

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

**MEASURING EFFICIENCY PERFORMANCE OF COMMERCIAL
BANKS IN ETHIOPIA: A DATA ENVELOPMENT ANALYSIS
APPROACH**

By

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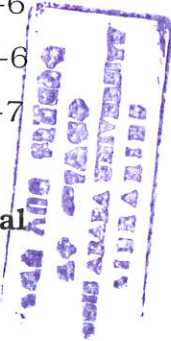
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Acronyms

AE	-Allocative efficiency
AIB	-Awash International Bank
BoA	-Bank of Abyssinia
Br.	-Birr
CBB	-Construction and Business Bank
CBE	-Commercial Bank of Ethiopia
CE	-Cost efficiency
CRS	-Constant returns to scale
DB	-Dashen Bank
DBE	-Development Bank of Ethiopia
DEA	-Data envelopment analysis
DMUs	-Decision making units
DRS	-Diminishing returns to scale
EEA	-Ethiopian Economic Association
FAO	-Food and agriculture organization
GDP	-Gross domestic product
IRS	-Increasing returns to scale
MPI	-Malmquist productivity index
NBE	-National bank of Ethiopia
NIB	-Nib International Bank

NPLs	-Non-performing loans
OLS	-Ordinary least squares
SE	-Scale efficiency
SFA	-Stochastic frontier approach
TE	-Technical efficiency
TFP	-Total factor productivity
UB	-United Bank
VRS	-Variable returns to scale
WB	-Wegagen Bank

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Abstract

This study concentrates on the efficiency performance of commercial banks in Ethiopia by examining the efficiency, changes in productivity and technology, and potential determinants of the efficiency of a sample of eight commercial banks during the period 2002/2003-2006/2007. In measuring the efficiency of commercial banks data envelopment analysis has been employed. The efficiency scores for the technical efficiency, allocative efficiency, cost-efficiency, and scale efficiency were found to be 97.68%, 90.24%, 88.5%, and 93.22% respectively. The Malmquist total factor productivity index showed that on average productivity has been growing by 2.1% and the growth in technology change was on average 2.4%. Results from the censored Tobit model showed that return on equity, total capital, total asset, gross profit, real GDP, number of bank branches, deposits, the growth rate of loans, the growth rate of the number of branches, the number of micro-finance institutions, the growth rate of gross profit, and the growth rate of returns on asset had a statistically significant effect on at least one of the efficiency scores. Though the commercial banks were found to be inefficient, there has been an improvement in productivity and technology change over the study period.

CHAPTER -ONE

Introduction

1.1) Background

Financial sectors play a critical role in day-to-day activities of humans and economic growth of a nation. The financial sector mobilizes savings and allocates credit across space and time. It provides not only payment services, but also enables firms and households to cope with economic uncertainties by hedging, pooling sharing and price risks. An efficient financial sector reduces the cost and risk of producing and trading goods and services and thus makes an important contribution to raising the standard of living (Herring et al, 1996). The financial sector plays its role in economic growth. Based on data from 80 countries over the periods between 1960 and 1989, King et al (1993) argued that financial system could promote economic growth. King et al noted that there are three major ways in which the financial system can influence the capital stock for growth purposes. First, financial institutions can promote efficient allocation of resources (capital in a broad sense), by changing the ownership and composition of resources, through intermediation among various types of owners of assets. Second, financial institutions can promote a more efficient allocation of new investments from relatively more productive uses by creating a bridge between savers and entrepreneurs. Third, they can facilitate the rate of

accumulation of capital by providing increased incentives to save, invest, and work.

Banks are categorized as financial institutions. Banks save deposits and give to investors, businessmen, and households in the form of loan and advances and get interest income on it. Banks can also facilitate transactions through checks and various electronic cards. So, we can see that there is a link between banks and economic activities.

In Ethiopia financial institutions are expanding. Currently there are about 10 banks, 9 insurance companies, and 26 micro-finance institutions (NBE annual report 2005/06). Still the number of banks and insurance companies is growing. New banks and insurance companies are joining the incumbents.

Annual report of the NBE showed that the total capital of the banking system at the end of June 2006 reached 5.4 billion Br. and the total resource mobilized by the banking system through deposits, borrowing, and loan collection reached 17.5 billion Br. However, various reports of commercial banks showed that the excess liquidity position is high (about 18 billion Br. at the end of June, 2006) and the non-performing loans (NPLs), as approximated by the provisions for doubtful loans, is not low.

1.2) Statement of the problem

Cost ratios based on the financial statement of commercial banks are the most widely used measures of performance of banks. Accounting based cost ratios are popular tools for analyzing the efficiency of banks, because they are simple to construct and easy to use (De Young, 1997).

But bank efficiency is a complex phenomenon for which simple analysis can yield misleading conclusions due to difference in product mix, bank size, market conditions, and other characteristics that can affect the banks' expenses (ibid, 1997).

To overcome the shortcomings of the cost ratios, financial analysts and researchers use alternative approaches. These approaches are parametric and non-parametric approaches. In Ethiopia, as to the best of my knowledge, there is no study that used the non-parametric approach to measure the efficiency of the sample of eight commercial banks. However, Muluneh (May, 2006), Dereje (2006), and Misganaw (March, 2007) used the parametric approach (Stochastic Frontier Approach) to measure the efficiency of commercial banks in Ethiopia. Muluneh found that the cost efficiency level of private commercial banks was 86 percent between 1997 and 2005 and Misganaw found that the mean level of cost and profit X-efficiencies of private commercial banks were 81 percent and 70 percent respectively between 2000 and 2005. Misganaw also found that returns on equity,

capital, asset level, and deposit ratio have negative correlation with predicted cost x-inefficiency while number of branches and non-performing loans were positively correlated. Moreover returns on equity, number of branches, and GDP negatively correlated with predicted alternative profit x-inefficiency, while NPLs positively correlated.

The three studies followed similar approach to measure the efficiency of commercial banks. Muluneh and Misganaw exclude public commercial banks. Only Dereje studied the efficiency of both public and private commercial banks. Also in their study they did not show the change in productivity and technology of the banks. This study tried to fill the gap by examining the efficiency of public and private commercial banks and analyzed the productivity and technological change of the commercial banks using the non-parametric approach-data envelopment analysis (DEA). The findings from this study could help managers of individual banks in evaluating the efficiency performance of their bank. It could also help banks in preparing their strategic plan. Bank regulators and policy makers might also use this study in their endeavor to improve the efficiency of banks and designing policies. Researchers could also take advantage of the results in undertaking further researches in the banking industry.

1.3) Objectives of the study

The general objective of the study is to measure the efficiency performance of commercial banks.

The specific objectives are: -

- to investigate the (in)efficiency of commercial banks
- to analyze technical changes and productivity changes of the banks
- to determine factors that are likely to affect the (in)efficiency of commercial banks.

1.4) Significant of the study

The findings from this study could help bank managers in evaluating the efficiency of their banks. It might also help bank regulators and policy makers in improving the efficiency of the banking industry and in designing policies respectively. Finally, researchers could take advantage of the results in undergoing further researches in the sector.

1.5) Scope and limitation of the study

This study tried to measure the efficiency performance of commercial banks in Ethiopia over the periods 2003-2007. Development Bank of Ethiopia,

National Bank of Ethiopia, and the newly emerging private commercial banks of Cooperative Bank of Oromia, Oromia International Bank, Access Bank, Buna Bank, Anbessa International Bank, and Birhan International Bank are excluded from the sample since some of them have not yet started operation and some of them have not been stayed in business for long. Development Bank of Ethiopia and National Bank of Ethiopia are also excluded because their objective is different from the other banks. Due to limitation of data on non-performing loans, maximum exposure to a single borrower, and capital adequacy, these variables are dropped from the estimation process. This study considers banks as intermediaries. The research could have been comprehensive had the production approach to banks and the output-oriented DEA model also been used. Since the budget and time is limited only the intermediation approach to banks and the input oriented DEA are employed.

1.6) Organization of the study

The study is organized as follows: the overview of the banking industry and financial developments is discussed in chapter 2; literature review is discussed in chapter 3; chapter 4 discusses the methodology and data sources while chapter 5 presents and discusses the empirical results. Finally, conclusions and recommendations are discussed in chapter 6.

CHAPTER-TWO

Review of the Banking Industry and the Financial Structure in Ethiopia

2.1) Brief Banking History

The discussion in this section is from National Bank of Ethiopia (2001) report posted on its website and Alemayehu (1998).

The agreement that was reached in 1905 between Emperor Minilik II and Mr. Ma Gillivary, representative of the British owned National Bank of Egypt marked the introduction of modern banking in Ethiopia. Following the agreement the first bank called Bank of Abyssinia (BoA) was inaugurated in Feb.16, 1906 by the Emperor. The bank was totally managed by the Egyptian National Bank and the following rights and concessions were given upon the establishment of BoA:

- The capital of the bank was agreed to be Pound Sterling 500,000 and one-fifth was subscribed and the rest was to be obtained by selling shares in some important cities such as London, Paris, and New York.
- The bank was given full rights to issue bank notes and monitor coins which were to be legal tender and all

profits there from a ruing to the bank and freely exchangeable against gold and silver on cover by the bank as well as to establish silver coins and abolish Maria Theresa.

- Land was given to the bank free of charges and permitted to build offices and warehouses.
- Government public funds were to be deposited with the bank and all payments to be made by checks.
- The government promised not to allow any bank to be established in the country within 50-year concession period.

The bank started its branch expansion. However, despite its monopolistic position, the bank earned no profit until 1914. Profits were recorded in 1914, 1919, 1920, and from 1924 onwards. BoA faced enormous pressure for being inefficient and purely profit motivated and reached an agreement to abandon its operation and be liquidated in order to disengage banking from foreign control and to make the institution responsible to Ethiopian credit needs. Thus, by 1931 BoA was legally replaced by Bank of Ethiopia (BoE) shortly after Emperor H/Selassie came to power.

The new bank was a purely Ethiopian institution and was the first indigenous bank in Africa and established by an official decree on August



1931 with capital of £750,000. BoE continued successfully until the Italian invasion in 1935. During the invasion, the Italians established branches of their banks, namely, Banca de Italia, Banco di Roma, Banco di Napoli, Banca Nazionale de Lavoro and started operation in the main towns of Ethiopia.

After independence from Italy's occupation (of 1933-1941) where the role of British was paramount owing to its strategic consideration in World War II Barclay's bank had established and was in business in Ethiopia from 1941 to 1943 (Belay, 1990; Befekadu, 1995 cited in Alemayehu, 1998).

Following this period, the Ethiopian government established the State Bank of Ethiopia in 1943. The establishment of this bank by Ethiopia was a painful process since Britain was against it (Befekadu, 1995 cited in Alemayehu, 1998). This bank was operating both as commercial and central bank until 1963 when it was dissolved into today's NBE (the Central Bank, reestablished in 1976) and the CBE henceforth. After this period many other banks were established (Alemayehu, 1998).

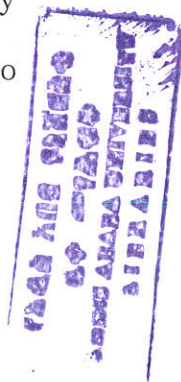
All privately owned financial institutions including three commercial banks, thirteen insurance companies and two non-bank financial intermediaries were nationalized on January 1975. The commercial banks were Addis Ababa Bank, Banco di Napoli and Banco di Roma. The insurance companies were African Solidarity, Ethio-American life, Blue Nile, Ethiopian General, Imperial, Afro-Continental, Pan African, Union, Ras, and Ethiopian Life and

Rasi. The non-bank financial intermediaries were the Imperial Saving and Home Ownership Public Association and the Mortgage Corporation (Befekadu, 1995 cited in Alemayehu, 1998).

During the “socialist regime” (1974-1990) the nationalized banks were reorganized and one commercial bank (the CBE), and a National Bank (recreated in 1976), two specialized banks (the Agricultural and Industrial Bank-renamed recently as the DBE and Housing and Saving Bank (HSB) renamed recently as the CBB) as well as one insurance company (Ethiopian Insurance Company), were formed. After the 1992 reform these financial institutions are being reorganized to work on market oriented policy framework. Besides, newly privately owned financial institutions are also being allowed to work along the publicly owned ones (Alemayehu, 1998).

2.2) Developments in the Banking System

The financial sector in Ethiopia is mainly composed of banks, insurance companies, and micro-finance institutions. At the end of June, 2006 the number of banks operating in Ethiopia reached ten (excluding NBE). Nine of them were commercial banks and one was development bank (a specialized bank). Three of the banks (Commercial Bank of Ethiopia (CBE), Development Bank of Ethiopia (DBE), and Construction and Business Bank CBB) are state owned and the rest are privately owned. Report of the NBE (2006) showed that the number of bank branches reached 421 at the end of June



2006, out of which 177 of them are CBE's branches. Out of the total branches 148 were located in Addis Ababa.

Total capital of the banking system reached Br. 5.4 billion at the end of June 2006. State- owned banks' share is 65 percent of the total capital. The report indicated that the share of private banks is increasing from time to time.

2.2.1) Resource Mobilization

Total resources mobilized by the banking system through deposits, borrowing, and loan collection reached Br. 17.5 billion at the end of June 2006. Deposit liabilities of the banking system for the same period was Br. 44.5 billion. Demand deposits accounted for 47.8% of the total deposits followed by saving deposits (46.1%) and time deposits (6.1%). Of the total deposits of the banking system, state-owned banks accounted for 70.7%. The share of CBE was 67%. The share of private banks in deposit mobilization is also increasing steadily and reached 29.4% in 2006.

NBE's report (2006) stated that as most of the banks have sufficient liquidity, borrowing is not an important source of mobilizing resources. It further noted that as of June 2006 only DBE and CBE borrow an amount of Br. 2 billion from foreign and domestic sources.

The banking system collected an amount of Br.10.2 billion loans. Of the total loan collection, public banks collected 50.5% and private banks 49.5 %.

2.2.2) Lending Activities

The banking system disbursed new loans amounting to Br.12.4 billion during 2005/06. More than 97% of the new loans were disbursed to the private sector. Disbursement to international trade took the largest share (28.6%) followed by domestic trade (19.8%), agriculture (17.6%), and industry (10.5%). Housing and construction and transport and communication sectors also received 9.4 % and 8.1% of the new loans. Of the total fresh loan disbursement, the share of private banks was 58.7%. This shows that the share of private banks in loan disbursement is gradually increasing (NBE, 2006).

2.2.3) Outstanding Loans

At the end of June, 2006 outstanding loan of the banking system (including holdings of government bonds and Treasury bills) reached Br. 39.6 billion. Total credit to the central government surged by 77% while credit to the private sector grew by 26%. But lending to public enterprises declined by 5%. The share of private banks in total outstanding loans of the banking system increased to 28.3% at the end of 2005/06 (NBE, 2006).

2.3) The Structure of the Financial System in the Pre- reform and Post-reform Period

Alemayehu (1998) has classified the structure of the financial sector in Ethiopia into two – the pre reform financial sector and the post reform financial sector. The following discussion is based on Alemayehu (1998).

2.3.1) The Pre-reform Financial Sector

In this period, the NBE was actively involved in direct controlling of all financial institutions by (a) fixing both deposit and lending interest rates, (b) directly controlling the foreign exchange and credit allocation in a discriminatory manner, by favoring the public sector, and (c) by directly financing (NBE, 1998 cited in Alemayehu, 1998). Bank supervision/regulation has been largely limited to on and off inspection on a few numbers of branches (Alemayehu, 1998).

