EFFICIENCY OF THE BANKING SECTOR IN SOUTH AFRICA

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ABSTRACT

This paper analyses the cost and profit efficiency of banks in South Africa. The cost-to-income ratio has always been used in the South African banking sector in measuring efficiency. However this approach is very simplistic and does not provide enough insight on real profit efficiency.

This paper uses a stochastic frontier model to determine both cost and profit efficiency of four large and four small, South African-based banks. The results of the study show that South African banks have significantly improved their cost efficiencies between 2000 and 2005. However, efficiency gains on profitability, over the same time period, have not been significant. No bank was found to be superior to another in terms of achieving efficiency gains in cost reduction and profitability.

A weak positive correlation was found to exist between the cost and profit efficiencies, with the most cost efficient banks also being most profit efficient. With regard to bank size, cost efficiency declined with increasing bank size.

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1 INTRODUCTION

The purpose of this paper is to investigate the cost and profit efficiency of South African banks, over the period of 2000-2005. South African banks are being faced with increasing competition and rising operational costs as a result of regulation requirements, entry of large foreign banks in the retail banking environment and the Financial Services Charter, amongst other factors. This puts pressure on the banks to review efficiencies if they are to remain competitive locally and in a global sense.

A number of studies have been carried out globally, mainly focused on the cost efficiency of banks and the drivers of the differences. However looking only at cost efficiency does not give a complete picture so there has been an increasing move by researchers to investigate both cost and profit efficiency (Berger & Mester, 1997; Isik & Hassan, 2002). In the literature, bank performance is still predominantly measured using accounting methods by comparing financial ratios related to costs and profitability. Whilst this is useful, using financial ratios as a sole measure of performance has been criticised by many researchers (Yen, 1996; Berger & Humphrey, 1997) to be limited in scope. There is therefore a need to use other approaches in measuring bank efficiencies, and the econometric approach is one option for use.

In South Africa there has been limited work done that investigates the efficiency of the banking sector using the econometric approach. Research done by Oberholzer & van der Westhuizen (2004) was narrow in scope in that it investigated the efficiencies of ten branches of one local bank. The other work done by Bedari (2004) in this field was focused on banks in Botswana and Namibia and the three South African banks covered in the study were only used for comparison purposes. Ikhide (2000) also conducted research on banks in Namibia, over the period of 1996 to 1998 and compared these results to those for other countries in the sub-Saharan region, including South Africa.

Napier (2005) stated that South African banks operate as a complex monopoly, with perceived high barriers to entry. A report by Falkena *et al* (2004), indicate that South African banks have outperformed their peers in terms of their profitability, over a sustained period. Isik & Hassan (2002) in a study of Turkish banks that are also oligopolistic in nature, found that the Turkish banks were better at controlling costs than generating profit. This indicates that they have high cost efficiency even if they are profit inefficient. It would be useful to understand if the profitability being realised by South African banks is due to high efficiencies. It would also be meaningful to understand if there are differences in cost and profit efficiencies for different bank sizes.

The aim of the analysis is to determine if there has been an improvement in the cost and profit efficiency of South African banks over a period of time. The research will also establish if there is a relationship between cost efficiency and bank size.

Furthermore, we will:

- determine if there has been a change in cost efficiency of South African banks over time,
- determine if there has been a change in profit efficiency of South African banks over time,
- determine if there is a relationship between cost efficiency and profit efficiency for South African banks, and
- determine if cost efficiency is related to bank size for South African banks.

Invariably the South African banking sector, currently use accounting approaches to measure cost and profit performance. However these methods have limitations (Yen, 1996; Berger & Humprey, 1997). Based on the literature, the econometric approach for measuring cost and profit efficiency proposed for this research is considered superior to the accounting-based ratios. This research presents an alternative approach that can be used by researchers and management in the banking sector in determining and comparing cost and profit efficiency among South African banks.

Berger & Humphrey (1997: 175) indicated that, “evaluating the performance of financial institution can inform government policy by assessing the effects of deregulation, mergers and market structure on efficiency”. On a micro-level, it can help improve managerial performance by identifying best and worst practices associated with high and low measured efficiency.

This research evaluates the cost and profit efficiency of South African banks over time in order to explain any changes based on prevailing economic conditions. This is useful to bank managers in understanding how cost and profit efficiencies have been affected by a number of economic, regulatory and competition factors. It will also help inform their strategies, should they be faced with similar issues in the future. It will also enable bank managers to compare their efficiencies with other local banks.

2 Efficiency Measurement

The purpose of this research is to determine the cost and profit efficiency of South African banks. This literature review provides a definition of efficiency, the efficiency concepts that are applicable to banking and the different methods used to measure efficiency. It also outlines some of the factors influencing efficiency of banks and provides a broad overview of the South African banking sector.

2.1 Efficiency in banking

The presence of inefficiencies is considered an inherent feature of banking. According to Turati (2003:2), “banks are regarded as firms that emerge as a result of some sort of market imperfections, hence they bring about a certain degree of inefficiency with respect to perfect competitive outcomes”. A study conducted by the European commission in 2001 supported the above thinking when it revealed that European banks were particularly inefficient (Turati, 2003). Banking efficiency is important at both macro and micro levels and in order to allocate resources effectively, banks should be sound and efficient Hussein (2000).

Efficiency in banking can be distinguished between allocative and technical efficiency. Allocative efficiency is the extent to which resources are being allocated to the use with the highest expected value. A firm is technically efficient if it produces a given set of outputs using the smallest possible amount of inputs (Falkena *et al*, 2004). Outputs could be loans or total balance of deposits, while inputs include labour, capital and other operating costs. A firm is also said to be cost efficient if it is both allocatively and technically efficient (Mester, 1997). Studies on X-inefficiency, which is a measure of the loss of allocative and technical efficiency, has been carried out particularly internationally. The results showed that X-inefficiency is between 20-30 % of total banking costs in the US (Berger & Mester, 1997). According to Falkena *et al* (2004:38), “the notion of X-inefficiency suggests that comfortable incumbents may not produce in the most efficient method. If a few players dominate the market, they may be sheltered from competitive forces and may use rule-of-thumb rather than best practice methods”.

Commercial banks have been operating in an increasingly competitive environment (Isik & Hassan 2002; Mester 1997; Yeh, 1996). The long term viability of commercial banks operating in this environment depends in part on how efficiently they are being run (Mester, 1997). The efficient and effective use of resources is a key objective of every banker. Whilst this issue has always been relevant, global trends such as increasing competition for financial services, deregulation, technological innovations and banking consolidation has brought more attention on controlling costs and providing products and services more efficiently (Spong, Sullivan & De Young, 1995).

According to Yeh (1996), the competitive banking environment has heightened the need to evaluate risks and returns involved in banking. There is also a need to explore other methods besides financial ratios for assessing economic performance and management quality of banks.

2.2 Efficiency Concepts in Banking

When measuring efficiency of financial institutions, a fundamental decision to be made is which efficiency concept to use. There are three most important economic efficiency concepts currently being used namely cost, profit and alternative profit efficiency. These are well documented by Berger & Mester (1997). The choice on the appropriate concept to use is informed by the problem being addressed.

2.2.1 Cost efficiency

According to Maudos, Pastor, Perez & Quesada (2002:38), "cost efficiency corresponds to one of two most important economic objectives; cost minimization". It is derived from a cost function in which variable costs depend on the input prices, quantities of variable outputs and any fixed inputs or outputs, environmental factors, random error and efficiency (Berger & Mester, 1997). According to Aigner, Lovell & Schmidt (1977), the cost function can be written as

$$C = C(w, y, z, v, u_c, \varepsilon_c) \quad (1)$$

and $Uc = Z_{it}\delta + \psi_{it}$ (2)

where *C* measures variable costs, *w* is a vector of prices of variable inputs, *y* is the vector of quantities of any fixed netputs (inputs/outputs), *v* is a set of environmental or market variables that may affect performance and u_c is an inefficiency factor that may raise costs above the best-practice level and ε_c is a random error term

The inefficiency and random terms are assumed to be multiplicatively separable from the rest of the cost function and both sides of (1) are represented in natural logs.

$$\ln C = f(w, y, z, v,) + \ln u_c + \ln \varepsilon_c \quad (3)$$

f denotes some functional form. The cost efficiency of bank *b* is estimated as the cost needed to produce *b*'s output vector if the bank was as efficient as the best-practice bank in the sample facing the same exogenous variables (*w,y,z,v*) divided by the actual cost of bank *b* , adjusted for random error i.e.,

$$CostEFF^b = \frac{C^{\min}}{C^b} = \frac{\exp\left[f(w^b, y^b, z^b, v^b)\right] \times \exp\left[\ln u_C^{\min}\right]}{\exp\left[f(w^b, y^b, z^b, v^b\right] \times \exp\left[\ln_C^b\right]} \quad (4)$$

where $u_C^{\min}$ is the minimum u_C^b across all banks in the sample.

According to Berger & Mester (1997), the cost efficiency ratio may be thought of as proportion of costs or resources that are used efficiently.

