Assessment of Foreign and Domestic Commercial Bank Efficiency in Uganda using a Data Envelopment Analysis Approach

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The Ugandan banking industry has undergone tremendous changes during the last two decades from a very repressed industry in the 1980s to a fully liberalized industry by the fall of the millennium. The industry has experienced challenges in the process of this transition. Notable among the challenges was the accumulation of Non-Performing Assets (NPA), inappropriate corporate governance systems and a regulatory framework that led to the banking crisis in 1998 – 2001. The banking industry was liberalized with a view to improving efficiency and financial sustainability through increased competition. This study was motivated by the need to assess the level of efficiency of foreign and domestic banks over time so as to determine their levels of efficiency and the factors that contribute to such efficiency. We used Data Envelopment Analysis (DEA) with quarterly bank level datasets for the period 2003Q1 – 2009Q4 to examine the cost and profit efficiency between domestic and foreign banks in Uganda. The number of observations was 224 from 28 quarters for each of the eight (8) banks. We also used the Tobit regression model to identify efficiency drivers. The findings revealed that domestically owned banks were more cost and profit efficient than their foreign owned counter parts. We also found out that determinants of bank efficiency were adequate fixed capital and low interest rates on deposits, which has resulted into accumulation of liquidity for most banks. The main policy recommendation is for government to support local banks to build strong capital bases. Also government should promote competition in the industry by attracting more banks. Competition may help to reduce the margin between deposits and lending rates.

Keywords: Data Envelopment Analysis (DEA), Efficiency ratios, Commercial banks

Introduction

The economic reforms and liberalization of business activities to private investors in many developing countries has resulted into a surge in foreign private capital. In the financial sector, foreign banks have become major players in attempts to reap economies of scope, and to strategically position themselves to efficiently meet the demands of their multinational clients.

In Uganda, foreign bank entry expanded in the 1990s following the liberalisation of the capital account, which allowed free movement of private capital in or out of the country. While foreign bank entry is being embraced in many developing countries, the causes and effects of foreign entry have raised a lot of debate in the recent past (Kiyota, 2009). This assessment of the relative efficiency between foreign and locally owned commercial banks is therefore of interest to policymakers,

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regulators and academicians. In this paper we give the background of commercial banking reforms in Uganda, a review of literature on banking efficiency, an explanation of DEA as applied in the study, and findings on efficiency levels and drivers of efficiency.

Background of Commercial Banking Reforms in Uganda

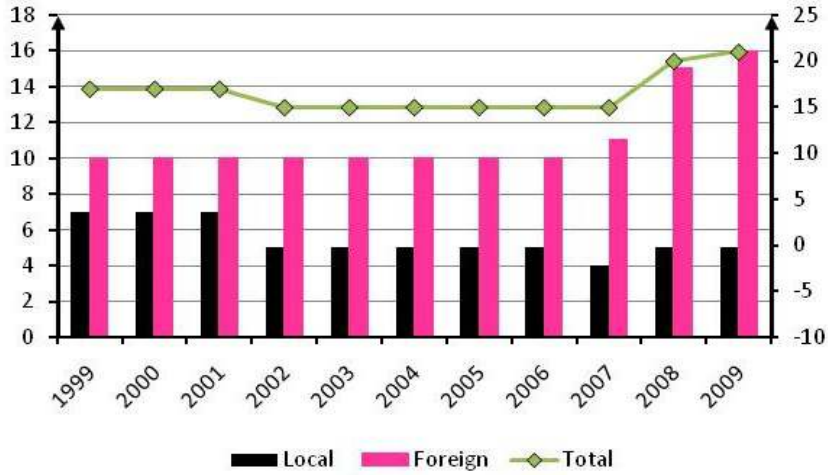
Commercial banking business has been in operation in Uganda for over a century. The first commercial bank in Uganda was the National Bank of India[i] which was incorporated in 1906 (Stanbic, 2010). Thereafter a number of foreign owned banks with roots in Britain or its colonies established operation in Uganda[ii]. Until the transformation of the Uganda Credit and Saving Society (UCSS) into Uganda Commercial Bank (UCB) in 1965, Uganda's banking industry was dominated by four foreign banks.

According to Thorsten and Heiko, (2009), the nationalisation policies of the 1970s forced foreign banks which had established up-country branches to either close or sell them to UCB – creating a pseudo-monopoly structure in the industry. During the 1970s up to early 1980s, the number of commercial bank branches and services contracted significantly. Whereas Uganda had 290 commercial bank branches in 1970, by 1987 there were only 84, of which 58 branches were operated by government owned Uganda Commercial Bank - UCB (Byrnes,1990). UCB was therefore the dominant commercial bank with the largest market share.

The other players within the finance sector are two development banks i.e. Uganda Development Bank (UDB) and the East African Development Bank (EADB). These were financial institutions set-up to provide long-term finance for investment, which could not be provided by the exiting commercial banks. UDB was wholly state owned while EADB was jointly owned by the three East African Countries.