The pre-reform period (1974-1991) is characterized by an economic policy largely informed by the ideology of “socialism”. The sin-qua-non of such setup is the prominent role accorded to the socialized (public sector included) sectors by discriminating against the private sector. During this time indirect ways of regulating the financial sector was not important since it can be controlled directly. The most important financial instruments used to directly control the sector were interest rate and discriminatory allocation of foreign exchange (Alemayehu, 1998).

This restrictive policy has resulted in excess liquidity in the banking sectors in 1980 chiefly because of the biased credit policy, the collateral requirement on the private sector, seasonal trends and the (then) existing economic condition as well as the CBE's inefficiency (Antonio 1988 cited in Alemayehu, 1998).

2.3.2) The Post-reform Financial System

Monetary and banking proclamation No.83/1994 and the licensing and provision of banking business No.84/1994 laid down the legal basis for investment in the banking sector. Consequently, shortly after the proclamation, the first private bank (Awash International Bank) was established in 1994 by 486 shareholders and by 1998 the authorized capital of the bank reached Br.50 million (Belay, 1987 cited in NBE (2001) website). Following this proclamation the country witnessed a proliferation of private financial institutions (Alemayehu, 1998).

The government undertook two significant liberalization schemes. These are the exchange rate policy and the interbank money market. Moreover, Alemayehu (1998) stated that in the post-reform period interest rate is fairly liberalized and the NBE has set only a floor for deposit rate leaving all other rates to be determined by market forces. Banks are free to set any interest rate within that range.

CHAPTER-THREE

Literature Review

3.1) Theoretical Literature

The aim of various economic units is to obtain the maximum benefit by employing different inputs. Given their technology firms want to produce the highest possible output from a given set of inputs.

If we define a firm as an organizational unit, engaged in the production and disposal of a commodity for some desired purpose, then the emphasis will rest on achieving 'business' or 'economic' efficiency. Efficiency is producing the right good/service of the right quality at the right cost. It is the success with which a firm uses its sources to produce output of a given quality (Misganaw, 2007). According to Farrell (1957) efficiency of a firm means its success in producing as large as possible an output from a given set of inputs.

However, in reality, due to factors that are internal and/or external to the organizations, firms do not achieve the highest target. Previous researches have been trying to develop measurements of productive efficiency. Among the notable ones is that of Farrell's (1957). Farrell (1957) has discussed the

concepts of technical efficiency and price efficiency (allocative efficiency) by assuming a single product firm, employing two factors, under constant returns to scale. He also presupposed that the efficient production function is known.

✓ Modern efficiency measurement begins with Farrell (1957) who drew upon the work of Debreu (1951) and Koopmans (1951) to define a simple measure of firm efficiency that could account for multiple inputs. He proposed that the efficiency of a firm consists of two components: technical efficiency, which reflects the ability of a firm to obtain maximal output from a given set of inputs, and allocative efficiency, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices. These two measures are then combined to provide a measure of total economic efficiency (Coelli, 1996).

Input-Oriented Measures

✓ The input-oriented approach measures the amount of input that should be proportionally reduced without changing the output produced.

Technical Efficiency

✓ A firm employs a given set of inputs in order to produce a certain amount of output. A bank can employ different factors in order to produce operational income. If it succeeds in achieving the maximum amount of income (or other output), then it is technically efficient. Hence, technical efficiency of a

firm is the success of a firm in producing the maximum amount of output using a given set of inputs. Farrell's (1957) input-oriented technical efficiency was defined in relation to a given set of firms from which the efficient production function is estimated.

Price Efficiency (Allocative Efficiency)

✓ Firms differ in selecting the combination of their input. Some firms employ factors so that optimal combination of inputs is achieved. If a bank succeeds in selecting its labor, physical capital, and other inputs in an optimal manner it is price efficient. Hence, price efficiency can be defined as the optimal combination of factors of production of a given firm.

Farrell (1957) has discussed the efficiency concepts using the following figure.

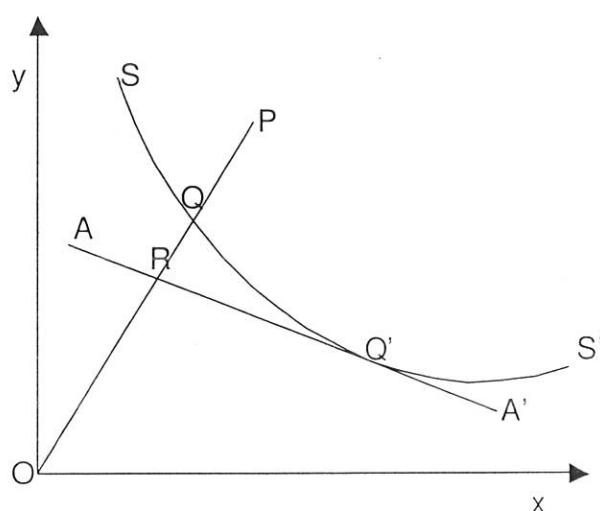


Figure-1: TE and AE from an input orientation (Farrell, 1957).

Since the isoquant is assumed to represent the different combinations of factors that can produce a unit output by a technically efficient firm, firms above or below the isoquant are technically inefficient. Point P represents the inputs of the two factors per unit of output. Point Q on the isoquant and point P above the isoquant produce the same output. But from the figure we can see that point Q uses lesser amount of the two inputs (a fraction of OP) than point P. In other words, the distance QP is the amount by which all inputs could be proportionally reduced without a reduction in output. That is, the input usage of point Q is OQ/OP , thus, OQ/OP can be defined as the technical efficiency of firm P. This ratio takes value 1 for the efficient firm and less than one but non-negative number for the inefficient firm.

In practice a firm that is technically efficient might not be price efficient due to lack of information on price of inputs. So, we might need to know how a firm selects its inputs in the best possible proportion given input prices. A line AA' that is tangent to the isoquant is drawn which shows that the slope of the line is equal to the price ratio of the two factors. In this case point Q' is the optimal method of production. Even though point Q' and Q are both technically efficient the costs of production at Q will only be a fraction of OQ'. Therefore, the price efficiency of Q can be defined as OR/OQ' . Farrell (1957) stated that this ratio could also be used to measure the price efficiency of the observed firm P.

From the concepts of the technical and price efficiency we can define the overall efficiency (cost efficiency) of a firm. The overall efficiency of a firm can be defined as the product of the technical efficiency and price efficiency conditional on the fact that the observed firm must both technically and price efficient. That is,

$$\text{Overall Efficiency} = \text{Technical Efficiency} * \text{Allocative Efficiency.}$$

$$= (OQ/OP) * (OR/OQ)$$

$$= OR/OP$$

Output-Oriented Measures

✓ The above input oriented technical efficiency measure addresses the question: "By how much can input quantities be proportionally reduced without changing the output quantities produced?" One could alternatively ask the question "By how much can output quantities proportionally expanded without altering the input quantities used?" This is an output-oriented measure (Coelli, 1996).

If we consider a production process, which involves two outputs (y_1 and y_2) and a single input (x_1), exhibiting constant returns to scale then we can

represent the technology by a unit production possibility curve in two dimensions.

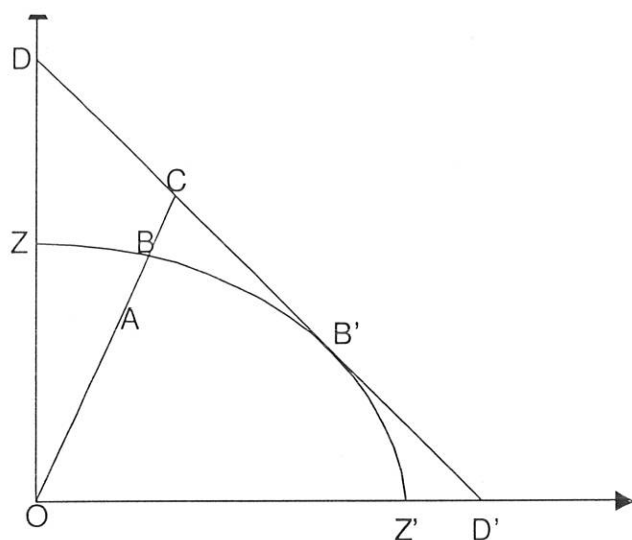


Figure-2: TE and AE from an output orientation (Coelli, 1996).

The curve ZZ' is the unit production possibility curve and the point A corresponds to an inefficient firm. Note that the inefficient point, A , lies below the curve in this case because ZZ' represents the upper bound of production possibilities. The distance AB represents technical inefficiency. Farrell's output oriented measure of technical efficiency is OA/OB . If we have price information then we can draw the isorevenue line DD' , and define the allocative efficiency to be OB/OC . The overall efficiency can be defined as the product of the two measures, that is,

$$\text{Overall Efficiency} = OA/OB * OB/OC.$$

Coelli(1996) stated that one of the major advantages of these radial efficiency measures is that they are unit invariant.

Other Measures of Efficiency

Scale Efficiency

✓ The assumption of constant returns to scale might not be satisfied in practice. A firm may exhibit decreasing or increasing returns to scale. Scale efficiency often arises from the ability of large firms to allocate fixed cost such as advertising expenses or cost of technology across a greater volume of output. It also shows whether the decision-making units (DMUs) such as banks operate at the minimum of their long run average cost curve (Adongo et al. 2005; cited in Misganaw 2007). Scale economies assume that firms are already on the efficient frontier, where firms are fully x-efficient and minimize costs for every scale of output. Analyzing firms other than those on the frontier confound scale effects with differences in x-efficiency (Berger and Humphrey, 1993 cited in Adongo et al., 2005).

Economies of Scope

An integrated multiple output firm can produce its outputs with the existing inputs at a lower cost. It does not require specialized inputs for each output.

For example, banks can produce operating income and other outputs at the same roof without employing a specialized separate staff or office for each output. Hence, economies of scope is a type of efficiency that arises from using a set of inputs at a lower price and the inputs being used are not specialized in producing only one type of output in a multiproduct firm.

X-Efficiency

✓ Leibenstein (1966) argued that microeconomic theory excludes other types of inefficiencies and focuses on allocative efficiency. Based on various evidences he stated that the amount to be gained by increasing allocative efficiency is trivial while the amount to be gained by increasing x-efficiency is frequently significant. X-efficiency is the reduction of costs for a given capital and labor under a given technology. By reorganizing the production process (e.g. controlling wastage, payment by results, and plant lay-out reorganization) a firm can reduce its costs without additional employment of capital and labor. Two firms may produce different volume of output mixes even if they employ the same amount of labor and capital under a given technology. This is because the existence of x-inefficiency. A firm that succeeds in improving its x-efficiency will manage to increase its output. X-efficiency could arise from managerial motivation to put the best effort for the success of an organization. Leibenstein (1966) has identified three factors, which determine what he has called "x-efficiency": 1) intra-plant motivational

efficiency, 2) external motivational efficiency, and 3) non-market input efficiency.

For example, the level of intra-bank efficiency can be represented by x-efficiency. This is defined as the general efficiency of a firm judged on managerial and technological criteria in transforming inputs at minimum costs into maximum profits. It includes intra-bank economic efficiency, intra-bank motivational efficiency -arising from management incentives, and the environment (Leibenstein, 1978 cited in Adongo et al., 2005). Banks that exhibit x-inefficiency are either wasting resources (technical inefficiency) or are using inefficient business processes (allocative inefficiency), or both, which is attributed to employee, management or environmental factors (Adongo et al, 2005).

3.2) Empirical Literature Review

Heffernan et al. (2005) investigated the cost x-efficiency in China's banking sector over the period 1985-2002 using the stochastic frontier approach. They found that on average banks were operating 50-60% below the efficiency frontier.

Adongo et al. (2005) measured the alternative profit x-efficiency of Namibia's banking sector for the period 1998-2003 applying the distribution free



approach (a stochastic frontier approach). They found that the mean level of alternative profit x-efficiency was 83% showing that banks in Namibia lost approximately 17% of their potential profits during the period due to x-inefficiency. Finally they concluded that the banking sector perform well relative to other profit efficiency studies that had been conducted internationally, using the distribution free approach.

Giokas et al (1990) studied the relative efficiency of branches of the Commercial Bank of Greece for the year 1987 using data envelopment analysis and found that out of a selected sample of 20 branches nine had a maximum efficiency rating of 1(100%) and 11 of them were inefficient (i.e. efficiency rating of less than 1. Since the data is only for one-year period, the model may face data inadequacy; hence, the estimated relative efficiencies may not be reliable.

Sandrine (2007) measured the efficiency of a sample of 35 banks of West Africa Economic Monetary Union (WAEMU) for the period 1996-2004 using data envelopment analysis and found average efficiency of 76% and 85% under constant returns to scale and variable returns to scale respectively. The limitation of this study is that it took some banks, which were not observed over all the considered period. However, calculating the Malmquist productivity index requires that all observations should appear in all the

considered periods. Hence, the calculated global technical efficiency change of 1.5% might not be dependable.

Aly et al. (1990) investigated the technical, scale, and allocative efficiencies of a sample of 322 US commercial banks for the year 1986 using DEA and found an overall mean efficiency of 65 percent.

Yeh (1996) evaluated the performance of 6 banks in Taiwan for the years 1981-1989 using the DEA and found that the average efficiency score of the six banks over the period was about 90%. Furthermore, Yeh found that the DEA efficiency scores decreased between the years 1982-1996 and gradually started increasing. Yeh explained that this trend was due to the drop in the business cycle that occurred in Taiwan in the mid 1980s.

Sufian (2007) studied the trends in the efficiency of a sample of six locally incorporated (full license) Singapore banks over the periods 1993-2003 using the DEA window analysis methodology and found a technical efficiency of 88.4%. Sufian also found that the Singapore banking groups' overall efficiency was on declining trend during the earlier periods.

Akhtar (2002) investigated the efficiency of a sample of 40 commercial banks of Pakistan for the year 1998 using DEA and found that under the constant returns to scale DEA the overall efficiency score of Pakistani banks was 80%

during the year and conclude that the overall efficiency score of Pakistan banks was lower than the world mean efficiency. The study assumed constant returns to scale. But this assumption is plausible when all the banks are operating at their optimum level. It also took only one year's data that may give misleading results due to shortage of observations.

Aikaeli (2008) analyzed the efficiency of Tanzania's commercial banks using a monthly data over the period 1998-2004. Employing the DEA, Aikaeli found that the average DEA technical efficiency and scale efficiency for all the banks in Tanzania were 96.1% and 97.3% respectively.

In Ethiopia, as to the best of my knowledge, Muluneh (2006), Dereje (2006), and Misganaw (2007) tried to measure the efficiency of commercial banks. Muluneh (2006) found that the cost efficiency level of private commercial banks was 86% between 1997 and 2005 under the stochastic frontier approach. Dereje (2006) found a predicted average cost-efficiency of 92.2% over the period 1994/95-2004/05. Misganaw (2007) took a sample of 6 private commercial banks and measured their efficiency over the periods 2000-2005 using the stochastic frontier approach. He found that the mean level of cost and profit x- efficiencies of private commercial banks were 81% and 70% respectively. He also explained that return on equity, capital, asset level, and deposit ratio correlated with predicted cost x-inefficiency negatively, while number of branches and non-performing loans were

positively correlated. Moreover returns on equity, number of branches and GDP negatively correlated with predicted alternative profit x-inefficiency, while non-performing loans positively correlated.