A translog functional form is the most frequently used for cost efficiency in literature. A generic translog cost function proposed by English, Grosskopf, Hayes & Yaisawarng (1993) is

$$\ln C(x, y) = \alpha_o + \sum_{n=1}^{N} \beta_n \ln x_n + \sum_{m=1}^{M} \alpha_m \ln y_m + 0.5 \sum_{n=1}^{N} \sum_{n'=1}^{N} \beta_{nn'} \ln x_n \ln x_{n'} + 0.5 \sum_{m=1}^{M} \sum_{m'=1}^{M} \alpha_{mm'} \ln y_m \ln y_{m'} + \sum_{n=1}^{N} \sum_{m=1}^{M} \gamma_{nm} \ln x_n \ln y_m \quad (5)$$

The equation is based on the fact that the bank’s total operational costs (C) are a function of *x* and *y* and a composite error term. The variable *x*, is a vector of quantities of the bank’s variable outputs and *y* a vector of the prices for the variable input. Cost efficiency ranges between zero and one and equals one for the best-practice bank in the sample.

The Fourier-flexible functional form has been used as an alternative to the translog, especially in studies of US banks. While this form is more flexible, it is very sensitive to the number of observations and may not be suitable for small samples (Ikhide, 2000), such as that of 8 banks in our research.

2.2.2 Standard Profit Efficiency (SP)

In contrast to cost efficiency, standard profit efficiency indicates performance based on the ability to generate revenues by varying outputs as well as inputs The profit function from which profit efficiencies are obtained does not hold all output quantities statistically fixed at their observed, possibly inefficient levels (Isik & Hassan, 2002).

The standard profit function in log form is

$$\ln(\pi + \theta) = f(w, p, z, v,) + \ln u_{\pi} + \ln \varepsilon_{\pi} \tag{6}$$

where π is the variable profits of the firm, which includes all the interest and fee income earned on the variable outputs minus variable costs *C* used in the cost function; θ is a constant added to every firm's profit so that the natural log taken is of a positive number; *p* is a vector of prices of the variable outputs, $\ln \varepsilon_{\pi}$ represents random error and $\ln u_{\pi}$ represents inefficiency that reduces the profits.

$$Std\pi EFF^{b} = \frac{\pi^{b}}{\pi^{\max}} = \frac{\exp\left[f(w^{b}, p^{b}, z^{b}, v^{b})\right] \times \exp\left[\ln u_{\pi}^{b}\right] - \theta}{\exp\left[f(w^{b}, p^{b}, z^{b}, v^{b}\right] \times \exp\left[\ln u_{\pi}^{\max}\right] - \theta} \tag{7}$$

where $u_{\pi}^{\max}$ is the maximum value of u_{π}^{b} in the sample

Standard profit efficiency is the proportion of maximum profits that are earned. Berger & Mester (1997) consider the profit efficiency concept to be superior to the cost efficiency concept for evaluating the overall performance of a firm. First, profit efficiency is based on a profit maximization, which requires that the same amount of focus is placed on maximizing marginal revenue as to reducing marginal costs. Second, the profit function deals with both input and outputs inefficiencies whilst the cost function accounts for only inefficiencies in inputs (Vivas, 1997). Finally a bank can be inefficient if it produces too few, or a non-optimal mix of outputs given the inputs it uses and the prices it faces. As highlighted by Isik & Hassan (2002:264), "cost efficiency models ignore this possibility and thus can misrepresent the nature and extent of efficiency of banks".

2.2.3 Alternative (Non-Standard) Profit Efficiency

Unlike in the standard efficiency concept, the alternative profit efficiency measures how close a bank is to generating maximum profits given its output levels instead of output prices (Isik & Hassan, 2002). It employs the same dependent variables as the standard profit function and the same exogenous variables as the cost function. Output prices are free to vary and affect profits (Berger & Mester, 1997). The alternative profit function can be represented in translog form as follows

$$\ln(\pi + \theta) = f(w, y, z, v,) + \ln u_{a\pi} + \ln \varepsilon_{a\pi} \tag{8}$$

Alternative profit efficiency is the ratio of predicted actual profits to the predicted maximum profits for a best-practice bank.

$$AltπEFF^b = \frac{a\pi^b}{a\pi_{\max}} = \frac{\exp\left[f(w^b, y^b, z^b, v^b)\right] \times \exp\left[\ln u_{a\pi}^b\right] - \theta}{\exp\left[f(w^b, y^b, z^b, v^b\right] \times \exp\left[\ln_{a\pi}^{\max}\right] - \theta} \qquad (9)$$

where $u_{\max}^b$ is the maximum value of u_π^b in the sample

The alternative profit function employs the same independent variables as the cost function, as shown below (Isik & Hasan, 2002)

$$\ln(\pi + \theta) = \alpha_o + \sum_{n=1}^{N} \beta_n \ln x_n + \sum_{m=1}^{M} \alpha_m \ln y_m + 0.5 \sum_{n=1}^{N} \sum_{n'=1}^{N} \beta_{nn'} \ln x_n \ln x_{n'} + 0.5 \sum_{m=1}^{M} \sum_{m'=1}^{M} \alpha_{mm'} \ln y_m \ln y_{m'} + \sum_{n=1}^{N} \sum_{m=1}^{M} \gamma_{nm} \ln x_n \ln y_m \qquad (10)$$

Berger & Mester (1997), De Young & Hasan (1998) provide conditions where the alternative profit efficiency concept is superior to both the cost and standard efficiency methods. The conditions are stated below:

a) if there is substantial unmeasured differences in the quality of banking products and services offered across banks.
b) if outputs are not completely variable, so that the bank cannot achieve every output scale and product mix.
c) if banks are not sole price-takers, so that they have some market power over the prices they charge.
d) if output prices are not accurately measured so that inaccurate measurement may result in poor estimation of opportunities for banks to earn revenues and profits in the standard profit function.
e) in relation to (d) if the availability of data impedes one to come up with an accurate market or accounting price for some of the bank outputs.

In some studies on efficiency (Kraft, Hofler & Payne, 2002; Berger & De Young, 1997; Berger & Mester, 1997), the translog function is replaced with a Fourier-flexible functional form that combines a standard translog function with the non-parametric Fourier form. This is a theoretical improvement to the translog. Since it includes trigonometric transformations, it can globally approximate the underlying cost function over an entire range of data. The translog function may perform poorly for observations far from the sample means (Berger & De Young, 1997).

2.2.4 Relationship between cost efficiency and profit efficiency

Berger, Hunter & Timme (1993: 221) asserts that "companies that are more efficient can be expected to have improved profitability". Studies have been carried out on both cost and profit efficiency and some correlations drawn between the two. Maundos *et al* (2002) in a study on European banks found that profit efficiency levels were lower than those of cost efficiency. Results from a study by Berger & Mester (1997) on US banks showed negative correlation between the two. Isik & Hassan (2002) also found similar results for Turkish banks. The Turkish banks were found to be relatively better at controlling costs that generating profits. These findings suggest that cost inefficient banks can continue to prosper, especially in a concentrated market like Turkey.

2.3 Inputs and Outputs for Efficiency Concepts

For any of the three efficiency concepts selected, one of the key elements is that appropriate inputs and outputs of the financial institution are defined. There are two main approaches used to determine the input and output variables (Zaim, 1995; Kaparakis, Miller & Noulas, 1994) and these are the

a) production approach and
b) intermediation approach

Under the production approach, a bank is viewed as a producer of deposits and loans using labour, capital and materials. The advocates of this approach use the number of accounts and loans outstanding as the bank's output (Zaim, 1995). Total costs include all operating costs incurred in the production of outputs.

Under the intermediation approach, banks are treated as collectors of funds, which are then intermediated to loans and other assets. The total balance of deposits and loans is used as a measure for outputs, while operating and interest costs are used to measure total costs. According to Kaparakis *et al* (1994), this approach seems more appropriate when the sample contains large banks, who fund a larger share of their assets from non-deposit sources. Berger & Humphrey (1997) suggest that the intermediation approach is best suited for analyzing firm level efficiency, while production approach is suited for measuring branch level efficiency, as at this level employees have little influence over funding and investment decisions.

There is no consensus amongst researchers on the actual variables to use in efficiency models. Instead the researchers choose variables depending on what they want to test (Sealey & Lindley, 1977; Kaparakis *et al*, 1994; Zaim, 1995). The two commonly used inputs are labour and capital while Fukuyama (1993) suggest that anything from total assets, total deposits, loans, gross operating income or a combination can be used as a bank's output.

2.4 Efficiency Measurement Methods

There are two broad approaches used to measure cost and profit efficiency, and are the accounting approach, which makes use of financial ratios and econometric approaches.

2.4.1 Accounting approach

Within the banking industry, cost efficiency is often measured by using a cost to income ratio (Isik & Hassan, 2000). The current international benchmark for this ratio is 0.6 (Falkena *et al*, 2004), indicating that banks with a higher value are inefficient. For profitability, the measurements that are used include return on assets (ROA), return on equity (ROE) and capital asset ratio, liquidity ratios and ratios measuring credit risk (Yeh, 1996; Maudos *et al*, 2002). Whilst these ratios are widely used to measure efficiency they have certain limitations. As highlighted by Falkena *et al* (2004:36) "whilst the cost to income ratio may provide a rule of thumb by which to measure efficiency, it does not allow for analysis of market dominance and the ability of a dominant firm to grow its income as expenses climb".