This nationalisation policy coupled with the command economy regime of the time resulted into a period of profound financial repression. Nevertheless, the financial liberalization programme which began in the early 1990s reversed this scenario and ushered-in periods of increased influx of both foreign and domestic investments into the banking industry as shown in Figure 1. However, until 2003, the industry remained small with only 12 banks operating in the market and was characterised by concentration of operations, mainly within Kampala and Jinja[iii].

Figure 1: Trends in the Number of Commercial Banks in Uganda



Source: Bank of Uganda

There was however, drastic turnaround in the 1990s, following the liberalization of both the current and capital accounts of the Balance of Payments in 1994. The liberalisation led to higher currency convertibility and capital mobility. The liberalisation coupled with the renewed confidence in the economy resulted in sustained private foreign and domestic investments in the banking industry. The number of commercial banks increased to 22, most of which were foreign owned or had major equity shares held by foreign investors and corporations. The transition was however not smooth as the country experienced a brief banking crisis between 1998 and 2003, which constrained the initial gain from liberalization of the industry.

During the period 1990-1995, 11 private banks were licensed resulting in a three-fold increase in the number of banks relative to the pre-reform period. The reforms culminated in the passing of the Financial Institutions Act (2004) and Bank of Uganda Statutes in 1993 that enhanced the regulatory authority of Bank of Uganda (BOU). This gave the central bank significant regulatory authority and powers to prevail over weak banks. As a result of the crisis, several indigenous commercial banks were declared insolvent and taken over by the central bank and eventually sold or liquidated. A crucial outcome of the banking crisis was that it changed the market structure from one previously dominated by domestic banks (local private or government)

to one dominated by foreign banks. In addition to the loss of indigenous banks, the largest bank Uganda. The current banking system with sufficiently strong capital base, profits, effective management, good corporate governance, and well designed systems and controls, is now well placed to provide a growing contribution to financial inclusion and development of the economy. This is being fostered by the competition created by the foreign owned banks whose main objectives are to increase shareholders value to their investors. A number of domestically owned banks operate alongside these foreign banks and their ultimate goal is to provide banking services in a competitive finance sector that drives the economy. Table 1 below shows the domestically owned and foreign owned commercial banks operating in Uganda as at 31st December 2010.

Table 1 Commercial Banks Operating in Uganda

Domestic	Foreign
Centenary Rural Development Bank (CRDB)	ABC Capital Bank (ABC)
Crane Bank Uganda Limited (CBU)	Bank of Baroda Uganda Limited (BOBU)
DFCU Bank Uganda Limited (DFCU)	Bank of Africa Uganda Limited (BOA)
Housing Finance Bank Uganda Limited (HFB)	Barclays Bank Uganda Limited(BBU)
National Bank of Commerce (NBC)	Cairo International Bank Uganda (CIB)
	Citibank Uganda Limited (CBU)
	Diamond Trust Bank Uganda Limited (DTBU)
	Ecobank Uganda Limited (ECO)
	Equity Bank Uganda Limited (EBUL)
	Fina Bank Uganda Limited (FBU)
	Global Trust Bank Uganda Limited (GTB)
	Imperial Bank Uganda Limited (IBUL)
	Kenya Commercial Bank Uganda (KCBU)
	Orient Bank Uganda Limited (OBL)
	Stanbic Bank Uganda Limited (SBU)
	Standard Charted Bank Uganda Limited (SCBU)
	Tropical Bank Uganda Limited (TBU)
	United Bank of Africa Uganda Limited (UBAU)

Note: 1) Abbreviations in parentheses; 2) Ownership is based on information from the annual financial statement and web-search.

Subsequent to these reforms, the banking industry has been strengthened in many important aspects over the last few years and is

now stronger and vibrant but still at lowly development in terms of market coverage and products compared to other developing countries. Financial deepening has shown positive trend and in part, this has been achieved through effective supervision and enforcement of prudential regulations in the banking system, increased frequency of on-site inspections and surveillance.

In addition, improvements in supervision methodology and the prudent management of monetary and exchange rate policy by the BoU have contributed to strengthening the financial sector. This contributed to minimizing the non-performing assets as well as enhancing the profitability of the sector. The cleanup of the portfolio of UCB and its subsequent merger, and closure of trouble banks are key factors in explaining this improvement. High interest rate margins and the marked reduction in NPA have underpinned banks' profitability.

Related Literature

Efficiency in Banking

Efficiency in banking has been defined and studied in different dimensions including scale, scope, and operational efficiency. Scale efficiency refers to relationship between the level of output and the average cost. Scope efficiency on the other hand refers to relationship between average cost and production of diversified output varieties; and operational efficiency, a widely used concept sometimes referred to as x-efficiency, measures deviation from the cost efficient frontier that represents the maximum attainable output for the given level of inputs.