CHAPTER-FOUR

Methodology, Model Specification, and the Data

4.1) Methodological Literature

The literature on banking is wide and attempts to measure the efficiency of the banking industry have always been made. Though there are different kinds of approaches to measure the efficiency of banks the non-parametric and the parametric approaches are the most common ones. There are at least four frontier analysis methodologies to compute financial institution efficiency and there is no consensus among researchers on which method is best. The approaches differ mainly in how they handle random error and their assumptions regarding the shape of the efficient frontier. The three main parametric methodologies include stochastic frontier approach, the thick frontier approach, and the distribution free approach. In general, parametric approaches specify a functional form for the cost, profit or, production relationship among inputs, outputs and environmental factors and allow for random error (Berger et al.1997). As stated by Barr et al. (1999) the main non-parametric approach is DEA, which computes the relative technical (or productive) efficiency of individual decision-making units by using multiple inputs and multiple outputs. The parametric (econometric) approach consists of an econometric estimate of the best

practice frontier by its specification in a Cobb-Douglas, constant elasticity of substitution or trans-logarithmic (cost or production) function. The econometric method can be deterministic. In this case, every deviation from the frontier is attributed to inefficiency. It can also be stochastic; it is then possible to separate random errors from the production unit inefficiency (Sandrine, 2007).

4.1.1) Approaches Used to Measure Bank Efficiency

Accounting Based Cost Ratios

These are simple ratios based on the balance sheet and income statements of the banks. These ratios are popular for analyzing the efficiency of banks because they are simple to construct and easy to use. These ratios are computed from the financial statements of the banks. However, bank efficiency is a complex phenomenon for which simple analysis can yield misleading conclusions (De Young, 1997).

Simple Regression Analysis

It applies ordinary least squares (OLS) for estimating production or cost functions and thereby to measure relative efficiency among firms. To measure relative efficiency, the following two steps will be sued. First a



simple regression model is formulated to identify the relationship that best fits the observed data. In the second step, the residuals of the estimated regression (the difference between the actual and predicted) would be taken as a measure of inefficiency (Sarafids, 2002 cited in Abdu Kedir, 2006).

As discussed in Abdu Kedir (2006) the weakness of this model is that it considers the error term as a measure of inefficiency. However, the error could be due to other factors like measurement error, environmental factors, or other factors that could affect the output of firms. As a result the estimates of the coefficients could be biased and inconsistent.

Stochastic Frontier Approach (SFA)

It is one of the parametric approaches, which apply econometrics in order to measure the efficiency of banks. It specifies a functional form for the cost, profit, or production relationship among inputs, outputs, and environmental factors, and allows for random error (Berger et al., 1997). In this approach the error term is decomposed into stochastic random component and true technical efficiency component. The stochastic frontier has two principal advantages. First it allows separating random error from the production unit inefficiency and takes into account the existence of exogenous shocks. At this purpose, the error term is divided into two components: an inefficiency component and a random one (which is composed of the error measurement

and the exogenous shocks). Second, the stochastic frontier analysis is less sensitive to absurd values (Sandrine, 2007). Brazdik (2005) has expressed the model for the stochastic frontier approach as follows:

$$Y_i = f(X_i, \beta) + e_i$$

Where Y_i is the output level produced by firm i

X_i is the vector of inputs

β is a vector of parameters to be estimated

e_i is the error component which can be decomposed into stochastic random component and true technical efficiency component which have normal and half normal distribution respectively.

One of the major weaknesses of the stochastic frontier function is that it is difficult for the model to handle multiple outputs. The second weakness is that it specifies a functional form, which presupposes the shape of the frontier. However, as noted in Berger et al (1997) if the functional form is misspecified, measured efficiency may be confounded with the specification error. In this model inefficiencies are assumed to follow an asymmetric distribution, usually the half normal. However, the half normal assumption for the distribution of inefficiencies is relatively inflexible and presumes that most firms are clustered near full efficiency [Green (1990) cited in Berger

(1997)]. But we know that there are firms that are far away from the full efficiency point.

Data Envelopment Analysis (DEA)

Based on Farrell's (1957) work concerning technical efficiency a linear programming formulation was developed for evaluating the technical efficiency of a given set of organizations (DMUs) with the same multiple inputs and multiple outputs that has subsequently known as data envelopment analysis (Haag et al, 1995).

DEA generalizes the Farrell (1957) single output/single input technical efficiency measure to the multiple output/multiple input case. It optimizes on each individual observation with the objective of calculating a discrete piecewise linear frontier determined by the set of Pareto-efficient decision making units. Using this frontier, DEA computes a maximal performance measure for each DMUs relative to all other DMUs. The only restriction is that each DMU lie on the efficient (external) frontier or be enveloped within the frontier. The DMUs that lie on the frontier are the best practice institutions and retain a value of one; those enveloped by the extremal surface are scaled against a convex combination of the DMUs on the frontier facet closest to it and have values between 0 and 1 (Barr et al., 1999).

The major advantage of DEA is that it can handle multiple inputs and multiple outputs. Sufian (2007) also noted that DEA requires less data and it does not require a preconceived structure or specific functional form to be imposed on the data in identifying and determining the efficient frontier error and inefficiency structure of the DMUs. In banking literature there is no consensus on the definition of inputs and outputs of banks, hence, DEA is commonly used as a possible way out. The major weakness of the model is that it considers the error term as a measure of inefficiency but the error could be due to measurement error or environmental conditions, or some other factors that are out of the control of the management of firms. There are two kinds of DEA models. The first is the constant returns to scale (CRS) DEA model and the second is the variable returns to scale (VRS) DEA model. The following discussion on the two models is based on Banker et al. (1984) and Sufian (2007).

The Constant Returns to Scale (CRS) DEA model

This model assumes constant returns to scale. But this assumption is relevant when all firms are operating at an optimal scale. In practice we know that firms exhibit either increasing or decreasing returns to scale. Thus, assuming CRS while some firms are not operating at an optimal scale results in inability to differentiate between technical efficiency and scale efficiency.

The Variable Returns to Scale (VRS) Model

The CRS assumption is only appropriate when all DMUs are operating at an optimal scale. The use of the CRS specification when not all DMUs are operating at the optimal scale will result in measures of technical efficiency, which are confounded by scale efficiencies (Coelli, 1996).

Recognizing the defects of the CRS assumption Banker et al. (1984) extended the assumption by introducing the VRS assumption. The CRS linear programming can be easily modified to account for VRS by adding a convexity constraint. This approach forms a convex hull of intersecting planes which envelope the data points more tightly than the CRS conical hull and thus provides technical efficiency scores which are greater than or equal to those obtained using the CRS model (Coelli, 1996).

This assumption allows us to measure pure technical efficiency. The difference between the pure technical efficiency and the technical efficiency will give us the measure of scale efficiency. Technical efficiency (TE) and scale efficiency (SE) can also be explained using the following figure.

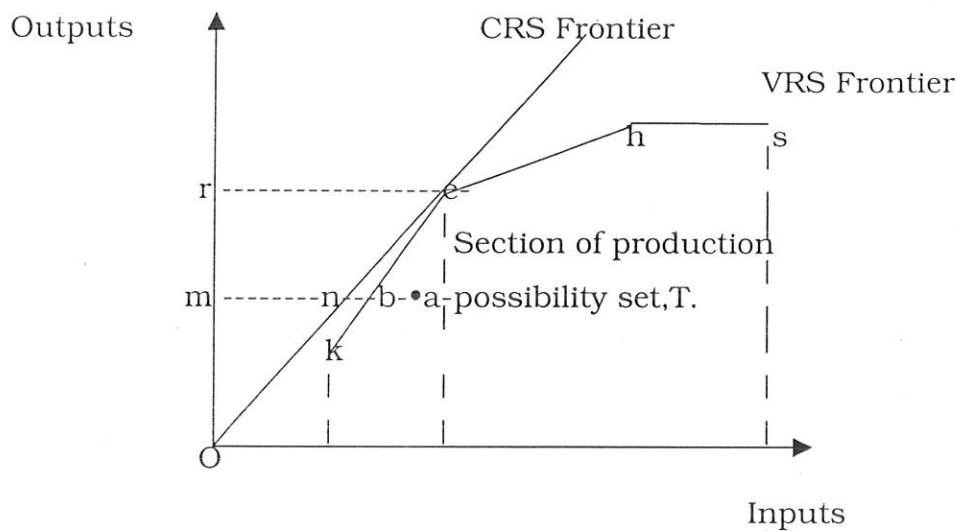


Figure-3: Technical efficiency and scale efficiency (Banker et al.1984).

Point "a" represents the DMU being evaluated. Its overall technical and scale efficiency is measured by the ratio mn/ma . The pure input TE of point "a" is measured by the ratio mb/ma . The input SE of "a" is measured by the ratio mn/mb . From the figure we can also see that firms on the line segment ke and es exhibit increasing and decreasing returns to scale while a firm on point "e" exhibits constant returns to scale.

4.1.2) Malmquist Productivity Index-MPI (DEA-Like Linear Programming Method)

Malmquist productivity index is an index which can be used to measure productivity and technical change in the production technology. It is a measure of total factor productivity (TFP) growth. If the Malmquist productivity index is greater than unity, then there is an improvement in productivity and in technology. If the index is equal to unity, then the productivity and technology are stagnant. Finally, if the index is less than unity, then the productivity and technology are worsening.

The Malmquist index numbers can be defined using either output-oriented approach or the input-oriented approach (Coelli et al, 1998). The output-oriented productivity measures focus on the maximum level of outputs that could be produced using a given input vector and a given production technology relative to the observed level of outputs (Coelli et al, 1998).

4.1.3) Second Stage Regression (the Censored Tobit Model)

After finding the values of the efficiency scores using the data envelopment analysis, we may need to know factors that are likely to affect the efficiency of the commercial banks. Since the measures of efficiency scores take values between 0 and 1 (i.e. $0 \leq e \leq 1$, where e is the magnitude of the efficiency

measure) we can use the censored Tobit model in order to analyze the determinants of the efficiency of banks.

4.2) Model specification

Models of VRS-DEA, MPI, and the censored Tobit model are specified as follows:

4.2.1) VRS-DEA model

This model is based on Banker et al (1984).

The model for the VRS-DEA model can be specified as follows:

$$E_o = \max \sum_{r=1}^s U_r W_{ro} - U_o$$

$$\text{Subject to } \sum_{i=1}^m V_i Z_{io} = 1$$

$$\sum_{r=1}^s U_r W_{rj} - \sum_{i=1}^m V_i Z_{ij} - U_o \leq 0; \quad j=1, \dots, n$$

$$r=1, \dots, s, \text{ and}$$

$$i=1, \dots, m.$$

$$U_r, V_i \geq 0.$$

Where E_o = the efficiency of the bank being measured

W_{ro} = output r of the bank being measured

Z_{io} = input i of the bank being measured

W_{rj} = output r of bank j

Z_{ij} = input i of bank j

U_r = the weight given to output r

V_o = the weight given to input i

U_o = is an intercept term and unconstrained in sign.

One of the major advantage of using VRS is that it enables us to identify whether a particular bank is exhibiting IRS, CRS, or DRS. Whether increasing, constant, or decreasing returns to scale are present depends on whether the solution to $U_o (=U_o^*)$ is less than, equal to, or greater than zero.

If $U_o^* < 0$, then there is increasing returns to scale

$U_o^* = 0$, then there is constant returns to scale

$U_o^* > 0$, then there is decreasing returns to scale.

4.2.2) Malmquist Productivity Index-MPI (DEA-like Linear Programming Method)

The model for the output oriented MPI is based on Coelli et al. (1998).

It is specified as follows:

$$m_0(W_s, W_t, Z_s, Z_t) = [m_{ot}(W_s, W_t, Z_s, Z_t) * m_{os}(W_s, W_t, Z_s, Z_t)]^{1/2}$$

$$= \left[\underbrace{\left(\frac{d_{ot}(W_t, Z_t)}{d_{ot}(W_s, Z_s)} \right)}_A \underbrace{\left(\frac{d_{os}(W_t, Z_t)}{d_{os}(W_s, Z_s)} \right)}_B \right]^{1/2}$$

Where W_s and W_t are interest income and non-interest income of the banks

in period s and in period t respectively

Z_s and Z_t are labor expense, value of physical capital, and deposits

in period s and in period t respectively

m_0 is the output-oriented productivity index

m_{ot} is the output-oriented productivity index for period t

m_{os} is the output-oriented productivity index for period s

d_{ot} and d_{os} are the distance functions for period t and period s respectively.

The first ratio (i.e. A) represents the period t Malmquist index that measures productivity change from period t to period s using period t technology as benchmark. The second ratio (i.e. B) is the period s Malmquist index that

If we express the relationship between the efficiency score of individual banks and the bank specific variables, macroeconomic condition, and the general business environment by the following function,

$$DEA_j = f(B_j, M, E)$$

where DEA_j measures efficiency score of j th commercial bank

B_j denotes bank specific variables (e.g. returns on equity, capital, asset, number of branches, etc...)

M describes the macroeconomic environment (e.g. GDP, annual average rate of inflation)

E represents general business environment (for example development of non-bank financial institutions).

then the coefficients could be estimated using the following specification:

$$DEA_j = \alpha + \beta_1 ROA + \beta_2 ROE + \beta_3 CAP + \beta_4 ASSET + \beta_5 NBRAN + \beta_6 DEP + \beta_7 GPROF + \beta_8 LOANS + \beta_9 RGDP + \beta_{10} INF + \beta_{11} M2/GDP + \beta_{12} NMFIS + \beta_i \text{Log}(X_{ij})$$

where DEA_j is the efficiency score of individual banks .

ROA represents returns on assets measured by the ratio of

profits/assets of individual bank

ROE represents return on equity measured by the ratio of
profits/total capital of individual bank

CAP stands for the capital of individual bank

ASSET represents asset size of individual bank

NBRAN stands for the number of branch of every bank

DEP denotes amount of deposits at each bank

GPROF represents gross profit

LOANS denotes the amount of loans

RGDP stands for real gross domestic product

INF denotes the inflation rate

M2/GDP denotes the monetary depth and size of the
financial sector that is measured by the ratio of
broad money to GDP

NMFIS represents the number of micro-finance institutions

Log(X_i) represents the logarithm of individual explanatory
variables

4.3) Data type, Sources and Description

This study measures the efficiency performance of 8 commercial banks using a panel data from 2002/2003 to 2006/2007.

Annual audited financial statements (audited income statements and audited balance sheet) of commercial banks and reports and bulletins of the

National Bank of Ethiopia are the main sources of data. Researches and journals related to the study are also used.

4.3.1) Approaches used to measure inputs and outputs of banks

Selecting proper input and output variables is perhaps the most important issue in using DEA to measure the relative efficiency of any type of firm, since it determines the evaluating context of the comparison. This is partially true for banks because there is considerable disagreement over the appropriate inputs and outputs in this industry (Yeh, 1996).

In general there is no agreement on the classification of inputs and outputs in the banking literature. Researchers take inputs and outputs that suit their objective. However, various studies use either the production approach or the intermediation approach to input-output selection.

Production approach

This approach considers banks as service giving organizations. Under this approach a financial institution is defined as producer of services for account holders. That is they perform transactions deposit accounts and process documents such as loans. Hence, according to this approach the number of accounts or its related transactions is the best measure for

output, while the number of employees and physical capital are considered as inputs (Sufian, 2007).

Intermediation approach

This approach assumes that financial firms act as an intermediary between savers and borrowers. Total loans and securities are considered as outputs whereas deposits, labor and physical capital are considered as inputs.

Based on Berger et al. (1997), Sufian (2007) stated that the production approach might be more suitable for branch efficiency studies as at most times bank branches basically process customer documents and bank funding, while investment decisions are mostly not under the control of branches. Furthermore citing Sathye (2001), Sufian noted that this approach is more relevant to financial institutions as it is inclusive of interest expense, which often accounts for one-half to two-thirds of total costs depending on the phase of the interest rate. This study considers banks as intermediaries and follows a version of the intermediation approach.