Yeh (1996) highlighted the disadvantages of financial ratios as being that they are only meaningful when used with a suitable benchmark, which may be difficult to establish. Secondly, each performance measure is calculated using only a subset of data available to a firm. The problem with partial measures is that a bank may perform well using one measure but badly when using another (van der Westhuizen, 2004). There is therefore a need for a more flexible way of expressing a bank's financial position (Yeh,1996). This would be a measure that incorporates all the bank's input and output data available on the firm and the econometric approach attempts to do this.

2.4.2 Econometric Approach

Under this approach, the measure of efficiency is the actual level of cost relative to an efficient production frontier (Fuentes & Vegara, 2003). This is a way of benchmarking the relative performance of production units by assigning numerical efficiency values and identifying areas of input overuse and/or output underproduction (Berger & Humphrey, 1997). Two econometric techniques have been applied in the literature to calculate cost efficiency and estimate frontier functions (Bauer & Hancock, 1993) namely:

a) Parametric techniques
b) Non-parametric i.e. linear mathematical programming techniques

2.4.2.1 Parametric techniques

This category includes three techniques as given below

a) Stochastic Frontier Approach (SFA)

The Stochastic Frontier Approach proposes that the observed bank costs may deviate from the cost frontier either because of inefficiency or random fluctuations (Maudos *et al*, 2002). The inefficiency and random error terms are separated by making explicit assumptions about their distributions. The inefficiency term ln u is assumed to be half-normally distributed, whilst the error term ln ε is assumed to be normally distributed. (Berger & Mester,1997). The parameters of the two distributions are estimated and can be used to obtain estimates of bank-specific inefficiency.

b) Distribution-free approach

This method assumes that there is core inefficiency for each firm over time. The core inefficiency is distinguished from random error by assuming that core inefficiency is persistent over time, while random errors tend to cancel each other out in the course of time. This approach is often used when panel data is available.

c) The thick frontier approach

In the thick frontier approach, a relatively large subset of firms is used to define the frontier. It therefore provides a firmer basis for establishing the realizable efficiency of an industry (Vivas, 1997). The differences in predicted costs within the quartile of banks with lowest average costs for a given size are attributed to random error. On the other hand, differences in predicted costs between the quartile with lowest and highest costs are ascribed to inefficiency.

2.4.2.2 Non- parametric techniques

There are two linear mathematical programming techniques that have been used in efficiency studies namely:

a) Data Envelopment Analysis (DEA)

Like any deterministic technique, Data Envelope Analysis assumes that all deviations between observed costs and the minimum costs are due to inefficient behaviour (Maudos *et al,* 2002).

b) Free Disposable Hull Analysis

Both the parametric and non-parametric techniques have been used to the same extent in efficiency studies. However, the parametric techniques are often preferred as they generally correspond well with cost and profit efficiency concepts studies (Berger & Humprey, 1997). The non-parametric methods have two major drawbacks. Firstly they generally assume there is no statistical measurement error and luck as factors affecting outcomes (Kaparakis *et al*, 1994; Vennet, 2002). Studies on US banks that use non-parametric techniques reported lower efficiency means than those using parametric techniques with much greater variation.

Secondly non-parametric techniques generally ignore prices and therefore can only account for technical inefficiency and not allocative inefficiency (Berger & Mester, 1997). Non-parametric methods typically focus on t*echnological* rather than *economic* optimization. They are therefore not suitable for comparing firms specializing in different inputs or outputs (Ikhide, 2000).

However it must be acknowledged that even econometric models are less than perfect as they do not incorporate every item or all dimensions of a bank's output in the model (Spong *et al*, 1995). The choice of econometric technique affects the results in measured efficiency and it has been found that the ranking of banks do not correspond well across methods (Ferrier & Lovell, 1990).

An extensive number of studies on the efficiency of financial institutions using the econometric approach have been carried out globally and the research findings are well been documented by Berger & Humprey (1997). However, very few of similar studies have been conducted in South Africa. Oberholzer & van der Westhuizen (2004) used the non-parametric DEA approach to analyze the relative efficiency of 10 branches of a small South African bank. Work done by Bedari (2004) in this field was focused on banks in Botswana and Namibia, and three South African banks were used only for comparison.

2.5 Factors influencing bank efficiency

A number of studies have been carried out to determine some of the factors impacting on efficiency of financial institutions, which includes bank size, management structure and ownership.

2.5.1 Bank size

According to Isik & Hassan (2002), the size of the bank can be an important driver of the variation of efficiency across banks. In order to operate optimally by obtaining scope and scale, banks must possess a certain degree of size. A number of studies have been carried out to determine relationship between bank size and efficiency but the results are ambiguous. Isik & Hassan (2002) and Kaparakis *et al* (1994) showed that average cost and profit efficiency decrease with increasing bank size. One plausible reason for this is that overhead costs for small bank are relatively low because they often operate few branches, so may possess operational advantage, which contributes to higher efficiency (Isik & Hassan, 2002). Secondly, larger banks often extend loans to a larger number of people, and in small amounts. The servicing and monitoring costs might be higher for large banks than small banks.

In contrast to these findings, Berger & Mester (1997) and Berger, Hancock & Humphrey (1993) noted a slight increase in cost efficiency with bank size for US banks, which may be induced by competitive pressures. Small banks on the other hand showed the highest level of profit efficiency in the study by Berger & Mester (1997). This could be related to profitability ratios, which are typically high for small banks. The conclusions drawn by Berger & Mester (1997: 936), was that “as banks grow larger, they are equally able to control costs but it becomes harder to create revenues efficiently”. Research by Kraft *et al* (2002) found that cost efficiency does not vary much across bank size categories.

2.5.2 Management structure

Pi & Timme (2003) conducted one of the first studies linking efficiency with the agency cost theory. They investigated whether the concentration of decision management and control in one hand brings about any deterioration of efficiency. They found that the efficiency of banks whose CEO and chairman of the board is the same person is significantly lower than those possessed by banks without similar governance structure. These findings were supported by Isik & Hassan (2002) indicating a strong link between management structure and efficiency.

2.5.3 Bank Ownership

Ownership of a bank can be considered as two-fold. It can either be whether a bank is state or privately owned. Another aspect of ownership is whether a bank is a domestic bank or foreign-controlled. Berger & Mester (1997) found that publicly traded US banks were more cost and profit efficient than state banks. Isik & Hassan (2002) also recorded similar results for Turkish banks.

This may indicate that public scrutiny is able to exert enough discipline on banks to be efficient in the countries where study was carried. However findings by Isik & Hassan (2002) on profit efficiency did not support the notion that private banks are more efficient in Turkey. Kraft *et al* (2002) found foreign banks to be more efficient than domestic banks in Croatia.

3. The South African Banking Sector

The South African banking industry is oligopolistic in nature, being dominated by five large commercial banks accounting for 86 % of deposits (Falkena *et al*, 2004). As of October 2005, there were 14 locally-controlled registered banks, 6 foreign controlled banks, 2 mutual banks, 15 foreign banks with registered branches and a further 30 with representative offices (South African Reserve Bank, 2005). Although there has been a sizeable presence of foreign banks, they have had minimal impact on retail banking as many of them have focused on corporate and merchant banking, treasury and capital markets dealings (Napier, 2005).

Barclays Bank, a giant UK retail bank was been granted approval in 2005, to acquire shareholding in ABSA, a local bank. This deal signifies the entrance of big players in the South African arena, which is likely to increase competition. The financial services sector signed the 2003 Financial Services Charter, in which it commits to increasing access to financial services, developing human capital and increasing provision of financing to small and medium enterprises. This is likely to put pressure on operating costs and efficiency, making research aimed at understanding efficiency in the South African banking sector relevant.

4 Modelling Efficiency

The methodology section initially identifies the population and then describes the sample used in the study. A description of the model and software package used is given in Section 4.3. Sections 4.4 and 4.5 outlines how the data was collected and analyzed including the statistical testing conducted. A brief description of how the reliability and integrity of the data was ensured is given in Section 4.6.

4.1 Population

The research population was all registered banks operating in South Africa between 2000 and 2005. In October 2005, the South African Reserve Bank recorded 14 locally-controlled registered banks, 6 foreign-controlled banks, 2 mutual banks, 15 foreign banks with registered branches and 30 foreign banks with representative offices.

4.2 Sample

The sample consisted of eight (8) South African commercial banks. The sample is split between large banks and small banks, classified according to the number of employees. For the purposes of this research, the number of employees was used instead of market capitalization as an indicator of bank size. The sample was made up of the following banks in each size category.

Large banks (Number of employees more than 10 000)

- ABSA
- FirstRand Bank
- Nedbank /Nedcor
- Standard Bank

Small banks (Number of employees less than 10 000)

- African Bank (ABIL)
- Capitec Bank
- Investec Bank
- Teba Bank

4.3 Modelling

This study is quantitative in nature and involves mathematical modelling in order to determine the cost and profit efficiency frontiers for the selected South African banks. The econometric approach that was used is the Stochastic Frontier Analysis (SFA) for both cost and profit frontiers. For modelling purposes the banks are classified as multi-product, 3-inputs and 2-outputs firms. The dependent variables are total costs (TC) and pre-tax profits (PP), and the independent variables are outputs and input prices.