With reference to various definitions, efficiency is therefore a multifaceted concept with several meanings depending on the perspective in which it is used (Leibenstein, 1966). Scale and scope economies for example, are achieved from the firms' output expansion resulting in an increase in the industry's output and that reduces costs of production thus leading to the strong technological external economy. Hirshleifer and Glazer (1993) argue that scope economies occur where it is cheaper to produce varieties in a plant than in separate plants, and this is the concept from which banking consolidation stems.

Efficiency in banking can also 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, a measure of the loss of allocative and technical efficiency, have been carried out internationally. The results showed that X- efficiency is between 20-30 % of total banking costs in the US (Berger & Mester, 1997). According to Falkena et al. (2004), "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 have 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.

Efficiency Measurement Methods

There are various methods that can be used to measure cost and profit efficiencies efficiency. These can be grouped into financial ratios and econometric approaches.

Ratio 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) "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). Therefore, there is 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.

Econometric Approaches

A number of approaches have been reported in the literature to evaluate bank efficiency. These include; Data Envelopment Analysis (DEA), (Sathye, 2001), Free Disposal Hull (FDH) (Chang, 1999), Stochastic Frontier Approach (SFA) also called Econometric Frontier Approach (EFA), as in (Koetter, 2005); Thick Frontier Approach (TFA) as in (De Young , 1998) and Distribution Free Approach (DFA) as in (Berger, Hancock, and Humphrey, 1993). In this paper we used DEA approach because of its ability to handle multiple inputs and outputs, and ability to identify possible benchmarks.

DEA is a non-parametric method for calculating relative efficiency scores in a multiple input and output production environment. The DEA methodology was first introduced by Charnes et al. (1978) based on the original Farrell (1957) efficiency measure. It measures the performance of all Decision-Making Units (DMU)[iv] compared to the generated efficient frontier. Within the banking industry a DMU can be a commercial bank operating within a given area under single management or if a branch is independent in its decision. The best-practice banks, produces given output combinations with the lowest level of inputs or achieve the highest level of output with a given level of inputs (optimal input-output combination)[v].

Technical efficiency reflects the ability of a firm to obtain maximum output from a given set of inputs (Farrell, 1957). The simplest ways to measure efficiency is to compute an output input ratio:

$$Efficiency = \frac{output\ of\ a\ firm\ (bank)_i}{input\ of\ a\ firm\ (bank)_i} \quad \textbf{[1]}$$

If a firm produces only one output, using one input this could be done easily. However, this method is often inadequate as firms normally produce multiple outputs by using various inputs related to different resources. However this is not realistic in the real world.

In most cases, the measurement of relative efficiency which involves multiple, possibly incommensurate inputs and outputs as was first addressed by Farrell (1957). This will require a frontier of most the efficient decision making units (DMUs) and then to measure how far from the frontiers are the less efficient units. The relative efficiency can be measured as:

$$Efficiency = \frac{Weighted\ sum\ of\ output}{Weighted\ sum\ of\ input} \quad \textbf{[2]}$$

Thus a bank's efficiency for a given period (year) is defined as the maximum of a ratio of the weighted sum of the outputs to the weighted sum of the production factor inputs. Thus, the efficiency of the period is determined as follows:

$$Maximize \quad \frac{\sum_{r=1}^{s} U_r Y_{r0}}{\sum_{i=1}^{m} V_i X_{i0}} \quad \textbf{[3]}$$

subject to:

$$Maximize \quad \frac{\sum_{r=1}^{s} U_r Y_{rj}}{\sum_{i=1}^{m} V_i X_{ij}} \leq 1; \qquad j = 1, \ldots n \quad \textbf{[4]}$$

$$U_r, V_i \geq 0; \quad r = 1, \ldots s \quad and \quad i = 1, \ldots m \quad \textbf{[5]}$$

The Y_{rj} and the X_{ij} are the r^{th} output and the i^{th} input for the j^{th} year. Both Y_{rj} and X_{ij} are known and positive. The U_r and V_i are weights (implicit) assigned to the inputs and outputs. In the DEA application that follows, these will be defined to be strictly positive. They are determined by the linear programming solution using the input-output for all the years under consideration. The particular year being evaluated is assigned the sub-scrip 0 and in equation [3]. All n years, including the ones under evaluation are used in determining the n^{th} constraint. This is necessary so that no year can be assigned efficiency rating of more than 100%.

For each year under consideration, the efficiency rating of each bank will be determined. This will be a relative rating in the sense that the

observation is compared to all other observations being examined. Year 0 will be considered inefficient if, in comparison to other years the bank could have reduced it input usage with no reduction in output produced or more output without reduction in input or both reduced input and output".

The simple DEA model described in equation [3.3] to [3.5] above assumes constant return to scale. However, it is possible to modify the model to accompany increasing or decreasing return to scale, should these conditions be determined to exist.

Concept of Profit Efficiency and Cost Inefficiency

Profit efficiency is the ratio of predicted actual profit to predicted maximum profit, which could be earned if a bank was as efficient as the best practice bank after adjusting for random error. Profit efficiency is ability to achieve maximum profits for a given set of output and the estimated values in logarithm are bounded between 0 and 1. The higher the profit efficiency score is, the more profit efficient the bank will be. If the score is 1, it means the most profit efficient bank.