4.3.2) Definition of outputs and inputs

The study considers three inputs and two outputs.

Outputs

1) Interest income

-It consists of income on interest earned from lending

2) Non-interest income

-It includes fee and commission incomes and other non-interest operating income

Inputs

1) Labor

-It is the amount of total expense on labor

2) Capital

-It is the value of the physical capital

3) Deposits

-This includes savings deposits and other deposits

Input prices were also included in order to examine the cost and allocative efficiencies.

Price of labor (P_1)-it is the unit labor cost per annum.

$$P_1 = \text{total labor expense} / \text{total number of employees}$$

Price of capital (P_2)-it is the physical capital cost divided by the value of the physical capital.

$$P_2 = \text{physical capital expense} / \text{value of physical capital}$$

Price of deposits (P_3)-it is the total interest expense per total deposits

$$P_3 = \text{total interest expense} / \text{total deposits}$$

In order to measure the efficiency of commercial banks this study has used the input oriented VRS-DEA model. It is used because it can handle multiple inputs and multiple outputs, demands less data, and does not require a prespecified functional form of the production function. The input oriented is used because the study assumed that banks could adjust their inputs to reach the frontier keeping output constant. Finally the VRS version is employed since the study assumed that most banks do not operate at an optimal scale. The MPI is used to examine the changes in productivity and technology because it enables us to find efficiency changes, technical changes, pure efficiency change, and scale efficiency changes. Furthermore, it can also help us to decompose the productivity change into technical change and technical efficiency change. Like the DEA it does not require specific functional form of the production function. The censored Tobit model is used to determine the potential determinants of the efficiency scores

because the efficiency scores vary between 0 and 1. Finally, softwares, like DEAP Version 2.1, Win4DEAP1.1.2, and STATA 9.1 have been used in order to undertake the study.

CHAPTER-FIVE

Empirical Results and Discussion

5.1) Results from the Constant Returns to Scale and Variable Returns to Scale DEA models

Table (1) summarizes the mean, maximum, minimum and standard deviations of the technical efficiency (TE), allocative efficiency (AE), cost efficiency (CE), and scale efficiency (SE) of the commercial banks during the sample period.

Table-1: Mean TE, AE, CE, and SE under CRS and VRS-DEA Models

YEAR		CRS-DEA MODEL			VRS-DEA MODEL			
		TE	AE	CE	TE	AE	CE	SE
2002/2003	Mean	0.914	0.868	0.802	0.981	0.839	0.883	0.933
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.780	0.617	0.571	0.853	0.624	0.575	0.817
	S.Dv.	0.097	0.158	0.181	0.052	0.175	0.184	0.092
2003/2004	Mean	0.859	0.890	0.764	0.986	0.901	0.889	0.871
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.707	0.665	0.557	0.896	0.676	0.742	0.707
	S.Dv.	0.120	0.140	0.167	0.036	0.128	0.135	0.114
2004/2005	Mean	0.917	0.827	0.761	0.967	0.908	0.882	0.948
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.753	0.640	0.520	0.814	0.640	0.569	0.835
	S.Dv.	0.098	0.114	0.151	0.068	0.150	0.180	0.072
2005/2006	Mean	0.956	0.953	0.912	0.974	0.954	0.930	0.978
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.780	0.788	0.651	0.921	0.624	0.796	0.859
	S.Dv.	0.099	0.075	0.128	0.057	0.070	0.094	0.050
2006/2007	Mean	0.913	0.813	0.754	0.976	0.910	0.891	0.931
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.556	0.637	0.354	0.889	0.708	0.629	0.605
	S.Dv.	0.161	0.126	0.210	0.045	0.111	0.133	0.137
2002/2003-2006/2007 AVERAGE								
		TE	AE	CE	TE	AE	CE	SE
	Mean	0.912	0.872	0.799	0.977	0.902	0.885	0.932
	Max	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	Min	0.556	0.617	0.354	0.810	0.624	0.575	0.605
	S.Dv.	0.035	0.056	0.066	0.007	0.041	0.034	0.039

The mean TE, AE, and CE of the banks was 91.4% (9.7%)*, 86.8 % (15.8%) and 80.2%(18.1%) respectively in 2002/03 under the CRS – DEA model whereas it was 98.1%(5.2%), 83.9%(17.9%), and 83.3%(18.4%) under the VRS-DEA model. In year 2003/04 it was 85.9%(12%), 89%(14.2%), 76.4%(16.7%), under the CRS-DEA and 98.6% (3.6%), 90.1% (12.8%), and 88.9%(13.5%) under the VRS-DEA. In year 2004/05 it was 91.7% (9.8%), 82.7% (11.4%), and 76.1 % (15.1%) under the CRS-DEA and 96.7%(6.8%), 90.8% (15%), and 88.2%(18%) under the VRS-DEA. In 2005/06 it was 95.6% (9.9%), 95.3% (7.5%), and 91.2% (12.8%) under the CRS and 97.4% (5.7%), 95.4% (7%) and 93% (9.4%) under the VRS. In 2006/07 it was 91.3% (16.1%), 81.3% (12.6%), and 75.4% (21%) under the CRS and it was 97.6% (4.5%), 91% (11.1%), and 89.1% (13.3%) under the VRS. The table also indicates that the mean scale efficiency for these banks was 93.3% (9.2%) in 2002/03, 87.1% (11.4%) in 2003/04, 94.8% (7.2%) in 2004/05, 97.8% (5%) in 2005/06, and 93.1% (13.7%) in 2006/07.

From the table we can see that the overall mean TE, AE, and CE, scores were 91.2% (3.5%), 87.2% (5.6%), and 79.9% (6.6%) respectively under the CRS-DEA model. But under the VRS-DEA model the overall mean TE, AE, CE, and SE scores were 97.7% (0.7%), 90.2% (4.1%), 88.5% (3.4), and 93.2% (3.9%) during the sample period.

*Note: Figures in parenthesis are standard deviations.

Table-2: TE, AE, CE, SE and returns to scale of individual banks under the CRS and VRS-DEA models

YEAR	BANK	CRS-DEA model			VRS-DEA model					
		TE	AE	CE	TE	AE	CE	SE	RTS	
2002/03	BoA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	CRS
	NIB	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	CRS
	WB	0.834	0.635	0.571	0.853	0.624	0.575	0.978	0.978	DRS
	CBB	1.000	0.617	0.617	1.000	0.648	0.648	1.000	1.000	CRS
	UB	0.887	0.938	0.832	1.000	1.000	1.000	1.000	0.887	IRS
	DB	0.780	0.848	0.661	1.000	0.702	0.702	0.780	0.780	DRS
	CBE	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	CRS
	AIB	0.811	0.904	0.733	0.993	0.741	0.736	0.817	0.817	DRS
2003/04	BoA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	CRS
	NIB	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	CRS
	WB	1.000	0.699	0.699	1.000	0.742	0.742	1.000	1.000	CRS
	CBB	0.838	0.665	0.557	0.990	0.676	0.669	0.846	0.846	IRS
	UB	0.707	0.816	0.577	1.000	1.000	1.000	0.707	0.707	IRS
	DB	0.787	0.957	0.753	1.000	0.902	0.902	0.787	0.787	IRS
	CBE	0.798	1.000	0.798	1.000	1.000	1.000	0.798	0.798	DRS
	AIB	0.741	0.980	0.727	0.896	0.888	0.796	0.827	0.827	DRS
2004/05	BoA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	CRS
	NIB	1.000	0.883	0.883	1.000	1.000	1.000	1.000	1.000	CRS
	WB	1.000	0.640	0.640	1.000	0.640	0.640	1.000	1.000	CRS
	CBB	0.903	0.842	0.761	0.920	0.924	0.850	0.982	0.982	DRS
	UB	1.000	0.861	0.861	1.000	1.000	1.000	1.000	1.000	CRS
	DB	0.843	0.814	0.686	1.000	1.000	1.000	0.843	0.843	DRS
	CBE	0.835	0.882	0.736	1.000	1.000	1.000	0.835	0.835	DRS
	AIB	0.753	0.691	0.520	0.814	0.700	0.569	0.925	0.925	DRS
2005/06	BoA	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	CRS
	NIB	0.718	0.906	0.651	0.837	0.925	0.774	0.859	0.859	CRS
	WB	1.000	0.788	0.788	1.000	0.796	0.796	1.000	1.000	CRS
	CBB	1.000	0.945	0.945	1.000	0.955	0.955	1.000	1.000	CRS
	UB	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	CRS
	DB	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	CRS
	CBE	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	CRS
	AIB	0.926	0.983	0.910	0.957	0.958	0.917	0.967	0.967	DRS
2006/07	BoA	1.000	0.920	0.920	1.000	1.000	1.000	1.000	1.000	CRS
	NIB	0.556	0.637	0.354	0.919	0.936	0.860	0.605	0.605	IRS
	WB	1.000	0.688	0.688	1.000	0.770	0.770	1.000	1.000	CRS
	CBB	1.000	0.826	0.826	1.000	1.000	1.000	1.000	1.000	CRS
	UB	0.974	0.793	0.772	1.000	0.933	0.933	0.974	0.974	IRS
	DB	0.988	0.911	0.894	1.000	0.936	0.936	0.982	0.982	DRS
	CBE	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	CRS
	AIB	0.790	0.728	0.575	0.889	0.708	0.629	0.889	0.889	DRS

Note: BoA = Bank of Abyssinia
 NIB = Nib International Bank
 WB = Wegagen Bank
 CBB = Construction and Business Bank
 UB = United Bank
 DB = Dashen Bank
 CBE = Commercial Bank of Ethiopia
 AIB = Awash International Bank

Under the CRS-DEA model four banks in 2002/03, three banks in 2003/04, four bank in 2004/05, six banks in 2005/06, and four banks in 2006/07 were technically efficient. WB, UB, DB, and AIB were inefficient in 2002/03;

CBB, UB, CBE, and AIB were inefficient in 2003/04; CBB, UB, DB, CBE, and AIB were inefficient in 2004/05, NIB and AIB were inefficient in year 2005/06 while NIB, UB, DB, and AIB were inefficient in 2006/07. In year 2002/03 the efficiency scores of WB, UB, DB, and AIB were 83.4%, 88.7% 78.0% and 81.1 % respectively while the efficiency score of the other banks was 100%. In 2003/004 the technical efficiency score of BoA, NIB, and WB was 100% while the others had less than 100%. In 2004/05, 50% of the banks were technically efficient. CBB DB, CBE, AIB had efficiency scores of 90.3%, 84.3%, 83.5%, and 75.3% respectively.

In 2005/06 the only technical inefficient banks were NIB and AIB with efficiency scores of 71.8% and 92.6% respectively. In 2006/07 NIB, UB, DB, and AIB were inefficient with efficiency score of 55.6%, 97.4%, 98.8% and 79.0% respectively.

Looking at the allocative efficiency of each bank BoA, NIB, and CBE were efficient while WB, CBB, UB, DB, and AIB were inefficient with efficiency scores of 63.5%, 61.7%, 93.8%, 84.8% and 90.4% respectively in 2002/03. In 2003/04 the same banks were inefficient with efficiency scores of 69.9%, 66.5%, 81.6%, 95.7%, and 98.0% respectively. In 2004/05 only BoA was allocatively efficient while the rest were inefficient with efficiency scores of 88.3% (NIB), 64.0% (WB), 84.2% (CBB), 86.1% (UB), 81.4% (DB), 88.2% (CBE), and 69.1% (AIB). In 2005/06 four of the banks were allocatively

efficient while four of the others were inefficient with efficiency scores of 90.6% (NIB), 78.8% (WB), 94.5% (CBB), and 98.3% (AIB). In 2006/07 only CBE was efficient while the others were inefficient with efficiency scores of 92.0% (BoA), 63.7% (NIB), 68.8% (WB), 82.6% (CBB), 79.3% (UB), 91.1% (DB) and 72.8% (AIB).

The table also indicates that only those banks, which were allocatively efficient in 2002/03, were cost efficient in the same year. The cost inefficient banks had efficiency scores of 57.1% (WB) 61.7% (CBB), 83.2% (UB), 66.1% (DB), and 73.3% (AIB). In the second year of the sample period only BoA and NIB were cost efficient while the rest were cost inefficient with efficiency scores of 69.9% (WB), 55.7% (CBB), 57.7% (UB), 75.3% (DB), 79.8% (CBE), and 73.7% (AIB).

In the third year of the sample period only BoA was cost efficient. NIB, WB, CBB, UB DB, CBE, and AIB were cost inefficient with efficiency scores of 88.3%, 64.0%, 76.1%, 86.1%, 68.6%, 73.6% and 52.0% respectively. In 2005/06 half of the banks were cost inefficient with efficiency scores of 65.1% (NB), 78.8%(WB), 94.5% (CBB), and 91.0% (AIB). In year 2006/07 only CBE was cost efficient while BoA, NIB, WB, CBB, UB, DB, and AIB were cost inefficient with efficiency scores of 92.0%, 35.4%, 68.8%, 82.6%, 77.2%, 89.4%, and 57.5% respectively

Under the VRS-DEA model all banks except WB, and AIB were technically efficient in year 2002/03. The efficiency scores of WB and AIB were 85.3% and 99.3% respectively. In 2003/04 and 2004/05 CBB and AIB were inefficient with efficiency scores of 99.0% and 89.6% in 2003/04, and 92.0% and 81.4% respectively in 2004/2005. In 2005/06 NIB and AIB were found to be technically inefficient compared to the other banks with efficiency scores of 83.7% and 95.7% respectively. In year 2006/07 NIB and AIB were technically inefficient with efficiency scores of 91.9% and 88.9% in the same order.

In the first year of the sample period, 50% of the sampled banks were allocatively efficient. WB (62.4%), CBB (64.8%), DB (70.2%), and AIB (74.1%) were allocatively inefficient. In the second year, the above banks were inefficient with efficiency scores of 74.2%, 67.6%, 90.2% and 88.8% in the same order. In year three WB, CBB, and AIB were found to be inefficient with efficiency scores of 64%, 92.4%, and 70.0% respectively. In year four half of the banks were inefficient with efficiency scores of 92.5% (NIB), 79.6% (WB), 95.5% (CBB), and 95.8% (AIB). In year five only three banks were allocatively efficient. NIB, WB, UB, DB, and AIB were allocatively inefficient with efficiency scores of 93.6%, 77.0%, 93.3%, 93.6%, and 70.8% respectively.

The table also shows that all the banks, which were allocatively efficient in all the sample periods, were also cost efficient in all the sample periods. In the first period WB, CBB, DB, and AIB were inefficient with efficiency scores of 57.5%, 64.8%, 70.2% and 73.6% respectively. In the second period the above banks were inefficient with efficiency scores of 74.2%, 66.9%, 90.2% and 79.6% in the same order. In the third year WB, CBB, and AIB were cost inefficient with efficiency score of 64.0%, 85.0% and 56.9% in the same order. In the fourth year NIB, WB, CBB, and AIB were cost inefficient with efficiency score of 77.4%, 79.6%, 95.5%, and 91.7% respectively. In the final year only three banks (BoA, CBB, and CBE) were efficient. NIB, WB, UB, DB, and AIB, were inefficient with efficiency score of 86.0%, 77.0%, 93.3%, 93.6%, and 62.9% respectively.