The inputs are assumed to be labour, capital and funds, with the outputs as advances and deposits. This assumption on outputs is consistent with other studies conducted by Fuentes & Vegara (2003), Kraft, *et al* (2002) and Vivas (1997). Other studies such as those conducted by Berger & Mester (1997), Isik & Hassan (2002), included other assets such as investment and trading securities, as outputs. Other assets as a third output, was excluded in this study as at least two of the banks did not have any values recorded for these assets. Since the model variables are in logarithms, this would have introduced an error in the inputs, hence the exclusion.

Table 1 below outlines the data extracted from the banks' annual reports that was used in the estimation of cost and profit efficiency frontiers.

Table 1: Variables used in the estimation of the cost and profit functions

Variable	**Variable name**	**Definition**
TC	Total costs	Interest expenses and operating expenses
PP	Pre-tax Profit	Income before taxation
Outputs		
Q_1	Advances	Loans issued
Q_2	Deposits	Deposits and current accounts)
Inputs		
P_1	Labour	Number of full-time employees
P_2	Capital	Fixed Assets (Property and Equipment)
P_3	Funds	Deposits and current accounts
Input Prices		
P_L	Labour	Total staff costs/Number of employees

P_K	Capital	Expenses on fixed assets/Book value of fixed assets
P_D	Deposits	Interest expense/Deposits

4.3.1 Cost Frontier

The model for costs is derived from equations (1), (2), (3) and (5) in the literature review and can be represented by a translog function

$$\ln C(y,P) = \alpha_o + \sum_{n=1}^{2} \beta_n \ln y_n + \sum_{m=1}^{3} \alpha_m \ln P_m + 0.5\sum_{n=1}^{2}\sum_{n'=1}^{2} \beta_{nn'} \ln y_n \ln y_{n'}$$
$$+ 0.5\sum_{m=1}^{3}\sum_{m'=1}^{3} \alpha_{mm'} \ln P_m \ln P_{m'} + \sum_{n=1}^{2}\sum_{m=1}^{3} \gamma_{nm} \ln y_n \ln P_m + U_c + V_{it} \quad (11)$$

and

$$Uc = Z_{it}\delta + \psi_{it} \quad (2)$$

where:

y is a vector of outputs and *P* a vector of input prices, *i* and *t* represent cross-sectional, *t* the time values of the firm, ψ and V_{it} are random errors.

For the 3- input, 2-output model used in the study, the expanded equation is represented as follows

$$\ln TC = \beta_0 + \alpha_1 \ln Q_1 + 0.5\alpha_{11}(\ln Q_1)^2 + \alpha_2 Q_2 + 0.5\alpha_{22}(\ln Q_2)^2 + \beta_1 \ln P_L + \beta_2 \ln P_K$$
$$+ \beta_3 \ln P_D + 0.5\beta_{11}(\ln P_L)^2 + 0.5\beta_{22}(\ln P_K)^2 + 0.5\beta_{33}(\ln P_D)^2 + \beta_{12} \ln P_L \ln P_K + \beta_{13} \ln P_L \ln P_D$$
$$+ \beta_{23} \ln P_K \ln P_D + \gamma_{Q11} \ln Q_1 \ln P_L + \gamma_{Q12} \ln Q_1 \ln P_K + \gamma_{Q1_3} \ln Q_1 \ln P_D + \varepsilon_{Q21} \ln Q_2 \ln P_L +$$
$$+ \varepsilon_{Q22} \ln Q_2 \ln P_K + \varepsilon_{Q_{23}} \ln Q_2 \ln P_D + \varepsilon_{Q1Q2} \ln Q_1 \ln Q_2 + U_c + V \quad (12)$$

Where, $U_c \geq 0$, and zero for the most cost efficient firm (best practice firm) and increasing values imply more inefficient.

For natural log, the most cost efficient firm will have a value of 1, the farther the value from 1, the most cost inefficient the firm is.

4.3.2 Profit Frontier

The *alternative profit function* specified by Berger & Mester (1997) was used for the profit frontier, instead of the standard profit function. Some of the conditions under which the alternative profit function is preferable to the standard function, hold for the South African case. One such condition is that South African banks have influence over the prices they charge for services.

This alternative profit function is represented by

$$\begin{aligned}\ln PP &= \beta_0 + \alpha_1 \ln Q_1 + 0.5\alpha_{11}(\ln Q_1)^2 + \alpha_2 Q_2 + 0.5\alpha_{22}(\ln Q_2)^2 + \beta_1 \ln P_L + \beta_2 \ln P_K \\ &+ \beta_3 \ln P_D + 0.5\beta_{11}(\ln P_L)^2 + 0.5\beta_{22}(\ln P_K)^2 + 0.5\beta_{33}(\ln P_D)^2 + \beta_{12}\ln P_L \ln P_K + \beta_{13}\ln P_L \ln P_D \\ &+ \beta_{23}\ln P_K \ln P_D + \gamma_{Q11}\ln Q_1 \ln P_L + \gamma_{Q12}\ln Q_1 \ln P_K + \gamma_{Q1_3}\ln Q_1 \ln P_D + \varepsilon_{Q21}\ln Q_2 \ln P_L + \\ &+ \varepsilon_{Q22}\ln Q_2 \ln P_K + \varepsilon_{Q_{23}}\ln Q_2 \ln P_D + \varepsilon_{Q1Q2}\ln Q_1 \ln Q_2 - U_c + V\end{aligned} \quad (13)$$

$$Uc = Z_{it}\delta + \psi_{it} \quad (2)$$

Where U_c is the value of efficiency, and is determined is determined by a set of variables Z, ψ_{it} is noise error.

For the profit function, $Uc \leq 0$; (0 for highest profit). In logarithm, the values are bound between 0 and 1, 1 for firm with highest profit.

PP is pretax profit of each bank.

Where a bank recorded zero profits or a loss, a constant (θ) was added to make the profit a positive number, so that the natural log of a positive number could be used. The same constant was added to all the other bank's profits in that year.

4.3.3 Software package

The two models, equations (12) and (2) for cost, and equations (13) and (2) for the profit functions were simultaneously estimated using the maximum likelihood criterion. This methodology was advanced by Battese & Coelli (1995). A software package Frontier 4.1 developed by Coelli (1996) was used to estimate the cost and profit efficiency levels for each bank in every year under consideration (2000-2005). The twenty regressor variables were first converted to logarithm values before being used in the model, and the truncated normal distribution was selected for the error term. The number of observations, banks (8) and time periods (6) were also defined.

4.4 Data

The data used was documentary in nature. As the data can be classified as interval data, there was no need to have it rescaled.

Data on the selected variables was collected from published annual reports of the selected banks. Two of the small banks, Capitec and Teba Bank were only granted banking licences after 2001, and therefore did not have data covering the entire period. For these two and the other small banks, only the data for 2002 to 2005 was used in the research.

The following financial information was obtained from the annual reports for each of the banks.

- Operating expenditure
- Interest expenses
- Income before tax (Pre-tax profit)
- Advances (loans issued)
- Deposits (including current accounts)
- Number of full-time employees
- Staff costs (including employee benefits)
- Fixed Assets (defined as Property and Equipment)
- Depreciation and Impairment losses and

A database with data for each bank was created in Excel in order to form panel data. The datasets were checked for completeness and accuracy. As far as possible, where a bank was part of a holding company, the results of the banking group and not the holding company were used. The data was then used in the Frontier 4.1 software package to determine the efficiency measures for each bank achieved in each year.

5 Results

5.1 Input financial data

The financial data used in the modelling of each of the banks is tabulated in Appendix 1. Table 2 is a summary of the size of banks based on the loans, deposits and number of employee in 2005.

Table 2: Bank size based on loans, deposits and number of employees (2005)

Bank	Loans (Rm)	Deposits (Rm)	Employees
Absa	268,240	278,583	32,515
FirstRand	226,552	247,084	39,385

Nedbank	248,408	261,311	22,188
Standard Bank	250,939	314,703	36,682
African Bank	5,282	644	2,845
Capitec	208	222	1,708
Investec	42,690	74,492	4,096
Teba Bank	206	1,464	739

5.2 Efficiency Estimates

The stochastic translog cost and profit efficiency frontier parameter estimates from the maximum likelihood model are given in Table 3.