Cost inefficiency measures the change in a bank's variable cost adjusted for random error, relative to the estimated cost needed to produce an output bundle as efficiently as the best-practice bank in a sample facing the same exogenous variables, which include variable input prices, variable output quantities and fixed outputs (inputs and outputs). It arises due to technical inefficiency, which results in the use of an excess or sub-optimal mix of inputs given input prices and output quantities.

The value of cost inefficiency can be equal to or greater than one. It is equal to one for the best-practice commercial bank within the given sample. If it is greater than one, then the bank is thought of wasting a certain proportion of its resources relative to a best practice bank facing the same condition. Thus, the higher value of cost inefficiency is, the greater the inefficiency is. For example, a value of 1.17 implies that a bank has costs that are 17 percent above minimum defined by the frontier. It also means that 17 percent of its costs are wasted relative to the "best-practice" commercial bank producing the same output and facing the same conditions.

Studies on Assessing Bank Efficiency using DEA

Most studies on performance measurement focus on the operational (technical) efficiency of an organization(s) and the aspect of operational

effectiveness is usually ignored. Nevertheless, in recent years, there exist a few studies which explicitly recognized the efficiency and effectiveness as two mutually exclusive components of the overall performance of an organization. For instance, Byrnes and Freeman (1998) utilized DEA to assess the efficiency and effectiveness in contractor delivery of service in Franklin County Alcohol, Drug and Mental Health Board at Ohio State. They concluded that integrating DEA results into current board performance funding could be a valuable instrument for promoting efficiency and effectiveness.

Karlaftis (2004) utilized DEA to evaluate the efficiency and effectiveness of 256 US urban transit systems over a five-year period (1990-1994). The results show that efficiency and effectiveness are positively related and, thus, the systems performing well in one dimension (i.e. efficiency) generally perform well in the other dimension (i.e. effectiveness).

Ho and Zhu (2004) utilized a two-stage DEA model to evaluate the performance of 41 Taiwan's commercial banks for the financial year 2001. The main empirical finding is that the bank with better efficiency does not always mean that it has better effectiveness. They found no apparent correlation between efficiency and effectiveness.

Data

In this study we used secondary bank-level panel data sourced from the central bank's quarterly reports. Quarterly data was collected from publicised financial reports of the banking industry and from the International Financial Statistics (IFS) Online Services database. The financial surveillance database has two major advantages. First, the data is very accurate and reliable since they are rigorously checked by the commercial banks, their regulators and researchers. Second, the accounting information for each bank is presented in standardized form (BS 100[vi]) whose coverage is fairly comprehensive, with 100% of the commercial banks covered and the data aggregated for economic statistics.

However, there are has some limitations. First, there is a sample-selection bias for the domestic banks which were limited to only four (4) banks. The sample selection for foreign banks was based on stratified random sampling approach. The 18 foreign owned banks were stratified according to the book value of the owners' equity as at 2009Q4 and random samples drawn from each category.

Quarterly data for the period 2003Q1-2009Q4[vii] were used. The sample covered eight (8) commercial banks four (4) of which are

domestically owned and the other four (4) are foreign owned banks[viii]. The number of observations was 224 from 28 quarters for each of the eight (8) banks. The detailed list of commercial banks from which this sample was drawn is presented in Table 2.

DEA for the Study

This research utilized the out-put oriented DEA with variable return to scale (VRS) models. The assumption of VRS was used in specifications because this hypothesis is more relevant with the environment of imperfect competition in which banks operate. All the banks in Uganda are not operating at optimal capacity with constraints arising from imperfect competition, mobilization of deposits and input costs. This assumption was made by Grigorian and Manole (2002) to evaluate the efficiency of transition countries banks from Eastern Europe, following the technological changes which occurred in the banking industry and the banking system reforms after financial liberalization. The applied DEA methodology also views banks as institutions that collect and allocate funds into loans and other assets.

This research applied the input oriented variable return to scale (VRS) DEA, which focused on the technical-physical aspects of production. The VRS DEA model is adopted because it is assumed that banks can vary their input cost in order to maximise returns. The approach is appropriate if bank managers can make behavioural assumption of firms' objectives like cost minimization or profit maximization. Thus the objective functions of the VRS DEA can be considered to be reasonable if reliable price information is available to identify allocative efficiency.

Variables used in the Study

To define inputs and outputs in the banking industry may be the greatest problem associated with efficiency measurement (Mlima & Hjalmarsson, 2002). With the multi-product nature of a banking firm, there is still no agreement as to the definition and measurement of a bank's inputs and outputs (Girardone et al., 2004). Berger and Humphrey (1997) pointed out that the intermediation approach is the most appropriate approach for evaluating financial institutions. The reason is because this approach includes interest expenses, which account for up to two-thirds of total costs.