From the table we can see that in year 2002/03 BoA, NIB, CBB, and CBE were scale efficient while WB, UB, DB, and AIB were scale inefficient with efficiency scores of 97.78.0%, 88.7%, 78.0% and 81.7% respectively. In the year 2003/04 only BoA, NIB, and WB were scale efficient while CBB, UB, DB, CBE, and AIB were scale inefficient with efficiency scores of 84.6%, 70.7%, 78.7%, 79.8%, and 82.7% respectively. In year 2004/05 CBB, DB, CBE and AIB were scale inefficient. In year 2005/06 only NIB and AIB were scale inefficient with efficiency score of 85.96% and 96.7% in their respective order. In year 2006/07 NIB, UB, DB, and AIB were scale inefficient with efficiency score of 60.5%, 97.4%, 98.2% and 89.9% in the same order.

Looking at the returns to scale all the banks, which were scale efficient exhibit constant returns to scale. But those banks, which were scale inefficient, exhibit either increasing returns to scale or decreasing returns to scale. In the first period WB, DB, and AIB exhibited decreasing returns to scale while UB exhibited increasing returns to scale. In the second period DB, CBE, and AIB exhibited decreasing returns to scale whereas CBB and UB exhibited increasing returns to scale. In period three CBB, DB, CBE, and AIB exhibited decreasing returns to scale. In period four AIB exhibited decreasing returns to scale while NIB exhibited increasing returns to scale. In period five DB and AIB exhibited decreasing returns to scale whereas NIB and UB exhibited increasing returns to scale.

Output and input slacks

Table 3 shows that under the CRS-DEA model AIB could have increased its interest income by Br. 10.05 million in 2002/03. WB, UB, and DB could have increased their non-interest income by Br. 2.36 million, 0.33 million, and 5.93 million respectively. WB, DB, and AIB could have reduced their labor cost (salaries and benefits) by an amount of Br. 1.92 million, 0.88 million, and 10.04 million respectively.

Table-3: Summary of Output and Input Slacks under the CRS and VRS- DEA models (in 000's)

YEAR	BANK	CRS-DEA MODEL					VRS-DEA MODEL				
		Output slacks		Input slacks			Output slacks		Input slacks		
		W1	W2	Z1	Z2	Z3	W1	W2	Z1	Z2	Z3
2002/03	BoA	0	0	0	0	0	0	0	0	0	0
	NIB	0	0	0	0	0	0	0	0	0	0
	WB	0	2356	1919	0	0	0	0	2149	0	0
	CBB	0	333	0	0	0	0	0	0	0	0
	UB	0	5931	0	4432	0	0	0	0	0	0
	DB	0	0	875	0	0	0	0	0	0	0
	CBE	0	0	0	0	0	0	0	0	0	0
	AIB	10049	0	1036	22498	0	3931	0	3791	26091	0
	Mean	1256	1077	478	3366	0	491	0	742	3261	0
2003/04	BoA	0	0	0	0	0	0	0	0	0	0
	NIB	0	0	0	0	0	0	0	0	0	0
	WB	0	0	0	0	0	0	0	0	0	0
	CBB	3437	0	426	17466	0	3157	0	1511	21057	0
	UB	314	0	0	1583	0	0	0	0	0	0
	DB	0	0	0	14914	0	0	0	0	0	0
	CBE	180099	0	0	91509	4978815	0	0	0	0	0
	AIB	8581	0	0	22407	0	3050	0	0	21453	0
	Mean	24054	1077	53	18485	622351	775	0	188	5313	0
2004/05	BoA	0	0	0	0	0	0	0	0	0	0
	NIB	0	0	0	0	0	0	0	0	0	0
	WB	0	0	0	0	0	0	0	0	0	0
	CBB	3689	0	0	19034	0	6805	0	0	0	0
	UB	0	0	0	0	0	0	0	0	0	0
	DB	0	30631	1925	18738	0	0	0	0	0	0
	CBE	505183	0	0	0	0	0	0	0	0	0
	AIB	0	3994	4222	25152	3968281	0	2301	6362	9228	0
	Mean	63609	4329	768	7865	496035	850	287	795	343	0
2005/06	BoA	0	0	0	0	0	0	0	0	0	0
	NIB	7004	0	0	0	0	24269	6164	0	6173	0
	WB	0	0	0	0	0	0	0	0	0	0
	CBB	0	0	0	0	0	0	0	0	0	0
	UB	0	0	0	0	0	0	0	0	0	0
	DB	0	0	0	0	0	0	0	0	0	0
	CBE	0	0	0	0	0	0	0	0	0	0
	AIB	0	0	0	6628	0	0	0	0	13385	0
	Mean	875	0	0	828	0	3033	770	0	2444	0
2006/07	BoA	0	0	0	0	0	0	0	0	0	0
	NIB	107550	0	0	0	0	61725	16249	0	0	129913
	WB	0	0	0	0	0	0	0	2149	0	0
	CBB	0	0	0	0	0	0	0	0	0	0
	UB	0	0	275	0	0	0	0	0	0	0
	DB	0	0	0	6943	0	0	0	0	0	0
	CBE	0	0	0	0	0	0	0	0	0	0
	AIB	0	0	6327	0	0	0	8491	11938	4177	0
	Mean	1344	0	825	867	0	7715	3092	1492	522	16239

*Note: W1 =interest income
W2 =non-interest income
Z1 =labor expense
Z2 =value of physical capital
Z3 =amount of deposit

UB and AIB could have reduced their value of physical capital by Br. 4.43 million and 22.5 million respectively. In year 2003/04 CBB, UB, DB, CBE and AIB could have increased their interest income by Br. 3.44 million; 0.31million; 180.09 million; and 8.58 million respectively. CBB could also have reduced its labor expense by Br.0.42 million. CBB, UB, DB, CBE, and AIB could also have reduced their value of physical capital by Br.17.47 million, 1.58million, 14.91million, 91.50million, and 22.41million respectively,. CBE could also have reduced its deposits by Br. 4.98billion. In year 2004/05 CBB could have increased its interest income by 3.69 million and CBE could have increased the same output by 505.18 million. DB could have increased its non-interest income by Br. 30.63 million and AIB could have increased its non-interest income by Br. 3.99 million. DB could have reduced its labor expense by Br. 1.93 million whereas AIB could have reduced the same input by Br. 4.22 million. CBB, DB, and AIB could have also reduced their value of physical capital by Br. 11.03 million; 18.74 million; and 25.15 million respectively. CBE could also have reduced its deposits by Br. 3.97 billion.

In 2005/06 NIB could have increased its interest income by Br. 7 million; AIB could have reduced its value of physical capital by Br. 6.63 million. In year 2006/07 NIB could have increased its interest income by Br. 10.76 million. UB and AIB could have cut their labor cost by Br. 0.28 million and

Br. 6.33 million respectively. DB could have cut its value of physical capital by Br. 6.94 million.

When we look at the VRS-DEA Model AIB could have increased its interest income by Br. 3.93 million in year 2002/03. In the same year WB and AIB could have cut their labor cost by Br. 2.15 and 3.79 million respectively. AIB could have also cut its value of physical capital by 26.09 million.

In 2003/04 CBB could have reduced its labor cost and value of physical capital by 1.51 million and 21.06 million respectively. AIB could have reduced its value of physical capital by 21.45 million.

In 2004/05 AIB could have increased its non-interest income by Br. 2.30 million and cut its labor cost and value of physical capital by Br. 6.36 million and 9.23 million respectively.

In year 2002/03 the cost minimizing labor cost, value of physical capital, and deposits for DB were Br. 12.34 million, 13.25 million, 1.33 billion respectively under CRS-cost efficiency DEA and 13.10 million, 19.23 million, and 1.75 billion respectively under VRS-cost efficiency DEA model (see appendix-2). In year 2003/04 the cost minimizing labor cost, value of physical capital, and deposits for CBE were 131.42 million; 103.26 million and 12.92 billion respectively under the CRS-cost efficiency DEA whereas

the cost minimizing input levels were 164.73 million; 244.14 million; and 22.43 billion respectively under the VRS-cost efficiency DEA model. In the year 2006/07 the cost minimizing labor expense, value of physical capital, and deposits for BoA were 29.17 million; 52.03 million; and 6.54 billion respectively under the CRS-DEA model and 31.73 million; 40.64 million; 2.73 billion under the VRS-cost efficiency DEA model.

5.2) Results from the Malmquist index

Table-4: Malmquist index summary of annual means

Year	Effch	Techch	Pech	Sech	Tfpch
2003/04	0.936	1.053	1.001	0.934	0.986
2004/05	1.072	1.005	0.989	1.083	1.077
2005/06	1.042	0.972	0.981	1.062	1.013
2006/07	0.944	1.070	0.980	0.963	1.010
Mean	0.997	1.024	0.988	1.009	1.021

Note: the total factor productivity change (Tfpch)(i.e. the Malmquist index) is a product of technical efficiency change (Effch) and technical or technology change (Techch). Pech=Pure technical efficiency change. Sech=scale efficiency change.

The above table shows that the average level of the Malmquist index was 1.021 during the study period. The overall average efficiency change of the banks was 0.997 whereas the overall average of technical or technology change was 1.024. The overall average pure technical efficiency change was

0.988 while the overall average scale efficiency change was 1.009 over the study period.

In the year 2003/04 the indices for Effch, Techch, Pech, Sech, and Tfpch were 0.936, 1.053, 1.001, 0.934, and 0.986 respectively. For year 2004/05 the indices for the above variables were 1.072, 1.005, 0.989, 1.083, and 1.077 respectively. For the year 2005/06 the indices were 1.042, 0.972, 0.981, 1.062, and 1.013 respectively. For the final year the indices were 0.944, 1.070, 0.980, 0.963, and 1.010 respectively.

Table-5 Malmquist index summary of individual bank means

Bank	Effch	Techch	Pech	Sech	Tfpch
BoA	1.000	1.024	1.000	1.000	1.024
NIB	0.963	0.976	0.901	0.958	0.843
WB	1.046	1.053	1.027	1.018	1.102
CBB	1.000	1.098	1.000	1.000	1.098
UB	1.023	0.986	1.000	1.023	1.009
DB	1.059	0.997	1.000	1.059	1.056
CBE	1.000	1.077	1.000	1.000	1.077
AIB	0.994	0.990	0.980	1.013	0.984
Mean	0.997	1.024	0.988	1.009	1.021

Table-5 shows the mean Malmquist indices for individual banks. BoA had Effch, Techch, Pech, Sech, and Tfpch indices of 1.000, 1.024, 1.000, 1.000, and 1.024 respectively. NIB had Effch, Techch, Pech, Sech, and Tfpch indices of 0.963, 0.976, 0.901, 0.958, and 0.843 respectively. WB had Effch, Techch, Pech, Sech, and Tfpch indices of 1.046, 1.053, 1.027, 1.018, and 1.102 respectively. CBB had Effch, Techch, Pech, Sech, Tfpch indices of 1.000, 1.098, 1.000, 1.000, and 1.098 respectively. UB had Effch, Techch,

Pech, Sech and Tfpch indices of 1.023, 0.986, 1.000, 1.023, and 1.009 respectively. DB had Effch, Techch, Pech, Sech, and Tfpch indices of 1.059, 0.997, 1.000, 1.059, and 1.056 respectively. CBE had Effch, Techch, Pech, Sech, and Tfpch indices of 1.000, 1.077, 1.000, 1.000, and 1.077 respectively. AIB had Effch, Techch, Pech, Sech, and Tfpch indices of 0.994, 0.990, 0.980, 1.013 and 0.984 respectively.

5.3) Second stage regression results

In order to investigate the potential determinants of the technical efficiency, cost efficiency, allocative efficiency, and scale efficiency scores, a further step was undertaken. This study took eight explanatory variables as bank specific variables, two explanatory variables as macroeconomic variables, one explanatory variable as non- bank financial institution development (especially, the development in the number of micro-finance institutions), and one variable as the depth of the financial sector. The censored Tobit model was used in order to analyze the determinants.

The following specification was used:

$$DEA_e = \alpha + \beta_1 ROA + \beta_2 ROE + \beta_3 CAP + \beta_4 ASSET + \beta_5 NBRAN + \beta_6 DEP + \beta_7 GPROF + \beta_8 LOANS + \beta_9 RGDP + \beta_{10} INF + \beta_{11} M2 / GDP + \beta_{12} NMFIS + \beta_i \text{Log}(X_i)$$

Where DEAE is the efficiency score obtained from section (5.1)

and the other variables are as defined in Chapter-4.

Results of the censored Tobit model are presented in the following table.

Table-6: Results from the censored Tobit model

Independent variables	Dependent variables (Efficiency scores)											
	Technical efficiency			Allocative efficiency			Cost efficiency			Scale efficiency		
	coeffs.	Se.	p	coeffs.	Se.	p	coeffs.	Se.	p-values	coeffs.	Se.	p-values
ROA	0.183328	0.15584	0.239	-0.62978	0.905962	0.487	-10.68767	6.12602	0.081	0.876833	0.68388	0.200
ROE				-2.99605	8.467734	0.723	0.561933	0.5199	0.280	-5.41718	5.95679	0.036
CAP				1.33E-09	4.33E-10	0.002	9.26E-10	5.10E-10	0.070			
ASSET	-2.71E-11	1.59E-11	0.088	-6.95E-11	4.13E-11	0.093	-8.47E-11	4.01E-11	0.035	-9.96E-12	2.67E-11	0.709
NBRAN	-0.00565	0.00309	0.068	0.013961	0.007405	0.059	0.001889	0.00297	0.525	0.01032	0.00523	0.048
GPROF	-5.29E-10	2.90E-10	0.068	2.95E-09	9.04E-10	0.001	1.24E-09	7.46E-10	0.096	-8.27E-10	4.87E-10	0.089
LOANS	9.90E-11	5.66E-11	0.080	-4.08E-10	1.61E-10	0.011	-1.30E-10	9.52E-11	0.171	-4.60E-11	1.02E-10	0.652
RGDP				2.66E-11	1.03E-11	0.010	2.27E-11	1.32E-11	0.085			
INF							-1.24	1.32671	0.352			
M2/GDP							-0.02620	0.98632	0.979			
NMFIS	-0.00712	0.0076	0.349	-8.78E-02	0.04458	0.049	-0.08521	0.05734	0.137	9.63E-03	0.01263	0.248
DEP	4.38E-11	2.43E-11	0.072	-1.39E-11	5.23E-11	0.790	3.28E-11	2.98E-11	0.199	4.16E-12	4.06E-11	0.918
LOGROE	0.00895	0.02366	0.705							-0.08953	0.04277	0.042
LOGROA				0.582524	0.290599	0.045				0.453075	0.23588	0.709
LOGCAP	0.086398	0.06327	0.172							0.083585	0.22389	0.709
LOGASSET	0.141612	0.1053	0.179	0.132067	0.364575	0.717				-0.39846	0.28886	0.168
LOGNBRAN	0.21383	0.1046	0.041	-0.53951	0.237706	0.023				-0.3581	0.17365	0.039
LOGGPROF				-0.60642	0.269592	0.024						
LOGLOANS	-0.28883	0.13446	0.032	0.679111	0.345542	0.049				0.453075	0.23588	0.055
LOGRGDP												
LOGINF				-0.09021	0.101438	0.374						
LOGM2/RGDP				-0.11101	0.311008	0.721						
LOGNMFIS												
LOGDEP	-0.04707	0.0397	0.236	0.017314	0.086129	0.841				0.013257	0.06712	0.843
cons	2.825321	1.08462	0.009	-3.24987	2.560411		1.485427	0.79609	0.062	-1.51369	1.95133	0.438
LLH-ratio	66.589813			36.827198			26.024445			46.317685		

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All the independent variables were found to be statistically insignificant when the technical efficiency score was regressed against them. However, to reduce the collinearity problem, the logs of these variables were included

(dropping inflation, real GDP, M2/GDP, capital, LOGROA, LOGGPROF, and returns on equity) and some of them were found to be statistically significant at 5% significant level. Asset, number of branches, gross profit and the growth of loans had a statistically significant negative relationship with technical efficiency score while loans, deposits, and growth of branches were inversely related.