Table 3: The maximum likelihood cost and profit frontier parameter estimates for South African Banks (2000-2005)

		Cost Function		**Profit Function**	
Parameter	Variable	Estimate	T statistic	Estimate	T statistic
β_0	Constant	19.41	23.9*	10.02	9.3*
α_1	Q_1	-3.3	-14.4*	-17.17	-19.6*
α_{11}	Q_1^2	0.070	3.0*	5.55	13.1*
β_1	P_L	1.57	3.0*	39.2	-26.1*
β_2	P_K	2.41	6.1*	25.9	16.3*
β_3	P_D	4.75	18.3*	7.82	5.4*
β_{11}	P_L^2	-0.0019	-0.12	-2.63	-1.7***
β_{22}	P_K^2	0.13	22.3*	2.98	3.0*
β_{33}	P_D^2	1.19	10.3*	7.28	4.0*
β_{12}	$P_L \times P_K$	0.389	4.7*	2.24	-2.2**
β_{13}	$P_L \times P_D$	0.517	26.4*	15.15	-6.3*
β_{23}	$P_D \times P_K$	-0.251	1.8**	11.91	16.5*
γ_{Q11}	$Q_1 \times P_L$	-0.697	5.5*	4.87	5.6*
γ_{Q12}	$Q_1 \times P_K$	0.174	3.2*	4.46	10.2*
γ_{Q13}	$Q_1 \times P_D$	-0.529	11.4*	7.53	-9.2*
				14.22	18.6*

α_2	Q_2	2.21	28.5*	5.74	13.8*
α_{22}	Q_2^2	0.010	0.27	5.70	-5.0*
ε_{Q21}	$Q_1 \times P_L$	0.712	5.7*	4.93	11.2*
ε_{Q22}	$Q_1 \times P_K$	-0.357	6.94*	7.44	7.9*
ε_{Q23}	$Q_1 \times P_D$	0.49	16.6*	5.52	-13.7*
ε_{Q1Q2}	$Q_1 \times Q_2$	0.041	1.66 ***		

* Significant at 1% level, ** Significant at 5%, *** Significant at 10% level

5.3 Cost inefficiency Values

Table 4 presents the cost inefficiency values for the South African banks. The model output is included in Appendix 2.

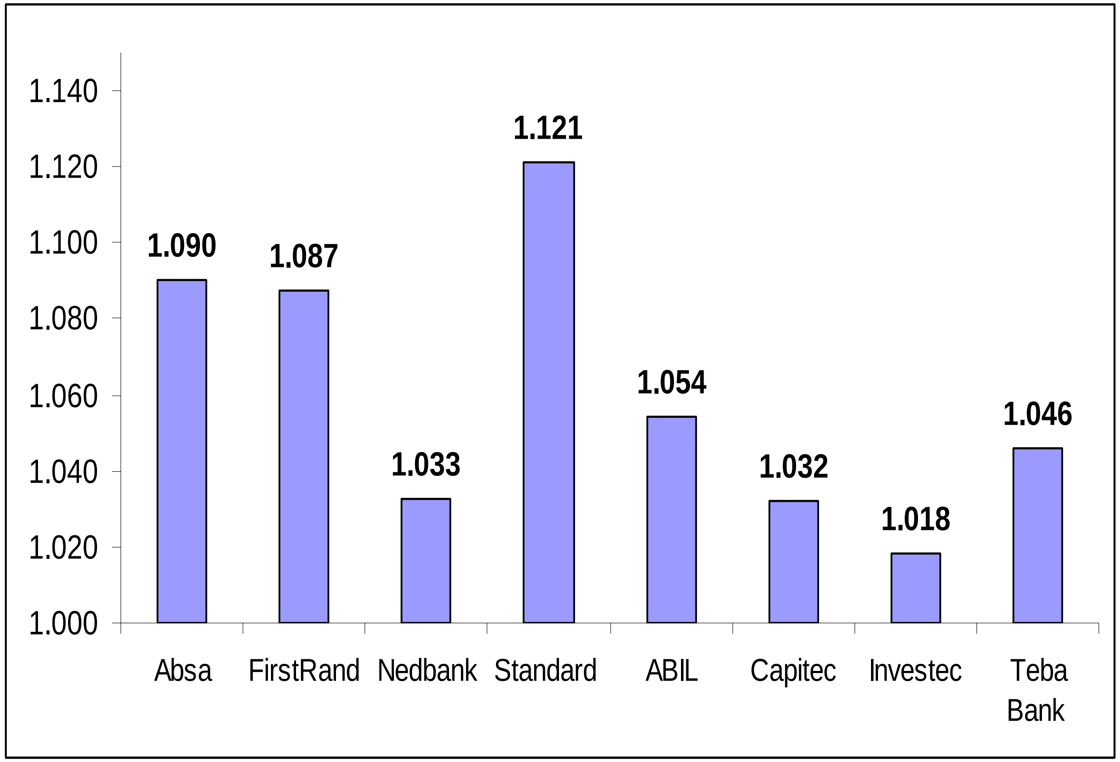
Table 4: Cost inefficiencies of South African banks

Bank	2000	2001	2002	2003	2004	2005
Absa	1.075	1.184	1.114	1.078	1.086	1.004
FirstRand	1.227	1.172	1.010	1.053	1.024	1.037
Nedbank	1.069	1.003	1.011	1.013	1.094	1.005
Standard Bank	1.239	1.130	1.178	1.053	1.123	1.002
African Bank			1.023	1.156	1.008	1.030
Capitec			1.059	1.033	1.007	1.028
Investec			1.048	1.013	1.006	1.005
Teba Bank			1.132	1.013	1.031	1.006
Mean	***1.153***	***1.123***	***1.072***	***1.052***	***1.047***	***1.015***

Table 4 shows that for all the banks, the values are greater than 1 indicating a level of cost inefficiency amongst the banks. For all the banks, there is an overall decline in the values recorded indicating an improvement in the cost efficiency over the six year period.

Figure 2 shows the mean cost inefficiency values for the different banks. The graph shows that Investec is the most cost efficient and Standard Bank the least.

Figure 2: Mean cost inefficiency values for the 6 banks



5.4 Profit efficiency Values

The profit efficiencies for the eight South African banks over the six year period between 2000 and 2005 are shown in Table 5 below. This table also includes the averages for each bank over the years.

Table 5: Profit Efficiencies of South African Banks

Bank	2000	2001	2002	2003	2004	2005
Absa	0.116	0.129	0.128	0.382	0.954	0.571
FirstRand	0.337	0.694	0.647	0.999	0.403	0.383
Nedbank	0.553	0.130	0.036	0.002	0.423	0.464
Standard Bank	0.610	0.742	0.566	0.999	0.251	0.873
African Bank			0.212	0.915	0.367	0.999
Capitec			0.999	0.634	0.698	0.531

Investec			0.449	0.509	0.925	0.518
Teba Bank			0.896	0.575	0.166	0.953
Mean	***0.404***	***0.565***	***0.491***	***0.627***	***0.523***	***0.662***

Figure 3 below shows the mean profit efficiency values for the different banks.

Figure 3: Mean profit efficiency values for the 6 banks

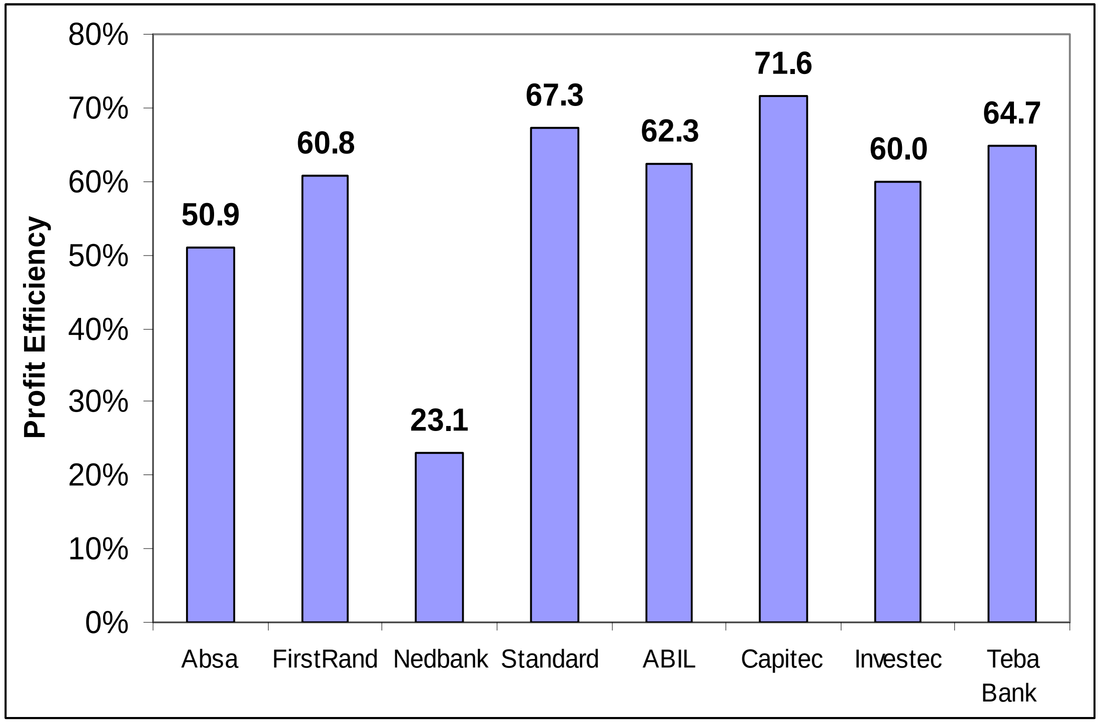


Figure 3 shows that Capitec is the most profit efficient and Nedbank the least.