Molyneux et al. (1996) and Mester (1996) stated that the intermediation approach is used because it views financial institutions as mediators between the supply of and the demand for funds. Elyasiani

and Mehdian (1990) also stated that the intermediation approach is preferred because the quality of data benefits the intermediation approach.

Under the intermediation approach, banks are treated as financial intermediaries that combine deposits, labour and capital to produce credits (loans and advances) and other investments inured make profits. The interest earnings from credits, investments and profits were treated as output measures while the cost of labour, deposits and value of owners' equity were treated as inputs. The components of each variable are as shown in Table 2.

Table 2: Variables used in DEA

Variables	Component from the BS[ix] or IS[x]
Data Envelopment Analysis	
Labour cost	Staff salary, wages and other staff cost from IS.
Interest on deposits	Total Interest on Demand, Saving and Time deposits from IS.
Equity capital	Tier I & II capital, Retained earnings from the IS and revaluation reserves.
Interest from credits	Interest earned on credits and advances from the IS.
Interest from investments	Interest earned on other investments (BOU schemes, government securities and interbank investments) from the IS
Profit	Net profit from the IS.

Cost efficiency DEA Specifications

The DEA frontier is formed as the linear combination that connects the set of these best practice observations, yielding a convex production possibility set. The DEA provides an analysis of relative efficiency for multiple input/output situations, by evaluating each DMU and measuring its performance relative to an envelopment surface composed of best practice units. The units that do not lie on the surface are considered inefficient. This way, the method provides a measure of relative efficiency.

In this study we assumed that banks minimize cost and consequently, it can consider the input orientated efficiency with variable return to scale (VRTS). The cost model can be written as follows:

$$\min \quad \sum_{i=1}^{m} C_{i0} x_{i0}, \quad (i = 1, 2, 3, \ldots m)$$

$$s.t. \quad x \geq \sum_{j=1}^{n} x_{ij} \lambda_j, \quad (j = 1, 2, 3, \ldots n)$$

$$y \leq \sum_{r=1}^{s} y_{rj} \lambda_j, \quad (r = 1, 2, 3, \ldots s)$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$$\lambda_j \geq 0, \quad \textit{for all value of } j$$

[3.1]

where j = *(1, 2, 3, ..., n)* are the number of bank, i = *(1, 2, 3, …, m)* are input volumes used by bank j, *(r = 1, 2, 3, …, s)* measures the volume if output r and C_{i0} is the unit cost of the input i of bank DMU_0 (which is the benchmark projection), that can be different from one bank to another. The minimization problem is calculated for each bank of the sample by utilizing its benchmark combination of inputs cost and outputs. The DEA model assumes a returns-to-scale characteristic that is represented by $L \leq \lambda_1 + \lambda_2 + \cdots + \lambda_n \leq U$. In this case, we compute variable returns to scale and use $L = U = 1$. Our model allows substitutions in inputs. Based on an optimal solution of the problem (4.1), (x^*, λ^*), the cost efficiency of DMU_0 is defined as:

$$CE_0 = \frac{c_0 x^*}{c_0 x_0}$$

[3.2]

where CE_0 is the ratio of minimum cost to observed cost for the 0^{th} bank. This approach implies that all observed input-cost combinations are measured with no error. Outliers may be considered as very efficient as data error implies no comparison unit for these banks or they may be simply unique. The hypothetical bank co-determinates the frontier relative to which all other peers are evaluated, mean efficiency may be low as the majority of banks are located far above this benchmark. By assuming that measurement errors occur randomly, a stochastic approach can alleviate the problem.

The Profit Efficiency DEA Specifications

Building on the previous model [3.2] let where p_i^0 and q_i^0 are the unit price of the input i and unit price of the output r of $bank_0$, respectively. These price data may vary from one bank to another. The cost efficiency and revenue efficiency of $bank_0$ is defined as:-

$$\frac{\sum_{i=1}^{m} p_i^0 x_i^*}{\sum_{i=1}^{m} p_i^0 x_{i0}}$$

[3.3]

And;

$$\frac{\sum_{r=1}^{s} q_r^0 y_{r0}}{\sum_{r=1}^{s} q_i^0 y_{r0}^*} \qquad \textbf{[3.4]}$$

The cost and revenue efficiency scores are within the range of 0 and 1. Therefore the profit efficiency DEA model is defined as:

$$\max \quad \sum_{r=1}^{s} q_r^0 y_{r0}^* - \sum_{i=1}^{m} p_i^0 x_{i0}^*$$

Subject to

$$\sum_{j=1}^{n} \lambda_i x_{ij} \leq x_{i0}^*, \quad (i = 1, 2, 3, \ldots, m)$$

CRTS

$$\sum_{j=1}^{n} \lambda_i y_{rj} \leq y_{r0}^*, \quad (r = 1, 2, 3, \ldots, s) \qquad \textbf{[3.5]}$$

$$x_{i0}^* \leq x_{i0}, y_{r0}^* \geq y_{ro}$$

$$\lambda_j \geq 0$$

The profit efficiency of $Bank_0$ is defined as:

$$\frac{\sum_{i=1}^{m} q_i^0 y_{r0} - \sum_{i=1}^{m} p_i^0 x_{i0}}{\sum_{i=1}^{m} q_i^0 y_{r0}^* - \sum_{i=1}^{m} p_i^0 x_{i0}^*} \qquad \textbf{[3.6]}$$

Equations 3.2 and 3.8 will be evaluated to estimate the cost and profit efficiency of domestic and foreign owned commercial banks.