Regressing the allocative efficiency score on all the variables of interest results in statistically insignificant relationship. As has been done to the technical efficiency score, the allocative efficiency score was regressed on all the independent variables and their logs. The results from the model showed that capital, number of branches, gross profit, real GDP, the growth of returns on asset, and the growth of loans were found to have a statistically significant positive influence on the allocative efficiency score. Assets, loans, number of micro-finance institutions, growth of profits, and growth of number of branches had a negative significant influence on the efficiency score of the banking industry over the study period.

The table indicates that five of the twelve independent variables had a statistically significant effect on cost efficiency. Out of them capital, gross profit and real GDP had a positive effect while asset and returns on equity had a negative impact on the cost efficiency score. The growth of returns on equity, growth of capital, growth of real GDP, inflation rate, and the depth of

the financial sector were dropped from the estimation due to collinearity problem.

Like the technical and allocative efficiencies, when the scale efficiency was regressed on all the independent variables, all the variables, except deposits had a statistically insignificant influence. In order to reduce the collinearity problem capital, inflation, monetary depth of the financial sector, the growth of returns on asset, and the growth of gross profit were dropped. Including the growth rate of the other variables made five variables statistically significant. Three of them (growth of number of branches, growth of return on equity, and gross profit) had inverse relationship while two of them (number of branches and growth of loans) had a direct relationship with the scale efficiency score of the banking sector over the study period.

5.4) Discussion of results

Efficiency scores

Table-1 showed that on average the commercial banking sector was technically, allocatively, cost, and scale inefficient in both CRS and VRS-DEA models. During the study period the mean technical efficiency score of all the commercial banks was 91.18% with a standard deviation of 3.5%. This result is higher than the technical efficiency of Singapore's commercial

banks (88.4%) reported by Sufian (2007). Under the CRS-DEA model the commercial banks could have produced their interest income and non-interest income with 8.82% less input, had they been operating on the best performance. In other words the industry could have increased its output by 8.82% without employing additional resources. But under the VRS- DEA model the commercial banks could have produced with only 2.32% less input.

Regarding the allocative efficiency of the sampled commercial banks it was found that the mean efficiency score was 87.02% under the CRS-model whereas it was 90.28% under the VRS-DEA model. This indicates that the industry could have produced its output with 9.72% less input price ratios had it been operating on the best practice of the estimated frontier i.e. by changing the combination of the input the industry can increase its output by 9.7%.

From section 5.4 we also saw that the mean cost efficiency score for the banks was 88.50%, which indicates that the industry is paying 11.5% more input cost to produce its interest income and non-interest income. This score is relatively lower than Taiwan's commercial banks (90%) reported by Yeh (1996). This result is also lower than the cost efficiency (92.2%) reported by Dereje (2006). But it was higher than the cost efficiency (81%) reported by Misganaw (2007).

When we compare the mean technical efficiencies and the mean allocative efficiencies over the sample period, the mean technical efficiencies are higher than the mean allocative efficiencies showing that the source of the cost inefficiency of the industry was not managerial problem.

Looking at the mean scale efficiencies the banking sector exhibits non-constant returns to scale. It exhibits either increasing or decreasing returns to scale over the studied period. This indicates that some of the banks could allocate their fixed cost or their cost of technology across a greater volume of their interest income and non-interest income. The non-constant return to scale of the industry also indicates that there is a potential for the banking sector to expand.

Malmquist indices

When we see the Malmquist indices the mean total factor productivity change was 1.021, which indicates that there was a 2.1% increase in total factor productivity during the study period. This increase in total factor productivity change could be due to a 2.4% increase in technical or technology change of the banking sector. This increase in total factor productivity change could also be explained by the fact that in recent years most banks are automating their operation. Except in the year 2003/04 for

which the banking sector showed a reduction in TFP (by an amount of 1.4%) the banking sector had a positive TFP growth. In year 2004/05 the banking industry showed 7.7% TFP growth while in years 2005/06 and 2006/07 it showed 1.3% and 1.0% TFP growth respectively.

Potential determinants of efficiency scores

The inverse relationship between assets (size of the banks) and technical efficiency score shows that as the size of the banks increases the technical efficiency of larger banks declines. This could be explained by the fact that as the size of a bank increases a manager would not be able to control inputs of the bank efficiently.

The direct and significant relationship between loans and technical efficiency score shows that as a bank manager faces more risks (by giving more loans to customers), he/she expects more interest income given his/her input. When the loans given to customers expand the risk of default also increase. In order to reduce the risk and to increase its interest income the manager follows the activities of its customers technically (for example by following the projects of customers).

Deposits and technical efficiency score related positively. As deposits increase banks have to pay interest to depositors and by lending the deposits banks get interest income. As deposits increase managers invest some of the

deposits on buying some interest earning assets and fixed assets which earn income. In the process managers try to employ their available inputs in such a way that they can produce higher interest income and non-interest income.

The growth rate of the number of branches and the absolute change in the technical efficiency score had a positive and statistically significant relationship. This indicates that as the growth rate of the number of bank branches goes up banks tend to be more technically efficient. This could be due to the fact that Ethiopia has small number of banks.

The growth rate of loans had an inverse relationship with the technical efficiency score. This indicates that as the growth rate of loans increases banks face difficulty in collecting the loans, thereby fail to achieve the maximum output (especially interest income) from the available inputs.

The number of branches had a statistically significant negative impact on the technical efficiency. This indicates that as the number of bank branches increase, the bank would not produce the same output without employing additional inputs. Greater numbers of branches demand greater labor, physical capital, and other inputs. This would challenge a bank's manager on its way towards achieving technical efficiency.

Capital had a statistically significant positive influence on the allocative efficiency of the commercial banks. Just by changing the mix of labor, physical capital, and deposits banks could increase their interest and non-interest income.

Banks were found to be more allocatively inefficient as their asset size increases. By acquiring additional assets banks incur additional costs that might have unfavorable effect on their operating income.

Gross profit and allocative efficiency were positively related. This indicates that as profit rises banks had managed to increase their output by changing the combination of their inputs. Since the objective of banks is making profit, they can use the combination of the available resources to produce the maximum interest and non-interest income. But the growth rate of gross profit was related negatively. This shows that as the growth rate of gross profit increases banks could not increase their output, instead they reduce their output due to a lesser profit margin.

Real GDP had a positive and significant effect on the allocative efficiency. As the gross domestic product increases the demand for the services of the banking sector by the public also rises. Knowing this situation banks could change their mix of inputs in order to absorb the growing demand. Having a

high demand from the public, banks could manage to get a higher amount of operating income from a given inputs.

The number of micro-finance institutions affected the allocative efficiency negatively. As discussed earlier these institutions compete with banks in providing different services. So banks could not increase their output as they wish by changing their input combination.

The number of branches was related positively with the allocative efficiency. As the number increases banks could increase their output by changing the combination of labor, physical capital, and their deposits. But the growth rate of the number of branches had a negative effect. As the expansion of branches keep increasing from year to year managers would face difficulty in controlling all the branches. Therefore, output cannot be increased by just altering the input mixes.

The amount of capital had a positive and statistically significant effect on the cost efficiency of banks. Derege (2006) also found such relationship in his study of the efficiency of commercial banks in Ethiopia employing the stochastic frontier approach. But employing the same methodology, Misganaw (2007) arrives at opposite conclusion. The positive relation indicates that the management had an incentive to cut costs because it expected a return on its capital.

The bank size (as measured by the asset size) had a significant and inverse relationship with cost efficiency over the study period. This relation could arise because of the difficulty that managers face in controlling and managing the banks as the asset expands and diversifies.

Though the relationship was statistically insignificant the cost efficiency score and loans went in opposite direction. This indicates that as the risk faced by the management (risk of higher non-performing loans) increases banks tend to be less cost efficient since they incur a higher cost to reduce that risk.

Gross profit and cost-efficiency had a statistically significant positive relationship. This shows that as banks collect higher profits they tend to reduce their cost. Some of the objectives of bank managers are to get a higher interest income, higher non-interest income and higher gross profit. In achieving these objectives they cut the cost of their bank to become cost-efficient.

Real gross domestic product (RGDP) had a positive and statistically significant effect on the cost-efficiency of the commercial banks. Studies showed that economic growth enhances the development of the financial sector (see chapter -1). Also, citing Robinson (1952), Andrus (2001) noted

that growth creates demand for financial services. One of the methods that the financial sector, particularly the banking sector, can develop is through making profits. As the economy grows, people need the banking services more, hence with a higher demand for banking services making a profit will not be a problem. Given the high demand for banking services and the expansion of the economy, bank managers will try to reduce their cost in every dimension to become cost efficient.

Returns on equity had a negative and statistically significant effect on cost efficiency. As the profit from each Br. of capital increases banks become more cost-inefficient. This could be due to the fact that most banks in Ethiopia do not engage themselves in investment activities.

Though statistically insignificant, the number of micro-finance institutions had an inverse relationship with the cost efficiency score. We know that MFIS in Ethiopia have similar activities with the commercial banks. For example they serve as deposit institutions and give loans to customers. In this respect MFIS compete with the banking industry. In order to overcompete the MFIs the banking industry incurs additional costs on advertising and other activities. This could result in cost-inefficiency of commercial banks.

The number of branches and scale efficiency score had a positive relationship. This indicates that as the number of branches expands

commercial banks in Ethiopia move towards the optimal scale of operation. Since commercial banks are not operating at their optimal size opening more branches would reduce their fixed cost and make them scale efficient.

Gross profit affects scale efficiency negatively. As the profit earned by the banks rise they tend to reduce their scale of operation. This could be due to less profit margins.

The growth rate of return on equity had an inverse relation on the scale efficiency of commercial banks. As the profit from each Br. of capital rises the scale efficiency falls. This could be due to less investment made by the banks on different projects, fixed assets, and various investment activities.

The growth rate of loans and scale efficiency were related positively. As the growth rate of loans increases from year to year banks tend to increase their size. When the growth rate of loans increase banks need more branches and more operation but may not necessarily increase their fixed assets.

CHAPTER-6

Conclusion and Recommendation

6.1) Conclusion

An efficient banking sector plays a vital role in enhancing the economic growth of a country. Levine (2005) stated that banks that mobilize and allocate savings efficiently, allocate capital to endeavors with the highest expected social returns, and exert sound governance over funded firms foster innovation and growth. Levine (2005) also added that banks play vital roles in mobilizing and allocating resources, monitoring firms, and providing liquidity and risk management services.

The study measured the performance of a sample of eight commercial banks in Ethiopia over the periods 2002/2003-2006/2007. In analyzing the technical efficiency, allocative efficiency, cost efficiency, and scale efficiency of the banks data envelopment analysis was utilized. The Malmquist total factor productivity index was also used to examine the total factor productivity change, technical change and efficiency change of the banks. Finally the censored Tobit was employed in order to determine the potential determinants of the banks' efficiency scores.

Results of the constant returns to scale and variable returns to scale DEA models showed that commercial banks in Ethiopia were not technically efficient. The banks use more inputs while they could have been reduced their input usage to produce the same output. From the VRS-DEA model it can be seen that banks could have saved 2.3% of their input usage. In other words banks could have increased their output by 2.3% using the same inputs.

From the second stage regression results it was found that the main statistically significant sources of technical inefficiency were larger size of the banks, loan and its growth rate over time, and the number of branches. But deposits and higher growth rate of the number of branches tends to improve technical efficiency.

Looking at the allocative efficiency of the banks they were not efficient. They could not increase their output by changing the composition of their inputs. Had they been capable of changing their input mixes they could have increased their interest and non-interest income by 9.18%.

The expansion of asset size, high growth rate of gross profit, the increase in the number of micro-finance institutions, and high growth rate of the number of bank branches retarded the allocative efficiency of commercial banks while the amount of higher capital, higher gross profit, higher real

GDP, and large number of branches improves the allocative efficiency of the banks.

The banks were not cost efficient. They pay 11.5% higher cost. Having large asset size reduces the cost efficiency. Aikaei (2008) also found that as banks' asset size increases the x-inefficiency of Tanzania's commercial banks increase. Higher returns on equity also reduced the cost efficiency of banks while larger total capital, higher gross profits, and higher real GDP facilitated the cost efficiency of banks.

The banks were also not scale efficient. They were operating below their optimal size. Higher number of bank branches and higher growth rate of loans and advances to customers would improve the scale efficiency while higher gross profits, higher growth rate of returns of the profits per Br. of capital, and a higher growth rate of the number of branches reduces the scale efficiency of commercial banks.

Results from the Malmquist index showed that due to 2.4% technology change, commercial banks exhibited an average of 2.1% increase in total factor productivity change over the study period. In recent years commercial banks have been introducing new technologies to their operation. This could help them improve their productivity.

6.2) Recommendations and policy implications

The study has tried to point out the main sources of inefficiencies in the banking sector. Based on the findings the study recommends that bank managers can improve their efficiencies by increasing their capital and reserve and by having sufficient deposits from the public. Bank managers should take advantage of the real GDP growth in the economy. Banks should engage in investment activities in order to earn additional non-interest and interest income. Banks can also reduce their inefficiencies by reducing their asset size. Keeping introducing new technologies and new services can benefit banks. Finally bankers should try to convince the general public to use their services.

Bank regulators should evaluate the performance of banks at a regular basis using different methodologies apart from the conventional financial ratios used and they must encourage the relatively efficient ones. They have to control reserves, asset, and returns on equity in such a manner that the regulation improves the efficiency of the banks. The expansion made by banks (in terms of opening additional branches and their growth rates) should also be supervised. Finally the regulator should follow the development of micro-finance institutions in the economy.

Policy makers should design prudent policies that increase the efficiency of the banking industry. They have to design instruments that promote competition in the sector. Designed policies should encourage new firms to enter the market. Policy makers should also consider the asset quality of individual banks in designing policies of the banking industry.

This study followed a version of the intermediation approach to input-output classification of the banking sector. However, there are other approaches to the classification. These approaches are not applied in this study. Also the study has employed only the input-oriented DEA model. Future researchers in the banking industry can extend this study in this direction.

References

- 1) Abdu Kedir Seid (2006), Technical Efficiency of Selected Hospitals in Addis Ababa: Data Envelopment Analysis Approach, Master Thesis.
- 2) Adongo Jonathan, Stork Christoph, and Elisa Hasheela (2005), Measuring the Alternative Profit X-Efficiency of Namibia's Banking Sector, the Namibian Economic Policy Research Unit, Research Report No.36, 2005.
- 3) Alemayehu Geda (1998), the Structure and Performance of Ethiopia's Financial Sector in the Pre and Post-reform Period: With a Special Focus on Banking, Proceeding of the 8th Annual Conference on the Ethiopian Economy, Oct.30-Nov.1998, Publisher EEA, 1999.
- 4) Allen N. Berger and David B. Humphrey (1997), Efficiency of Financial Institutions: International Survey and Direction for Future Research, European Journal of Operational Research 98,175-212,January 1997.
- 5) Aly Hassan Y., Richard Grabowski, Carl Pasurka, and Nanda Rangan (1990) Technical, Scale and Allocative Efficiencies in US Banking: An Empirical Investigation, the Review of Economics and Statistics, Vol.72, No.2 (1990), pp 211-218.
- 6) Andrus Oks (2001). Efficiency of the Financial Intermediaries and Economic Growth in Central and Eastern European Countries, Tartu University Press, 2001.