5.5 Results of hypothesis testing

5.5. 1 Hypothesis tests 1 and 2

Hypothesis 1, H_o: There has been no change in the cost efficiency of the selected South African banks over the period of 2000-2005

Hypothesis 2, H_o: There has been no change in profit efficiency of the selected South African banks over the period of 2000-2005

The Krusral–Wallis one-way analysis of variance (ANOVA) test in NCSS was used to determine if the cost efficiency levels have changed significantly over time at a significance level of 5%. The results of the tests for the cost efficiency are summarised in Tables 6.

Table 6 (a) : ANOVA test results on the difference in cost efficiencies between 2000 and 2005

Year	Sample size	Mean	Test	Null hypothesis	Decision	P-Value
2000	4	1.153				
2001	4	1.123				
2002	8	1.072	Kruskal Wallis	All medians are equal	Reject H_0	0.00356
2003	8	1.051				
2004	8	1.048				
2005	8	1.015				

The Krusral-Wallis test shows that there are at least two medians that are different. This indicates that there has been a significant change in cost efficiency between 2000 and 2005, hence the null hypothesis for test 1 is rejected. The Krusral-Wallis Multiple Comparison Z-Value test results in Table 6 (b), highlights where the differences in the medians are.

Table 6 (b): Krusral-Wallis Multiple Comparison Z-Value Test

Year	2000	2001	2002	2003	2004	2005
2000	0.0000	0.6958	1.3799	1.6593	1.9999	**3.2924**
2001	0.6958	0.0000	0.5764	0.8559	1.1965	2.4890
2002	1.3799	0.5764	0.0000	0.3423	0.7594	2.3424
2003	1.6593	0.8559	0.3423	0.0000	0.4171	2.0002
2004	1.9999	1.1965	0.7594	0.4171	0.0000	1.5830
2005	**3.2924**	2.4890	2.3424	2.0002	1.5830	0.0000

* Medians significantly different if z-values > 2.952

Similar results were obtained when the test was conducted at an alpha level of 10 %. Results in Table 6(b) show that the change in cost efficiency of the banks is significant between 2000 and 2005.

An ANOVA test was conducted to test hypothesis 2 on profit efficiency at an alpha of 5 % and 10%. The results are presented in Table 7 for alpha of 5 %.

Table 7: ANOVA test results on the difference in profit efficiencies between 2000 and 2005

Year	Sample size	Mean	Test	Null hypothesis	Decision	P-Value
2000	4	0.404	Kruskal Wallis	All medians are equal	Accept H_0	0.7223
2001	4	0.565				
2002	8	0.491				
2003	8	0.627				
2004	8	0.523				
2005	8	0.662				

The ANOVA tests results above indicate that the null hypothesis that there has been no improvement in banks' profit efficiency between 2000 and 2005 is accepted.

5.5. 2 Testing hypothesis 3

Hypothesis 3 states that there is a negative correlation between a banks' cost efficiency and its profit efficiency.

The values given in Table 4 indicate how inefficient each bank is, and these values were converted to reflect the efficiency levels between 0 and 100 %, with 100 % representing perfect efficiency (i.e. no inefficiencies, relative to other banks on the sample).
Using the modified values for cost efficiency, Hypothesis 3 was tested in NCSS using Pearson's and Spearman's correlations, and the correlation matrices for the two tests are shown in Table 8.

Table 8: Correlation matrix between cost and profit efficiency

Pearson Correlations

	Profit Efficiency	*Cost Efficiency*
Profit Efficiency	1.0000	0.0452
Cost Efficiency	0.0452	1.0000

Cronbachs Alpha = 0.038299
Standardized Cronbachs Alpha = 0.086483

Spearman Correlations

	Profit Efficiency	*Cost Efficiency*
Profit Efficiency	1.0000	0.0703
Cost Efficiency	0.0703	1.0000

Both the Pearson's and Spearman's correlation indicate a very weak positive correlation. The null hypothesis on a negative correlation between cost and profit efficiency is therefore rejected in favour of the alternative.

5.5. 2 Testing of Hypothesis 4

Hypothesis 4 H_0 : For South African banks, there is no correlation between a bank's cost efficiency and its size

The following method was used to test the hypothesis on NCSS

H_0 : $\rho = 0$

H_A : $\rho \neq 0$

where ρ is a correlation coefficient between the cost efficiency and bank size, In this study, the number of employees is used as a proxy for bank size. The resulting correlation matrix is given in Table 9.

Table 9: Correlation between cost efficiency and bank size

Pearson Correlations

	Cost Efficiency	*Number of Employees*
Cost Efficiency	1.0000	-0.3791
Number of Employees	-0.3791	1.0000

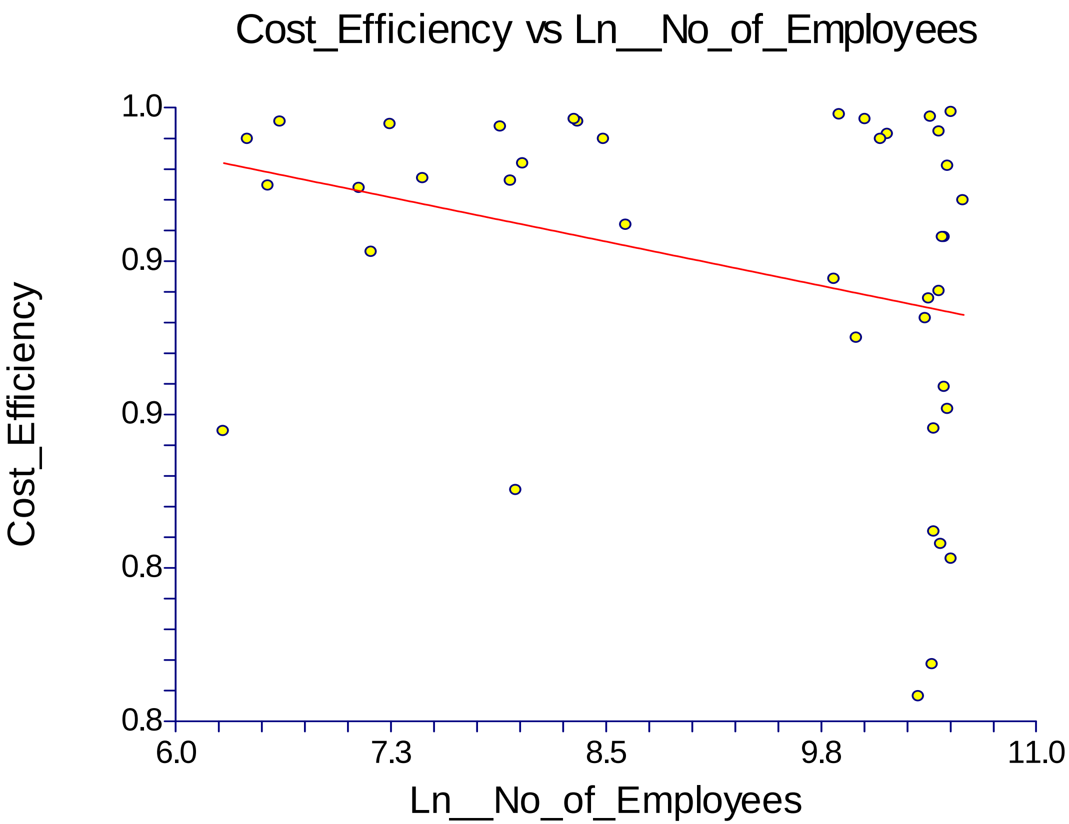
Cronbachs Alpha = - 0.000007
Standardized Cronbachs Alpha =- 1.2214

The null hypothesis that there is no correlation between a bank's cost efficiency and its size is rejected. Table 9 shows a negative correlation between cost efficiency and bank size. At a 5 % significance level, the correlation is significant as represented by the Cronbach alpha of less than 0.05.

The cost efficiency was also regressed against bank size, based on the natural logarithm for number of employees and the linear plot is shown in

Figure 4.

Figure 4: Plot of cost efficiency against ln (Number of employees)



The statistics for the regression in Figure 4 is summarised in Table 10

Table 10: Summary statistics for the regression between cost efficiency and bank size.

Parameter	**Value**
Dependent Variable	Cost Efficiency ln (Number of Employees)

Independent Variable	
Intercept	1.0677
Slope	-0.0144
R-Squared	0.1011
Mean Square Error	0.0004156
Prob Level (T Test) – Slope	0.0455
Reject H_0 (Alpha = 0.0500)	Yes

Figure 4 shows a negative correlation between cost efficiency and bank size. A significance test that the slope is zero resulted in a t-value of -2.0677. The significance level of this t-test is 0.0455. Since 0.0455 is less than 0.0500, the hypothesis that the slope is zero is rejected.

The R^2 is very low at 0.1011, indicating that whilst the relationship between cost efficiency and bank size is significant, only 10 % of it is explained by the data.

6 Results

6.1 Analysis of efficiency estimates

Table 3 showed the stochastic translog cost and profit frontier parameters from the maximum likelihood model used in the Frontier 4.1 package. Based on the t- statistic, all the variables used in model are significant at either 1%, 5% or 10 % levels except for P_L^2 and Q_2^2. It must be noted that the frontier estimates are not perfect as there are few observations relative to the number of parameters to be predicted, and this is mainly as a result of limited data.