Tobit Model for Estimation of Drivers of Bank Efficiency

To establish the factors which drive commercial banks operational efficiency (x-efficiency), the Tobit[xi] model is applied to the results of the DEA and macroeconomic variables. The Tobit model has the strength of estimating equations whose dependent variables values are restricted within some range. To establish the inefficiency index of an observation, the research undertakes exponential transformation of the difference between1 (or 100% efficiency) and the estimated efficiency score from the DEA estimations, such that, efficient observations are assigned a 0 inefficiency index value. In this regard some observations are assigned positive inefficiency indices while others, the efficient ones, are assigned zero index value. This kind of regressions are best handled by the two limit Tobit model since estimates of the simple linear models such as ordinary least squares (OLS) would be biased. The original Tobit

regression model is referred to as a censored regression model with reference to Tobin (1958) who first proposed the model. The model is specified in terms of the indexed function as:

$$y_i^* = x_i^{'} \ddot{a} + \overset{0}{a}_i$$
$$y_i = 0, \; if \;\; y_i^* \leq 0 \;\; and$$
$$y_i = y_i^* \;, \;\; if \;\; y_i^* \rangle \; 0 \qquad \textbf{[3.7]}$$

Where y_i is a new random variable transformed from the original one, and $y_i^* . x_i$ is a column vector of independent variables which is a transpose of $1 \times K$ row of x, and $\ddot{a}$ is a vector of parameters. In a column vector of disturbances is represented by $\overset{0}{a}_i$. This model may require adjustment for data with lower and upper truncation. Below is the two-limit specification of the doubly-truncated Tobit model; this model is the version used in the estimation of the source of efficiency in this research.

$$y_i = x_{2i} \ddot{a} + \overset{0}{a}_i$$
$$y_i^* = L_{1i} \quad if \;\; y_i^* \leq L_{1i}$$
$$= y_i \quad if \;\; L_{1i} \langle y_i \langle L_{2i}$$
$$= L_{2i} \quad if \;\; y_i \leq L_{2i} \qquad \textbf{[3.8]}$$

Where y is a latent variable while y^* is observed dependent variable. L_{1i} is a lower limit and L_{2i} is an upper limit.

The model is therefore specified with x-inefficiency (operational) index as a function of repressors hypothesized as determinant of x-inefficiency among Ugandan banks,

$$Ineff = f(K, I, AQ, S, EL, ER) \qquad \textbf{[3.9]}$$

where $Ineff$ denotes x-inefficiency index estimated from the multi-product translog cost function. K is capital adequacy measure of which the research uses the proportionate spending on capital goods relative to other non-tax expenses as a proxy. I is interest rate relative to the bank's net income. AQ is a proxy for asset quality – captured in this case by the ratio of non-performing loans to total loans, while S is the bank size measured by total assets. EL is excess liquidity variable constructed by total bank liquid assets less the amount sufficient to finance its statutory required reserves, deposit outflows and short-term

maturing obligations, and ER is the exchange rate. The x-efficiency model is expressed mathematically as:

$$\begin{aligned} &if\ \ LHS \rangle 0 \\ &\qquad (Ineff)_i = 0, otherwise. \end{aligned} \qquad \textbf{[3.10]}$$

This means x-efficiency index is estimated for all inefficient observations; otherwise observations that are efficient have indices of zero inefficiency.

Findings

Descriptive Statistics

The summary statistics for the input and output variables used in the study are presented table 4. The mean, median, minimum, maximum and standard deviation for the six variables used are shown. The first part of the table gives the descriptive statistics for all the eight banks and the remaining two parts give the statistics for the 4 domestic and the 4 foreign banks.

Table 3: Input and Output Variables 2003-2009 (UGX, millions)

