject H_0

Note: * denotes significance at 5% level (p-values < 0.05); Critical values = 1.96 (at 5%) ** denotes significance at 1% level (p-values < 0.01); Critical values 2.57 (at 1%). Dependent Variable = Technical Efficiency scores derived from Model B

5.5 Discussion

The study hypothesized a positive relationship between managerial Skill and technical efficiency. This hypothesis was based on the argument that managerial skill is one of the key inputs in the production process that appears to significantly contribute to variations in technical efficiency of firms. The analysis was based on two stochastic production frontier models. In the first model (Model A), it was regarded that banks use labour, borrowed funds and deposits, and fixed assets as inputs to produce risk-weighted assets (as output). The results from OLS estimations however established that the labour input was insignificant in the model at 95% level of confidence. This implies that banks produce their risk-weighted assets through use of borrowed funds and deposits and their fixed assets. Technical efficiency scores under Model A showed that on average the banks were able to produce 15% of the output (loans, securities, investments and other off balance sheet items) after input of borrowed funds and deposits and fixed assets. This is 3% points lower than the average 18% score of X-efficiency reported by Sakina (2006) upon studying 33 commercial banks in Kenya. Under Model A, the overall trend in technical efficiency of the commercial banks improved slightly from 14% in 2002 to 17% in 2006. This implies that there is huge room for improvement as far as transformation of deposits and borrowed funds into risk weighted assets is concerned. The slow pace at which the banks are moving towards the best production frontier implies that liberalization of the banking sector has not had the desired effects of enhancing the efficiency of financial intermediation.

In the second model (Model B), banks incur interest expenses and operating expenses as inputs in order to generate income. Both input variables (IE and OE) were found to be jointly significant in the model at 95% level of confidence. Technical efficiency scores indicated that over the sample period, the banks were able to realize about 86% of the total income from interest and operating expenses. This is in agreement to Barr et al (1999) that there is a noticeable tendency for efficiency to be positively correlated with interest income. The upward trend in technical efficiency from 83% in 2002 to 89% in 2006 under Model B implies that the banks are moving closer to the best production frontier in terms of maximizing income from loans, securities and other investments. Pearson's correlation coefficient measure of linear association indicated that the technical efficiency scores were positively and significantly correlated at 95% level of confidence to the level of education and experience as well as the frequency of training. Positive correlation was reported between technical efficiency and the three control variables namely, the size of the bank, capitalization level, and profitability.

The findings of this study are consistent with those of previous studies that found a positive relationship between managerial skill and technical efficiency. Kirkley et al (1998) and Kebede (2001) found that managerial skill characteristics such as experience and education are an important determinant of firm productivity and technical efficiency in the sense that they enhance the ability of managers to seek, decipher, and make good use of information about production inputs. Stefanou and Saxena (1998) also found that an increase in efficiency may result from more management experience.

The technical efficiency of commercial banks can therefore be improved by hiring managers with high educational levels and longer years of experience. In addition, continuous development of managers through training is necessary in order to keep up with the rapid changes in techniques, financial instruments and technological developments in banking (Limam, 2001). Regression results of model A indicated a significant (negative) relationship between technical efficiency and the proportion of female managers. To the contrary, the results of model B showed no significant between technical efficiency and the proportion of female managers. These findings contradict those of Mathijis and Vranken (2001) who found that firms in Bulgaria and Hungary with a high proportion of women were more efficient. The study does not support the findings of (Kirkley et al., 1998; Vandenberg, 1980; and lmai, 2003) who suggested possible substitution possibilities between education and years of experience.

The findings were consistent with the expectation that there is a positive relationship between technical efficiency and the bank's size and profitability and supported the findings of Sakina (2006) that the average large bank is more efficient than the average small bank. However, the results contradicted those of Mutanu (2002) who found that highly capitalised commercial banks in Kenya are more inefficient than lowly capitalised banks. The positive correlation between the level of capitalisation and technical efficiency observed in this study could be due to the evolution of the banks' capital structure over the period of study. Commercial banks have avoided expensive long term borrowing and prefer the less expensive equity capital. This is evidenced by more and more banks resorting to equity offerings such as share splits and bonus issues. When there is an increasing preference for equity to long term debt, it has been shown that banks would be more efficient as shareholders are in a position to apply stricter monitoring on bank's management (Limam, 2001).

6. Conclusions

Managerial skill was found to be significant and positively correlated to technical efficiency. This implies that if bank managers are equipped with better managerial skills, then the banks will tend to report higher earnings, production, and technical efficiency. Three characteristics of managerial skill namely level of education, the number of years of managerial experience, and the frequency of training were found to explain variations in technical efficiency scores across banks.

Substitution possibilities between years of experience and managerial skill were non existent indicating that the two variables are independent and that the manager's level of education and years of experience cannot replace each other. An analysis of the technical efficiency scores in relation to the three control variables (size, capital, and profit) indicated that the size of a bank, level of capitalization, and profitability are essential determinants of banks' productivity and technical efficiency.

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