- 7) Banker R.D., Charnes A. and Cooper W.W. (1984), Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis, Management Science, Vol.30, No.9, 1984.
- 8) Barr Richard S. Killgo Kory A., Siems Thomas F., and Sheri Zimmel, (1999).Evaluating the Productive Efficiency and Performance of US Commercial Banks, 1999,USA.
- 9) Coeli Tim (1996), A Guide to DEAP version 2.1: A DEA Analysis (computer) Program, CEPA Working Paper 96/08,Australia.
- 10) Coelli T.D.S. Prasada Rao, and G.E. Battese (1998): An Introduction to Efficiency and Productivity Analysis. Kluwer Academic Publisher, USA.
- 11) DEAP version 2.1 (1996) Computer Program: A Software Written by Tim Coeli: CEPA University of Queens Land, Australia.
- 12) Dereje Getachew (2006), the Structure and Efficiency of Ethiopian Commercial Banks, Master Thesis, AAU.
- 13) Fadzlan Sufian (2007), Trends in the Efficiency of Singapore's Commercial Banking Groups: A Non-stochastic Frontier Data Envelopment Analysis Window Analysis Approach, International Journal of Productivity and Performance Management Vol.56, No.2, pp 99-139,2007.
- 14) Farrell M.J. (1957), The Measure of Productive Efficiency, Journal of the Royal Statistical Society, 120:252-290.

- 15) Frantisek Brazdik (2005), Oriented Stochastic Data Envelopment Models: Ranking Comparison to Stochastic Frontier Approach, Center for Economic Research and Graduate Education, Academy of Sciences of the Czech Republic, Economic Institute Working Paper Series (ISSN-3298), 2005.
- 16) Giokas D and Vassilglou M. (1990), a Study of the Relative Efficiency of Bank Branches: An Application of Data Envelopment Analysis, Journal of Operational Research Society Vol. 41.No.7, pp 591-597, 1990.
- 17) Grigorian David A. and Manole Vald (2002), Determinants of Commercial Bank Performance in Transition: An Application of Data Envelopment Analysis, World Bank Policy Research Working Paper 2850, 2002.
- 18) Haag Stephen E. and Jaska Patrick V. (1995), Interpreting Inefficiency Ratings: An Application of Bank Branch Operating Efficiencies, Managerial and Decision Economics, Vol.16, 7-17(1995).
- 19) Heffernan S. Magie X. and (2005), Cost X-Efficiency in China's Banking Sector Cass Faculty of Finance Working Paper No.WP-FF-14-2005.
- 20) Jehovaness Aikaeli (2008), Commercial Banks Efficiency in Tanzania: a Paper Presented in A CSAE Conference on "Economic Development in Africa", Catherin's College, Oxford, 16th -18th March 2008.

- 21) Leibenstein H. (1966), Allocative Efficiency Vs X-Efficiency, The American Economic Review, Vol.56, No.3 (1966).
- 22) Misganaw Habte (2007), Analyzing Cost and Alternative Profit Efficiency of Private Commercial Banks in Ethiopia: A Stochastic Frontier Approach: Master Thesis.
- 23) Muhammad Hanif Akhatar (2002), X-efficiency Analysis of Commercial Banks in Pakistan: A Preliminary Investigation, the Pakistan Development Review, Vol.41, pp 567-580, 2002.
- 24) Muluneh Ayalew (2006), Private Commercial Banking in Ethiopia: Efficiency Analysis, a NBE paper presented at the fourth international conference of the Ethiopian Economic Association.
- 25) NBE (2001): History of Banking and Money in Ethiopia, Posted on the National Bank of Ethiopia's Website in 2001, www.nbe.gov.et.
- 26) NBE (2006), Annual Report.
- 27) Quey-jen Yeh (1996), the Application of Data Envelopment Analysis in Conjunction with Financial Ratios for Bank Performance Evaluation, Journal of the Operational Research Society, No. 47, pp 980-988.
- 28) Richard J. Herring and Santomero Antony M. M. (1996), The Role of Financial Sector in Economic Performance, the Wharton School University of Pennsylvania, Philadelphia, P.A., Financial Institution Center, Working Paper 95-08, 1996.

- 29) Robert De Young (1997), Measuring Bank Cost Efficiency: Do Not Count on Accounting Ratios, Financial Practice and Education, 1997.

- 30) Robert G. King and Levine Ross (1993), Finance and Growth: Shumpeter Might be Right, the Quarterly Journal of Economics, 1993, MIT press.

- 31) Rose Levine (2005), Bank Regulation and Supervision, National Bureau of Economic Research Reporter: Research Summary, pp 9-12, Fall 2005.

- 32) Sandrine Kabian (2007), Measuring Bank Efficiency in Developing Countries: The Case of West African Economic Monetary Union, a Paper Presented at the African Economic Conference, November 2007.

- 33) STATA Corporation (2006), Statistics/Data Analysis Software, Version 9.1, College Station, Texas, USA.

- 34) Win4DEAP version1.1.2 (2006): Complementary Software to DEAP Version 2.1, Written by Michel Deslierres.

2002-03(DEA RESULTS-VRS)

APPENDIX-1:Results from DEAP Version 2.1(2002/2003)

Instruction file = \$\$TEMP\$\$\\$.INS
 Data file = \$\$TEMP\$\$\\$.DTA

Input orientated DEA

Scale assumption: VRS

Slacks calculated using multi-stage method

EFFICIENCY SUMMARY:

firm	crste	vrste	scale	
1	1.000	1.000	1.000	-
2	1.000	1.000	1.000	-
3	0.834	0.853	0.978	drs
4	1.000	1.000	1.000	-
5	0.887	1.000	0.887	irs
6	0.780	1.000	0.780	drs
7	1.000	1.000	1.000	-
8	0.811	0.993	0.817	drs
mean	0.914	0.981	0.933	

Note: crste = technical efficiency from CRS DEA
 vrste = technical efficiency from VRS DEA
 scale = scale efficiency = crste/vrste

Note also that all subsequent tables refer to VRS results

SUMMARY OF OUTPUT SLACKS:

firm	output:	1	2
1		0.000	0.000
2		0.000	0.000
3		0.000	0.000
4		0.000	0.000
5		0.000	0.000
6		0.000	0.000
7		0.000	0.000
8		3931.248	0.000
mean		491.406	0.000

SUMMARY OF INPUT SLACKS:

firm	input:	1	2	3
1		0.000	0.000	0.000
2		0.000	0.000	0.000
3		2149.997	0.000	0.000
4		0.000	0.000	0.000

	2002-03 (DEA RESULTS-VRS)		
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	3792.907	26091.131	0.000
mean	742.863	3261.391	0.000

SUMMARY OF PEERS:

firm	peers:			
1	1			
2	2			
3	6	2	4	1
4	4			
5	5			
6	6			
7	7			
8	7	2		

SUMMARY OF PEER WEIGHTS:
(in same order as above)

firm	peer weights:			
1	1.000			
2	1.000			
3	0.019	0.691	0.213	0.077
4	1.000			
5	1.000			
6	1.000			
7	1.000			
8	0.041	0.959		

PEER COUNT SUMMARY:
(i.e., no. times each firm is a peer for another)

firm	peer count:
1	1
2	2
3	0
4	1
5	0
6	1
7	1
8	0

SUMMARY OF OUTPUT TARGETS:

firm	output:	1	2
1	61952.000	18778.000	
2	37295.000	28716.000	
3	41841.000	25481.000	
4	45749.000	15075.000	
5	18949.000	13336.000	
6	82010.000	51806.000	
7	670029.000	631446.000	
8	63091.248	53289.000	

2002-03(DEA RESULTS-VRS)

SUMMARY OF INPUT TARGETS:

firm	input:	1	2	3
1		8235.000	11547.000	1076170.000
2		5887.000	5634.000	588115.000
3		7175.035	12942.096	651007.662
4		9962.000	36068.000	614909.000
5		3512.000	9723.000	331264.000
6		18662.000	25915.000	1621385.000
7		127734.000	217265.000	18942938.000
8		10854.641	14262.090	1336431.934

FIRM BY FIRM RESULTS:

Results for firm: 1
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	61952.000	0.000	0.000	61952.000
output	2	18778.000	0.000	0.000	18778.000
input	1	8235.000	0.000	0.000	8235.000
input	2	11547.000	0.000	0.000	11547.000
input	3	1076170.000	0.000	0.000	1076170.000

LISTING OF PEERS:

peer	lambda	weight
1	1.000	

Results for firm: 2
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	37295.000	0.000	0.000	37295.000
output	2	28716.000	0.000	0.000	28716.000
input	1	5887.000	0.000	0.000	5887.000
input	2	5634.000	0.000	0.000	5634.000
input	3	588115.000	0.000	0.000	588115.000

LISTING OF PEERS:

peer	lambda	weight
2	1.000	

Results for firm: 3
 Technical efficiency = 0.853
 Scale efficiency = 0.978 (drs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	41841.000	0.000	0.000	41841.000
output	2	25481.000	0.000	0.000	25481.000
input	1	10931.000	-1605.968	-2149.997	7175.035
input	2	15171.000	-2228.904	0.000	12942.096
input	3	763125.000	-112117.338	0.000	651007.662

LISTING OF PEERS:

peer	lambda	weight
6	0.019	

2 0.691
4 0.213
1 0.077

2002-03(DEA RESULTS-VRS)

Results for firm: 4
Technical efficiency = 1.000
Scale efficiency = 1.000 (crs)
PROJECTION SUMMARY:

variable	original value	radial movement	slack movement	projected value
output 1	45749.000	0.000	0.000	45749.000
output 2	15075.000	0.000	0.000	15075.000
input 1	9962.000	0.000	0.000	9962.000
input 2	36068.000	0.000	0.000	36068.000
input 3	614909.000	0.000	0.000	614909.000

LISTING OF PEERS:
peer lambda weight
4 1.000

Results for firm: 5
Technical efficiency = 1.000
Scale efficiency = 0.887 (irs)
PROJECTION SUMMARY:

variable	original value	radial movement	slack movement	projected value
output 1	18949.000	0.000	0.000	18949.000
output 2	13336.000	0.000	0.000	13336.000
input 1	3512.000	0.000	0.000	3512.000
input 2	9723.000	0.000	0.000	9723.000
input 3	331264.000	0.000	0.000	331264.000

LISTING OF PEERS:
peer lambda weight
5 1.000

Results for firm: 6
Technical efficiency = 1.000
Scale efficiency = 0.780 (drs)
PROJECTION SUMMARY:

variable	original value	radial movement	slack movement	projected value
output 1	82010.000	0.000	0.000	82010.000
output 2	51806.000	0.000	0.000	51806.000
input 1	18662.000	0.000	0.000	18662.000
input 2	25915.000	0.000	0.000	25915.000
input 3	1621385.000	0.000	0.000	1621385.000

LISTING OF PEERS:
peer lambda weight
6 1.000

Results for firm: 7
Technical efficiency = 1.000
Scale efficiency = 1.000 (crs)
PROJECTION SUMMARY:

variable	original value	radial movement	slack movement	projected value
output 1	670029.000	0.000	0.000	670029.000
output 2	631446.000	0.000	0.000	631446.000
input 1	127734.000	0.000	0.000	127734.000
input 2	217265.000	0.000	0.000	217265.000



2002-03(DEA RESULTS-VRS)

input	3	18942938.000	0.000	0.000	18942938.000
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LISTING OF PEERS:

peer	lambda weight
7	1.000

Results for firm: 8
 Technical efficiency = 0.993
 Scale efficiency = 0.817 (drs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	59160.000	0.000	3931.248	63091.248
output	2	53289.000	0.000	0.000	53289.000
input	1	14756.000	-108.452	-3792.907	10854.641
input	2	40652.000	-298.779	-26091.131	14262.090
input	3	1346327.000	-9895.066	0.000	1336431.934

LISTING OF PEERS:

peer	lambda weight
7	0.041
2	0.959

2003-04(RESULTS-VRS)

APPENDIX-1:Results from DEAP Version 2.1(2003/2004)

Instruction file = \$\$TEMP\$\$\\$.INS
 Data file = \$\$TEMP\$\$\\$.DTA

Input orientated DEA

scale assumption: VRS

slacks calculated using multi-stage method

EFFICIENCY SUMMARY:

firm	crste	vrste	scale	
1	1.000	1.000	1.000	-
2	1.000	1.000	1.000	-
3	1.000	1.000	1.000	-
4	0.838	0.990	0.846	irs
5	0.707	1.000	0.707	irs
6	0.787	1.000	0.787	drs
7	0.798	1.000	0.798	drs
8	0.741	0.896	0.827	drs
mean	0.859	0.986	0.871	

Note: crste = technical efficiency from CRS DEA
 vrste = technical efficiency from VRS DEA
 scale = scale efficiency = crste/vrste

Note also that all subsequent tables refer to VRS results

SUMMARY OF OUTPUT SLACKS:

firm	output:	1	2
1		0.000	0.000
2		0.000	0.000
3		0.000	0.000
4		3157.263	0.000
5		0.000	0.000
6		0.000	0.000
7		0.000	0.000
8		3050.380	0.000
mean		775.955	0.000

SUMMARY OF INPUT SLACKS:

firm	input:	1	2	3
1		0.000	0.000	0.000
2		0.000	0.000	0.000
3		0.000	0.000	0.000
4		1511.086	21057.782	0.000
5		0.000	0.000	0.000
6		0.000	0.000	0.000
7		0.000	0.000	0.000
8		0.000	21453.169	0.000

2003-04 (RESULTS-VRS)

mean 188.886 5313.869 0.000

SUMMARY OF PEERS:

firm	peers:		
1	1		
2	2		
3	3		
4	3	5	
5	5		
6	6		
7	7		
8	7	3	2

SUMMARY OF PEER WEIGHTS:
(in same order as above)

firm	peer weights:		
1	1.000		
2	1.000		
3	1.000		
4	0.416	0.584	
5	1.000		
6	1.000		
7	1.000		
8	0.032	0.403	0.564

PEER COUNT SUMMARY:
(i.e., no. times each firm is a peer for another)

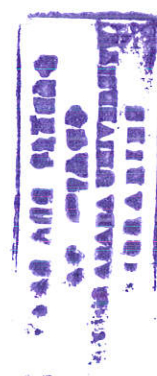
firm	peer count:
1	0
2	1
3	2
4	0
5	1
6	0
7	1
8	0

SUMMARY OF OUTPUT TARGETS:

firm	output:	1	2
1		97116.000	26094.000
2		55486.000	37684.000
3		66354.000	44496.000
4		43141.263	29118.000
5		26614.000	18169.000
6		116638.000	75386.000
7		680341.000	584379.000
8		80168.380	58191.000

SUMMARY OF INPUT TARGETS:

firm	input:	1	2	3
1		9765.000	16853.000	1275194.000



	2003-04 (RESULTS-VRS)		
2	8475.000	6659.000	833320.000
3	14392.000	16372.000	875650.000
4	10125.039	12251.652	677311.943
5	7087.000	9318.000	536097.000
6	23020.000	39297.000	2177734.000
7	164738.000	244144.000	22439000.000
8	15938.295	18292.238	1552227.079

FIRM BY FIRM RESULTS:

Results for firm: 1
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	97116.000	0.000	0.000	97116.000
output	2	26094.000	0.000	0.000	26094.000
input	1	9765.000	0.000	0.000	9765.000
input	2	16853.000	0.000	0.000	16853.000
input	3	1275194.000	0.000	0.000	1275194.000

LISTING OF PEERS:
 peer lambda weight
 1 1.000

Results for firm: 2
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	55486.000	0.000	0.000	55486.000
output	2	37684.000	0.000	0.000	37684.000
input	1	8475.000	0.000	0.000	8475.000
input	2	6659.000	0.000	0.000	6659.000
input	3	833320.000	0.000	0.000	833320.000