	Variables	Mean	Median	Minimum	Maximum	Std Dev
All	Labour Cost (X_1)	3,022.17	1,355.96	50.13	14,521.51	3,474.11
	Interest on Deposits (X_2)	1,699.06	1,073.87	26.28	10,957.24	2,098.81
	Equity Capital (X_3)	70,790.60	51,551.85	8,241.77	336,120.30	62,422.75
	Interest on Credits (Y_1)	5,799.48	4,161.82	56.77	22,949.77	5,687.90
	Other Investments (Y_2)	4,358.21	1,677.19	43.44	35,281.99	5,688.53
	Profits (Y_3)	5,828.99	2,301.38	(6,780.08)	41,974.98	8,635.39
Domestic	Labour Cost (X_1)	2,109.56	1,255.05	50.13	8,856.58	2,502.41
	Interest on Deposits (X_2)	1,382.44	873.67	26.28	10,333.58	1,957.36
	Equity Capital (X_3)	49,150.26	38,757.67	8,241.77	140,046.70	36,766.32
	Interest on Credits (Y_1)	4,786.67	3,561.70	56.77	22,949.77	4,964.17
	Other Investments (Y_2)	2,152.48	1,122.41	106.10	19,649.42	3,550.65
	Profits (Y_3)	2,972.12	1,661.73	(1,059.21)	19,841.26	4,248.46
Foreign	Labour Cost (X1)	3,934.77	1,982.91	130.96	14,521.51	4,037.93
	Interest on Deposits (X_2)	2,015.67	1,389.08	43.45	10,957.24	2,194.56
	Equity Capital (X_3)	92,430.94	90,387.36	10,702.49	336,120.30	74,374.02
	Interest on Credits (Y_1)	6,812.30	6,198.91	259.36	20,752.86	6,187.31
	Other Investments (Y_2)	6,563.95	3,733.53	43.44	35,281.99	6,525.71
	Profits (Y_3)	8,685.85	4,267.83	(6,780.08)	41,974.98	10,737.40

The analysis focuses on the assessment of the domestic and foreign owned bank's intermediation efficiency. This approach assumes that banks raise deposits from surplus spending units and re-package them into loans or other interest earning investments to make profits. Banks are therefore faced with cost minimization and profit maximization constraint in attaining their profit maximization objective. Therefore, we computed the DEA for cost, and profit efficiency.

DEA Cost and Profit Efficiency

The DEA cost and profit efficiency analysis covered the period after the banking crisis in Uganda. The DEA results in table 4 reveal that most banks in the sample were operating at increasing return to scale for both cost and profit efficiency. This suggests that after the banking crisis (1998-2001), commercial banks in Uganda began operating at the raising part of the average cost and profit curve.

The average cost efficiency of domestic banks was 86.7 percent while that of foreign banks was 55.3. These rates indicate the extent to which banks could reduce input and yet at the same time produce the same amount of output. The slack variable indicates that technical inefficiency resulted for inefficient use of input resources. The mean profit efficiency for the domestic banks is 83.1%, while for the foreign banks the score is 45.7%. Clearly domestic banks are more profit and cost efficient than foreign banks. This means that domestic banks have the ability to achieve maximum profits for a given set of outputs.

Table 4 DEA Results of Cost and Profit Efficiency Commercial Banks (2003-2009)

	Cost Efficiency			**Profit Efficiency**		
	VRS	**Scale**		**VRS**	**Scale**	
Domestic						
Bank - 1	1.000	1.000	-	0.323	0.007	IRS
Bank - 2	1.000	0.430	DRS	1.000	1.000	-
Bank - 3	0.468	0.788	IRS	1.000	0.007	IRS
Bank - 4	1.000	1.000	-	1.000	0.733	IRS
Mean	**0.867**	**0.805**		**0.831**	**0.437**	
Foreign						
Bank - A	1.000	0.234	DRS	0.226	0.006	IRS
Bank - B	1.000	1.000	-	1.000	1.000	-
Bank - C	0.096	0.009	IRS	0.266	0.052	IRS
Bank - D	0.010	0.014	IRS	0.338	0.045	IRS
Mean	**0.553**	**0.314**		**0.457**	**0.276**	

Note: CRS = technical efficiency from CRS DEA; VRS = technical efficiency from VRS DEA; Scale = scale efficiency = CRS/VRS; DRS = Decreasing Return to Scale; IRS = Increasing Return to Scale

Drivers of Bank Efficiency

The determinants of bank efficiency in Uganda were estimated using two-limit Tobit model (*see* Equation 3.9). X-efficiency indexes were regressed against six explanatory variables namely: Capital adequacy rating of the bank (K), interest rate (I) relative to the bank's net income, asset quality (AQ), bank size (S), excess liquidity (EL) and average exchange rate (EX) between the USD and UGX during the period. Using consolidated data from all the banks in Uganda the Tobit model was estimated and the results are as shown in Table 5.

Table 5: Tobit Estimate of the Determinants of Bank Efficiency

				Number of observations = 120		
				LR chi2(5) = 23.72		
				Prob>chi2 = 0.0001		
Log likelihood = 84.273695				Pseudo R2 = -0.2417		
Ineff	**Coef**	**Std Err**	**t**	**P>|t|**	**[95% Conf**	**Interval]**
Ki	-2.74e-8	8.34e-9	-2.75*	0.000	-4.74e-8	-1.59e-8
IRi	-746.236	154.7321	-5.53*	0.000	-2543.184	-371.3427
AQi	-4.6531	8.4329	-0.51	0.417	-32.60738	18.3467
Si	1.673e-10	10.47e-10	3.29**	0.092	1.57e-10	2.78e10
ELi	0.04172	0.0458	2.44*	0.006	0.02357	0.072343
EXi	-0.07451	1.5983	3.27**	0.057	0.04329	0.045327
Const	1.72851	0.0373	3.16*	0.000	0.06784	0.34628
	Se	0.0654792	0.0042171	(Ancillary parameters)		

*Significant at the1% level; **significant at 5% level

All the factors apart from asset quality significantly influence efficiency. Capital adequacy was significant but bears a negative sign. This implies that as commercial banks spends more on improvement of its capital base; it raises its efficiency gains. Investments in capital assets by commercial banks include efficiency generating items like: banking software, computers, ATM and point of sales machines, and network development linking branches which enhances efficiency in service provision. Thus, under capitalisation can be a source of bank operational inefficiency.