The values in the table suggest that of the two outputs used in the model, advances seem to be the most cost incentive output. The production costs per rand for loans are quite high, possibly due to the inflationary pressure experienced in recent years.

6.2 Cost Efficiency

The results show that overall the banks are over 85 % efficient, with Investec being the most efficient and Standard Bank the least. The average inefficiency score for Standard Bank is 1.121, implying that its inefficiency is 12.1 % higher than it should be. These results are consistent with those reported by Bedari

(2003), whose work compared efficiency of Botswana and Namibian banks to three South African Banks (Absa, Standard Bank and Nedbank). Nedbank was found to be the most efficient and Standard Bank the least amongst the South African banks.

The high level of efficiency for Investec may be explained by the nature of its business relative to other banks in the sample. Investec is mainly involved in corporate and investment banking, servicing a relatively fewer high net- worth clients. Hence its servicing costs are lower relative to banks such as Absa, FirstRand and Standard Bank, who disburse loans to many individuals.

Table 11 summarises the stochastic cost inefficiency scores for the six years.

Table 11: Summary statistics for cost efficiency

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**All**
Mean	1.153	1.123	1.072	1.052	1.047	1.015	1.077
σ	0.093	0.083	0.062	0.048	0.046	0.015	0.058
Minimum	1.070	1.003	1.010	1.013	1.006	1.002	1.002
Maximum	1.240	1.184	1.178	1.156	1.123	1.038	1.240
# of banks	4	4	8	8	8	8	
Delta	*0.170*	*0.181*	*0.168*	*0.143*	*0.117*	*0.036*	

Overall there has been an improvement in the cost efficiency over the 6 years as marked by the declining mean values in Table 11. The average cost efficiency over the six year period is about 92 % implying that the banks only required 92 % of the resources used to produce the services that they generated.

The Krusral-Wallis ANOVA test results present evidence to reject the null hypothesis that there has been no change in cost efficiency over the last six years. The improvement in cost efficiency of South African banks over the period is significant at a 5% level, with the significant differences between 2000 and 2005. The mean efficiency was only about 85 % in 2002, but had improved to about 98 % in 2005.The Tukey-Kramer multiple comparison test (included in Appendix 3) , which provides all pairwise differences between the means revealed that there has been a significant improvement in the last two years (2004 and 2005) from the first two (2000 and 2001).

The values in Table 4 and Figure 2 seem to suggest that small banks are more cost efficient than big banks as evidenced by the smaller inefficiency values. However ANOVA tests indicate that this difference amongst the banks is insignificant.

The inter-temporal comparison of the scores suggest that although cost efficiencies were stable in 2000 and 2001, there was significant improvement from 2002, possibly due to increased competition amongst banks to collect scarce deposits and regulatory pressures to make banking services more accessible to a broader base of individuals.

The variation in cost efficiency seems to have narrowed over time, as represented by the delta values in Table 11. The difference in cost efficiency between the best practice and worst practise banks was 17 % in 2000, but this had declined to less than 4 % in 2005. This may be a result of more emphasis being placed on cost efficiency and the effective deployment of technology such as ATMs in place of the more expensive brick and mortar structures.

6.3 Profit Efficiency.

On average during the period, the profit efficiency of banks in the sample was 55 %. This is much lower than the cost efficiency levels recorded for the same banks. This is consistent with what has been observed in literature that profit efficiency levels are lower than cost efficiencies.

In 2005, the banks on average only earned 66 % of their potential profits. The most profit efficient banks are Capitec and Standard Bank, with the least being Nedbank and Absa. The observations are similar to those reported by Bedari (2003). The profit efficiencies for Nedbank were particularly low in 2002 and 2003, a period when the bank was under financial difficulties and recorded losses. Since restructuring the business, the profit efficiency improved up to 46 % in 2005.

Results of the Krusral Wallis one- way ANOVA test indicate that the changes in the profit efficiency over the years were insignificant, hence the null hypothesis was accepted. The profit efficiency levels indicate that the small banks are relatively more profit efficient than the big banks. However on analysis using ANOVA test, it could be proven that these differences in the banks' efficiency level are insignificant at σ of both 5 and 10 %. Berger & Mester (1997) noted that small banks showed the greatest levels of profit efficiency as they often recorded higher profitability ratios. They also concluded that as banks grow larger, whilst they are equally able to control costs, it becomes harder for them to create revenue efficiently.

The average profit efficiency level of 55 % for the South African banks is similar to those obtained in other studies. Research by Berger & Mester (1997) recorded profit efficiency levels of about 50 % for U.S banks between 1990 and 1996, whilst 52 % was noted for European banks (Maudos *et al*, 2000).

It seems that South African banks are relatively better at controlling costs than generating profits as marked by the lower profit efficiency levels. A similar trend was observed by Isik & Hassan (2002), for banks operating in Turkey which has a very similar nature of banking environment to South Africa.

6.4 Correlation between cost and profit efficiency

The correlation coefficient between cost and profit efficiency of South African banks is very low at 0.045, but statistically significant. This implies that the most cost efficient banks are also the most profit efficient even though the correlation is very low, as is the case with Capitec. The weak positive correlation is consistent with observation by Isik & Hassan (2002) for Turkish banks and Maudos *et al* (2000) for European banks.

An interesting case in the South African sample is Standard Bank, which was found to be relatively cost inefficient but recorded high profit efficiency levels. This may have been driven by increased demand for banking services from individuals, large corporations and government, which has enabled cost inefficient banks to prosper.

High cost inefficiencies can also be compensated through achieving higher revenues than competitors by using a different composition of the vectors of production, or benefiting from market powers in pricing. The case of Standard Bank highlights the benefits of adopting a holistic approach in assessing efficiency instead of only focusing on the cost side, which the cost-to-income ratios does.

6.5 Correlation between cost efficiency and bank size

Table 9 shows a significant negative correlation between cost efficiency and bank size. The cost efficiency falls systematically as the bank size is increased. The South African results are similar to those by Isik & Hassan (2002) and Kaparakis *et al* (1994). However some studies have indicated a positive relationship (Miller & Noulas, 1996 and Berger *et al* , 1993).

There are a number of plausible reasons for the decline in cost efficiency as the bank size increases. Small banks may have low overhead costs as they operate few branches (less than 300), whilst the bigger banks have in excess of 500 brick-and-mortar branches country wide. Secondly the small banks such as African Bank, Capitec and Teba offer fewer basic services such as short-term loans and deposits, and employ fewer people to manage the operations. Whilst big banks can benefit from scale, small banks have also made significant investments in technology and are able to compete effectively with the big banks.

The small banks such as Investec also offer larger amounts of loans to corporations or fewer individuals and specialised services, hence incur relatively lower costs for originating, servicing and monitoring the loans.

7 Conclusion

We used the stochastic frontier approach to determine cost and profit efficiency levels of South African banks over a six year period. The intermediary approach was adopted in which a bank’s outputs were considered to be advances and deposits.

Cost efficiency was found to have significantly improved over time, whilst the change in profit efficiency levels was not significant. The small banks recorded higher average profit efficiency levels than the big banks, but these differences were found to be statistically insignificant.

A correlation analysis was done to establish the relationship between cost and profit efficiency. A very weak positive correlation was found to exist for the South African banks. The cost efficiency was also regressed against bank size, of which a negative correlation was observed with cost efficiency declining with increasing bank size.

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APPENDIX 1: FINANCIAL DATA FOR BANKS

ABSA

Variable name	Source	Definition	2000	2001	2002	2003	2004	2005
Total costs	IS			**R Millions**				
		Operating expenses	7,739	8,900	9,700	10,780	11,679	12,761
		Interest expenses	15,843	14,708	16,133	21,467	19,183	16,568
Pretax Profit	IS	Income before tax	2,172	3,260	1,643	5,189	6,223	7,633
Outputs								
Advances	BS	Loans issued	144,824	156,396	183,860	199,297	222,395	268,240
Other earning assets	BS	Investment and trading securities	18,917	21,044	29,005	28,525	25,447	28,876
		Other Assets	2,484	2,671	3,399	3,506	5,792	14,384
Inputs								
Labour	Notes on FS	Number of full-time employees	34,313	36,700	35,283	32,356	31,658	32,515
Capital	BS	Fixed Assets (Property & Equip)	2,916	2,562	2,552	2,613	2,597	2,683
Deposits	BS	Deposits (incl current acc)	153,541	167,736	213,766	222,056	234,380	278,582
Total Staff costs	Notes on FS		3,880	4,491	4,872	5,338	5,708	6,340
Expenses on fixed assets	Notes on FS		582	703	685	748	766	698

Interest Expense	IS	Interest expenses	15,843	14,708	16,133	21,467	19,183	16,568
Other data								
Cost to income ratio			63.5	62.3	60.3	60.0	57.0	56.8
ROE			17.1	19.1	12.9	21.4	24.6	25.5

- **IS**: Income Statement, **BS**: Balance Sheet , **FS**: Financial Statements
-