The interest rates have a negative significant influence on operational inefficiency. This indicates that when interest rates increase, operational inefficiency of commercial banks decreases. This is explained by difference in the interest margin between the lending and deposit rates. The deposit rates tend to be rigid there by allowing banks to increase their net earning if interest rates are high.

In the literature, the size of the bank is believed to be inversely related to operational inefficiency index. However, the results of the Tobit

estimate revealed that bank size is positively related operational inefficiency. The underlying argument is that large firms are more vulnerable to managerial utility maximization which may be motivated more by external factors than by internal performance objectives. As the size of a bank grows, the separation of ownership and management increases and thus the management self interest easily entrench the bank's efficiency objectives.

In terms of liquidity, the estimated parameters revealed significant relationship between bank efficiency and excess liquidity (EL). In this study, excess liquidity was found to be positively related to the operational inefficiency index. This finding confirms the hypothesis that excess liquidity in banks leads to inefficiency.

The impact of exchange rates as a determinant of efficiency was found to be significant and positive. Exchange rate movement is related to interest rate changes. Although there is limited trade between the US$ and Shs, this result revealed that exchange rate effect bank x-inefficiency in Uganda.

Conclusion and Policy Recommendation

The relative profit efficiency levels were found to be significantly lower than the cost efficiencies. According to the profit efficiency estimation results, the alternative profit estimates for domestic banks was lower than for foreign banks. From this result we conclude that approximately one-third of banks' profit was lost to inefficiency during the period reviewed. All banks have however, increased their profit efficiency since 2003Q1.

Estimates of the Tobit model indicate that the determinants of operational inefficiency in banks was the outcome of adequate fixed capital, low interest rates (deposit) and overwhelming accumulation of excess liquidity. This therefore suggests that an optimal interest rate and low liquidity is necessary for attainment of bank efficiency.

The implication from this finding is that there is room to improve efficiency of commercial banks in Uganda. It is therefore important to encourage more bank entry to enhance competition in the industry. Foreign banks are particularly encouraged since they tended to be efficient and a source of productivity and human capital spill overs to the local firms.

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Notes

[i] After several name changes the National Bank of India became Grindlays Bank in the 1980s. The Grindlays network in Africa was subsequently acquired by Standard Bank Group in October 1993 and now operates in Uganda under the corporate name Stanbic Bank Uganda Limited.

[ii] The first four foreign owned commercial banks in the market were; Grindlays, Standard Chartered, Barclays and Bank of Baroda. Standard Chartered and Barclays are British banking conglomerate which have been in operation in the Ugandan market since 1912 and 1927, respectively.

[iii] UCB was the only bank which established and operated branch networks in all major towns outside Kampala and Jinja in the 1980s and 1990s.

[iv] Charnes, Cooper and Rhodes used the term DMU (decision making unit) because DEA can be used not only to measure efficiency of firms but also braches within a firm.

[v] Note that, firms (banks), which do not operate on the optimal frontier, suffer a certain level of efficiency loss.

[vi] A statutory return designed by the BoU for all Credit Institutions in Uganda composed of the following: Assets and Liabilities, Off Balance Sheet Items, Analysis of Loans and Advances, Monthly Report on Interest Rates, Analysis of Deposits, Analysis of Equity Investments, Breakdown of Other Assets and Other Liabilities, Analysis of Borrowings, Analysis of Other Securities, Breakdown of Amounts due from Non-Resident Banks, Analysis of Securities Issued, Analysis of Financial Derivatives, Analysis of Subordinated Debt and Redeemable Preference Shares Exchange rates and Other Comments.

[vii] In this research report Q1, Q2, Q3 and Q4 represents the quarters based on calendar year. Where Q1 is for the quarter ending 31st March and Q4 is for the quarter ending 31st December.

[viii] A domestic bank is defined as one in which resident enterprise(s) and/or individual(s) investor(s) solely or collectively own more than 50% equity stakes. Foreign banks on the other hand are those in which the majority equity stakes are held by non-resident individual(s) and/or enterprise(s).

[ix] BS = Balance Sheet

[x] IS = Income Statement

[xi] Tobit regression is often encountered in second stage data envelopment analysis (DEA), i.e. when the relationship between exogenous factors (non-physical inputs) and DEA efficiency scores is assessed. It is however not obvious that Tobit is the only, or optimal, approach to modelling DEA scores.