AFRICAN INVESTMENT BANK LIMITED (ABIL)

Variable name	Source	Definition	2002	2003	2004	2005
Total costs	IS			**R Millions**		
		Operating expenses	938	1,036	946	968
		Interest expenses	212	202	112	102
Pretax Profit	IS	Income before tax	774	1,690	1,311	1,592
Outputs						
Advances	BS	Loans issued	4,900	4,400	4,472	5,282
Other earning assets	BS	Investment and trading securities	422	479	490	517
		Other Assets				
Inputs						
Labour	Notes on FS	Number of full-time employees	3,029	2,911	2,672	2,845
Capital	BS	Fixed Assets (Property & Equip)	189	194	140	112
Deposits	BS	Deposits (incl current acc)	690	884	544	644
Total Staff costs	Notes on FS		327	401	373	328
Expenses on fixed assets	Notes on FS		62	78	85	61
Interest Expense	IS	Interest expenses	212	202	112	102

Other data						
Cost to income ratio			37	36	30.8	28.6
ROE			23.6	25.9	31.3	37.4
Year End		September				

- **IS**: Income Statement, **BS**: Balance Sheet , **FS**: Financial Statements

CAPITEC BANK

Variable name	Source	Definition	2002	2003	2004	2005
				R Millions		
Total costs	IS					
		Operating expenses	178	243	301	386
		Interest expenses	6	3	4	17
Pretax Profit	IS	Income before tax	67	671	65	100
Outputs						
Advances	BS	Loans issued	92	116	135	208
Other earning assets	BS	Investment and trading securities	0	0	0	17
		Other Assets	0	0	0	0
Inputs						
Labour	Notes on FS	Number of full-time employees	1,267	1,180	1,402	1,708
Capital	BS	Fixed Assets (Property & Equip)	127	136	146	176
Deposits	BS	Deposits (incl current acc)	60	26	49	222
Total Staff costs	Notes on FS		67	95	117	162
Expenses on fixed assets	Notes on FS		11	23	33	54
Interest Expense	IS	Interest expenses	6	3	4	17
Other data						
Cost to income ratio	%			75	76	73
ROE			15.3	8.00	12.0	16.0

Year End	February

- **IS**: Income Statement, **BS**: Balance Sheet , **FS**: Financial Statements

FIRSTRAND (BANKING GROUP)

Variable name	Source	Definition	2000	2001	2002	2003	2004	2005
					R millions			
Total costs	IS							
		Operating expenses	6,348	7,091	8,378	9,537	10,503	12,389
		Interest expenses	9,701	9,770	12,305	17,189	13,505	13,920
Pretax Profit	IS	Income before tax	2,869	3,680	5,021	6,330	7,126	9,626
Outputs								
Advances	BS	Loans issued	102,652	119,659	175,145	189,611	210,414	226,552
Other earning assets	BS	Investment and trading securities	12,244	29,111	37,939	36,655	36,007	43,522
		Other Assets	16,914	6,114	3,286	0		
Inputs								
Labour	Notes on FS	Number of full-time employees (SA)	32,995	33,308	34,046	35,344	35,837	39,385
Capital	BS	Fixed Assets (Property & Equip)	3,330	2,911	3,412	3,455	3,839	3,633
Deposits	BS	Deposits (incl current acc)	117,592	137,584	201,404	186,031	225,886	247,084
Total Staff costs	Notes on FS		3,521	3,928	4,412	4,910	5,756	6,408

Expenses on fixed assets	Notes on FS		671	536	721	728	702	681
Interest Expense	IS	Interest expenses	9,701	9,770	12,305	17,189	13,505	13,920
Other data								
Cost to income ratio			60.2	59.5	57.6			56.0
ROE			24.1	25.1	26.0			28.8

- **IS**: Income Statement, **BS**: Balance Sheet , **FS**: Financial Statements

INVESTEC

Variable name	Source	Definition	2002	2003	2004	2005
				R millions		
Total costs	IS					
		Operating expenses	936	1,247	1,076	1,296
		Interest expenses	4,599	5,966	5,242	5,050
Pretax Profit	IS	Profit before tax	1,125	1,072	1,022	1,404
Outputs						
Advances	BS	Loans issued	28,955	28,158	35,726	42,690
Other earning assets	BS	Investment and trading securities	11,228	9,531	16,710	14,929
		Other Assets (Short-term securities)	7,354	8,199	6,336	7,982
Inputs						
Labour	Notes on FS	Number of full-time employees	5,529	4,874	4,170	4,096

Capital	BS	Fixed Assets (Property & Equip)	860	816	686	121
Deposits	BS	Deposits (incl current acc)	58,884	60,398	67,866	74,492
Total Staff costs	Notes on FS		619	701	665	850
Expenses on fixed assets	Notes on FS		80	101	51	35
Interest Expense	IS	Interest expenses	4,599	5,966	5,242	5,050

- **IS**: Income Statement, **BS**: Balance Sheet , **FS**: Financial Statements

NEDBANK

Variable name	Source	Definition	2000	2001	2002	2003	2004	2005
					R millions			
Total costs	IS							
		Operating expenses	4,516	5,409	7,334	9,950	11,736	11,157
		Interest expenses	10,504	11,918	17,522	21,333	16,258	14,705
Pretax Profit	IS	Income before tax	6,875	946	1,682	1	1,877	5,437
Outputs								
Advances	BS	Loans issued	120,085	151,329	201,539	210,096	221,128	248,408
Other earning assets	BS	Investment and trading securities	13,947	16,547	20,076	25,121	29,680	29,533

		Other Assets (Short term securities)	6,873	11,372	14,987	10,610	16,310	17,014
Inputs								
Labour	Notes on FS	Number of full-time employees	18,664	19,178	25,240	24,273	21,103	22,188
Capital	BS	Fixed Assets (Property & Equip)	1,793	1,793	2,854	2,684	2,740	3,095
Deposits	BS	Deposits (incl current acc)	140,689	177,160	235,449	250,329	254,299	261,311
Total Staff costs	Notes on FS		2,330	2,928	3,853	4,949	5,350	5,290
Expenses on fixed assets	Notes on FS		537	550	1,340	826	800	961
Interest Expense	IS	Interest expenses	10,504	11,918	17,522	21,333	16,258	14,705
Other data								
Cost to income ratio		%	50.0	49.3	55.4	70.1	74.5	62.8
ROE			24.0	25.1	17.2	0.3	9.2	15.5

- **IS**: Income Statement, **BS**: Balance Sheet , **FS**: Financial Statements

STANDARD BANK (BANKING OPERATIONS)

Variable name	Source	Definition	2000	2001	2002	2003	2004	2005
Total costs	IS				**R millions**			
		Operating expenses	8,462	9,744	12,587	13,608	10,718	12,061
		Interest expenses	13,465	16,159	20,697	25,359	21,130	22,684
Pretax Profit	IS	Income before tax	4,501	5,655	7,371	9,468	7,145	7,547
Outputs								
Advances	BS	Loans issued	127,057	157,841	170,377	220,375	201,225	250,939
Other earning assets	BS	Investment and trading securities	16,488	45,730	43,580	51,298	136,319	113,700
		Other Assets	31,323	55,194	40,766	124,334	6,828	4,376

Inputs								
Labour	Notes on FS	Number of full-time employees	30,315	33,086	34,509	35,034	35,820	36,682
Capital	BS	Fixed Assets (Property & Equip)	2,906	3,376	2,911	3,040	2,069	2,421
Deposits	BS	Deposits (incl current acc)	168,845	236,553	239,715	272,677	366,710	314,703
Total Staff costs	Notes on FS		4,477	5,242	6,934	7,581	5,850	6,933
Expenses on fixed assets	Notes on FS		640	640	1,008	1,134	779	686
Interest Expense	IS	Interest expenses	13,465	16,159	20,697	25,359	21,130	22,684
Other data								
Cost to income ratio			58.8	57.4	57.3	56.2	56.5	56.6
ROE			22.1	19.9	21.2	24.0	31.9	30.9
Year End		December						

- **IS**: Income Statement, **BS**: Balance Sheet , **FS**: Financial Statements

TEBA BANK

Variable name	Source	Definition	2002	2003	2004	2005
				R millions		
Total costs	IS					
		Operating expenses	175	214	274	295
		Interest expenses	35	41	43	41
Pretax Profit	IS	Income before tax	60	700	75	77
Outputs						
Advances	BS	Loans issued	263	188	207	206

Other earning assets	BS	Investment and trading securities	12	11	0	0
Inputs						
Labour	Notes on FS	Number of full-time employees	535	612	692	739
Capital	BS	Fixed Assets (Property & Equip)	48	47	52	49
Deposits	BS	Deposits (incl current acc)	971	1,031	1,243	1,464
Total Staff costs	Notes on FS		58	69	96	115
Expenses on fixed assets	Notes on FS		10	17	23	26
Interest Expense	IS	Interest expenses	35	41	43	41
Other data						
Cost to income ratio			66.8	63.3		
ROE			11.2	13.4		
Year End		February				

- **IS**: Income Statement, **BS**: Balance Sheet , **FS**: Financial Statements