LISTING OF PEERS:
 peer lambda weight
 2 1.000

Results for firm: 3
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	66354.000	0.000	0.000	66354.000
output	2	44496.000	0.000	0.000	44496.000
input	1	14392.000	0.000	0.000	14392.000
input	2	16372.000	0.000	0.000	16372.000
input	3	875650.000	0.000	0.000	875650.000

LISTING OF PEERS:
 peer lambda weight
 3 1.000

Results for firm: 4
 Technical efficiency = 0.990

2003-04 (RESULTS-VRS)

Scale efficiency = 0.846 (irs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	39984.000	0.000	3157.263	43141.263
output	2	29118.000	0.000	0.000	29118.000
input	1	11753.000	-116.876	-1511.086	10125.039
input	2	33644.000	-334.567	-21057.782	12251.652
input	3	684115.000	-6803.057	0.000	677311.943

LISTING OF PEERS:

peer	lambda weight
3	0.416
5	0.584

Results for firm: 5

Technical efficiency = 1.000

Scale efficiency = 0.707 (irs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	26614.000	0.000	0.000	26614.000
output	2	18169.000	0.000	0.000	18169.000
input	1	7087.000	0.000	0.000	7087.000
input	2	9318.000	0.000	0.000	9318.000
input	3	536097.000	0.000	0.000	536097.000

LISTING OF PEERS:

peer	lambda weight
5	1.000

Results for firm: 6

Technical efficiency = 1.000

Scale efficiency = 0.787 (drs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	116638.000	0.000	0.000	116638.000
output	2	75386.000	0.000	0.000	75386.000
input	1	23020.000	0.000	0.000	23020.000
input	2	39297.000	0.000	0.000	39297.000
input	3	2177734.000	0.000	0.000	2177734.000

LISTING OF PEERS:

peer	lambda weight
6	1.000

Results for firm: 7

Technical efficiency = 1.000

Scale efficiency = 0.798 (drs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	680341.000	0.000	0.000	680341.000
output	2	584379.000	0.000	0.000	584379.000
input	1	164738.000	0.000	0.000	164738.000
input	2	244144.000	0.000	0.000	244144.000
input	3	22439000.000	0.000	0.000	22439000.000

LISTING OF PEERS:

peer	lambda weight
7	1.000

2003-04 (RESULTS-VRS)

Results for firm: 8
 Technical efficiency = 0.896
 Scale efficiency = 0.827 (drs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	77118.000	0.000	3050.380	80168.380
output	2	58191.000	0.000	0.000	58191.000
input	1	17792.000	-1853.705	0.000	15938.295
input	2	44368.000	-4622.593	-21453.169	18292.238
input	3	1732759.000	-180531.921	0.000	1552227.079

LISTING OF PEERS:

peer	lambda weight
7	0.032
3	0.403
2	0.564

2004-05(RESULTS-VRS)

APPENDIX-1:Results from DEAP Version 2.1(2004/2005)

Instruction file = \$\$TEMP\$\$\\$.INS
 Data file = \$\$TEMP\$\$\\$.DTA

Input orientated DEA

Scale assumption: VRS

slacks calculated using multi-stage method

EFFICIENCY SUMMARY:

firm	crste	vrste	scale	
1	1.000	1.000	1.000	-
2	1.000	1.000	1.000	-
3	1.000	1.000	1.000	-
4	0.903	0.920	0.982	drs
5	1.000	1.000	1.000	-
6	0.843	1.000	0.843	drs
7	0.835	1.000	0.835	drs
8	0.753	0.814	0.925	drs
mean	0.917	0.967	0.948	

Note: crste = technical efficiency from CRS DEA
 vrste = technical efficiency from VRS DEA
 scale = scale efficiency = crste/vrste

Note also that all subsequent tables refer to VRS results

SUMMARY OF OUTPUT SLACKS:

firm	output:	1	2
1		0.000	0.000
2		0.000	0.000
3		0.000	0.000
4		6805.094	0.000
5		0.000	0.000
6		0.000	0.000
7		0.000	0.000
8		0.000	2301.740
mean		850.637	287.718

SUMMARY OF INPUT SLACKS:

firm	input:	1	2	3
1		0.000	0.000	0.000
2		0.000	0.000	0.000
3		0.000	0.000	0.000
4		0.000	18226.951	0.000
5		0.000	0.000	0.000
6		0.000	0.000	0.000
7		0.000	0.000	0.000
8		6362.206	9228.305	0.000

		2004-05 (RESULTS-VRS)	
mean	795.276	3431.907	0.000

SUMMARY OF PEERS:

firm	peers:			
1	1			
2	2			
3	3			
4	3	1	5	
5	5			
6	6			
7	7			
8	1	6		

SUMMARY OF PEER WEIGHTS:
(in same order as above)

firm	peer weights:			
1	1.000			
2	1.000			
3	1.000			
4	0.115	0.076	0.808	
5	1.000			
6	1.000			
7	1.000			
8	0.856	0.144		

PEER COUNT SUMMARY:
(i.e., no. times each firm is a peer for another)

firm	peer count:
1	2
2	0
3	1
4	0
5	1
6	1
7	0
8	0

SUMMARY OF OUTPUT TARGETS:

firm	output:	1	2
1		104677.000	69960.000
2		82955.000	52926.000
3		79913.000	69827.000
4		54364.094	49700.000
5		45956.000	44910.000
6		161886.000	72653.000
7		645755.000	743703.000
8		112914.000	70347.740

SUMMARY OF INPUT TARGETS:

firm	input:	1	2	3
1		12864.000	30785.000	1627627.000
2		11544.000	10185.000	1224177.000

	2004-05 (RESULTS-VRS)		
3	20070.000	21023.000	1288449.000
4	11046.788	13447.131	972308.690
5	9587.000	10725.000	865168.000
6	28999.000	45792.000	2833007.000
7	185722.000	232702.000	25379000.000
8	15187.131	32945.720	1801178.628

FIRM BY FIRM RESULTS:

Results for firm: 1
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable	original value	radial movement	slack movement	projected value
output 1	104677.000	0.000	0.000	104677.000
output 2	69960.000	0.000	0.000	69960.000
input 1	12864.000	0.000	0.000	12864.000
input 2	30785.000	0.000	0.000	30785.000
input 3	1627627.000	0.000	0.000	1627627.000

LISTING OF PEERS:
 peer lambda weight
 1 1.000

Results for firm: 2
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable	original value	radial movement	slack movement	projected value
output 1	82955.000	0.000	0.000	82955.000
output 2	52926.000	0.000	0.000	52926.000
input 1	11544.000	0.000	0.000	11544.000
input 2	10185.000	0.000	0.000	10185.000
input 3	1224177.000	0.000	0.000	1224177.000

LISTING OF PEERS:
 peer lambda weight
 2 1.000

Results for firm: 3
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable	original value	radial movement	slack movement	projected value
output 1	79913.000	0.000	0.000	79913.000
output 2	69827.000	0.000	0.000	69827.000
input 1	20070.000	0.000	0.000	20070.000
input 2	21023.000	0.000	0.000	21023.000
input 3	1288449.000	0.000	0.000	1288449.000

LISTING OF PEERS:
 peer lambda weight
 3 1.000

Results for firm: 4
 Technical efficiency = 0.920
 Scale efficiency = 0.982 (drs)

2004-05(RESULTS-VRS)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	47559.000	0.000	6805.094	54364.094
output	2	49700.000	0.000	0.000	49700.000
input	1	12009.000	-962.212	0.000	11046.788
input	2	34433.000	-2758.918	-18226.951	13447.131
input	3	1057000.000	-84691.310	0.000	972308.690

LISTING OF PEERS:

peer	lambda weight
3	0.115
1	0.076
5	0.808

Results for firm: 5
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	45956.000	0.000	0.000	45956.000
output	2	44910.000	0.000	0.000	44910.000
input	1	9587.000	0.000	0.000	9587.000
input	2	10725.000	0.000	0.000	10725.000
input	3	865168.000	0.000	0.000	865168.000

LISTING OF PEERS:

peer	lambda weight
5	1.000

Results for firm: 6
 Technical efficiency = 1.000
 Scale efficiency = 0.843 (drs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	161886.000	0.000	0.000	161886.000
output	2	72653.000	0.000	0.000	72653.000
input	1	28999.000	0.000	0.000	28999.000
input	2	45792.000	0.000	0.000	45792.000
input	3	2833007.000	0.000	0.000	2833007.000

LISTING OF PEERS:

peer	lambda weight
6	1.000

Results for firm: 7
 Technical efficiency = 1.000
 Scale efficiency = 0.835 (drs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	645755.000	0.000	0.000	645755.000
output	2	743703.000	0.000	0.000	743703.000
input	1	185722.000	0.000	0.000	185722.000
input	2	232702.000	0.000	0.000	232702.000
input	3	25379000.000	0.000	0.000	25379000.000

LISTING OF PEERS:

peer	lambda weight
7	1.000

2004-05 (RESULTS-VRS)

Results for firm: 8
 Technical efficiency = 0.814
 Scale efficiency = 0.925 (drs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	112914.000	0.000	0.000	112914.000
output	2	68046.000	0.000	2301.740	70347.740
input	1	26475.000	-4925.663	-6362.206	15187.131
input	2	51814.000	-9639.974	-9228.305	32945.720
input	3	2212885.000	-411706.372	0.000	1801178.628

LISTING OF PEERS:

peer	lambda weight
1	0.856
6	0.144



2005-06(RESSULTS-VRS)

APPENDIX-1:Results from DEAP Version 2.1(2005/2006)

Instruction file = \$\$TEMP\$\$\\$.INS
 Data file = \$\$TEMP\$\$\\$.DTA

Input orientated DEA

Scale assumption: VRS

Slacks calculated using multi-stage method

EFFICIENCY SUMMARY:

firm	crste	vrste	scale	
1	1.000	1.000	1.000	-
2	0.718	0.837	0.859	irs
3	1.000	1.000	1.000	-
4	1.000	1.000	1.000	-
5	1.000	1.000	1.000	-
6	1.000	1.000	1.000	-
7	1.000	1.000	1.000	-
8	0.926	0.957	0.967	drs
mean	0.956	0.974	0.978	

Note: crste = technical efficiency from CRS DEA
 vrste = technical efficiency from VRS DEA
 scale = scale efficiency = crste/vrste

Note also that all subsequent tables refer to VRS results

SUMMARY OF OUTPUT SLACKS:

firm	output:	1	2
1		0.000	0.000
2		24269.702	6164.061
3		0.000	0.000
4		0.000	0.000
5		0.000	0.000
6		0.000	0.000
7		0.000	0.000
8		0.000	0.000
mean		3033.713	770.508

SUMMARY OF INPUT SLACKS:

firm	input:	1	2	3
1		0.000	0.000	0.000
2		0.000	6173.420	0.000
3		0.000	0.000	0.000
4		0.000	0.000	0.000
5		0.000	0.000	0.000
6		0.000	0.000	0.000
7		0.000	0.000	0.000
8		0.000	13385.755	0.000

2005-06(RESSULTS-VRS)

mean 0.000 2444.897 0.000

SUMMARY OF PEERS:

firm	peers:			
1	1			
2	5	4		
3	3			
4	4			
5	5			
6	6			
7	7			
8	7	3	4	6

SUMMARY OF PEER WEIGHTS:
(in same order as above)

firm	peer weights:				
1	1.000				
2	0.755	0.245			
3	1.000				
4	1.000				
5	1.000				
6	1.000				
7	1.000				
8	0.001	0.187	0.276	0.536	

PEER COUNT SUMMARY:
(i.e., no. times each firm is a peer for another)

firm	peer count:
1	0
2	0
3	1
4	2
5	1
6	1
7	1
8	0

SUMMARY OF OUTPUT TARGETS:

firm	output:	1	2
1	165276.000	55163.000	
2	76226.702	58121.061	
3	120457.000	104043.000	
4	90437.000	68400.000	
5	71623.000	54791.000	
6	241893.000	124730.000	
7	826764.000	969389.000	
8	177927.000	106065.000	

SUMMARY OF INPUT TARGETS:

firm	input:	1	2	3
1	26104.000	36327.000	2176885.000	

	2005-06(RESULTS-VRS)		
2	14101.308	19724.432	1214516.158
3	29720.000	25007.000	1778418.000
4	17368.000	38672.000	973000.000
5	13043.000	13586.000	1292760.000
6	39918.000	60013.000	3691603.000
7	192137.000	228726.000	28149000.000
8	31922.572	47739.173	2605608.647

FIRM BY FIRM RESULTS:

Results for firm: 1
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable	original value	radial movement	slack movement	projected value
output 1	165276.000	0.000	0.000	165276.000
output 2	55163.000	0.000	0.000	55163.000
input 1	26104.000	0.000	0.000	26104.000
input 2	36327.000	0.000	0.000	36327.000
input 3	2176885.000	0.000	0.000	2176885.000

LISTING OF PEERS:

peer	lambda weight
1	1.000

Results for firm: 2
 Technical efficiency = 0.837
 Scale efficiency = 0.859 (irs)

PROJECTION SUMMARY:

variable	original value	radial movement	slack movement	projected value
output 1	51957.000	0.000	24269.702	76226.702
output 2	51957.000	0.000	6164.061	58121.061
input 1	16856.000	-2754.692	0.000	14101.308
input 2	30957.000	-5059.148	-6173.420	19724.432
input 3	1451772.000	-237255.842	0.000	1214516.158

LISTING OF PEERS:

peer	lambda weight
5	0.755
4	0.245

Results for firm: 3
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable	original value	radial movement	slack movement	projected value
output 1	120457.000	0.000	0.000	120457.000
output 2	104043.000	0.000	0.000	104043.000
input 1	29720.000	0.000	0.000	29720.000
input 2	25007.000	0.000	0.000	25007.000
input 3	1778418.000	0.000	0.000	1778418.000

LISTING OF PEERS:

peer	lambda weight
3	1.000

Results for firm: 4



2005-06(RESSULTS-VRS)

Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	90437.000	0.000	0.000	90437.000
output	2	68400.000	0.000	0.000	68400.000
input	1	17368.000	0.000	0.000	17368.000
input	2	38672.000	0.000	0.000	38672.000
input	3	973000.000	0.000	0.000	973000.000

LISTING OF PEERS:

peer	lambda weight
4	1.000

Results for firm: 5
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	71623.000	0.000	0.000	71623.000
output	2	54791.000	0.000	0.000	54791.000
input	1	13043.000	0.000	0.000	13043.000
input	2	13586.000	0.000	0.000	13586.000
input	3	1292760.000	0.000	0.000	1292760.000

LISTING OF PEERS:

peer	lambda weight
5	1.000

Results for firm: 6
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	241893.000	0.000	0.000	241893.000
output	2	124730.000	0.000	0.000	124730.000
input	1	39918.000	0.000	0.000	39918.000
input	2	60013.000	0.000	0.000	60013.000
input	3	3691603.000	0.000	0.000	3691603.000

LISTING OF PEERS:

peer	lambda weight
6	1.000

Results for firm: 7
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	826764.000	0.000	0.000	826764.000
output	2	969389.000	0.000	0.000	969389.000
input	1	192137.000	0.000	0.000	192137.000
input	2	228726.000	0.000	0.000	228726.000
input	3	28149000.000	0.000	0.000	28149000.000

LISTING OF PEERS:

peer	lambda weight
7	1.000

2005-06(RESULTS-VRS)

Results for firm: 8
 Technical efficiency = 0.957
 Scale efficiency = 0.967 (drs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	177927.000	0.000	0.000	177927.000
output	2	106065.000	0.000	0.000	106065.000
input	1	33340.000	-1417.428	0.000	31922.572
input	2	63839.000	-2714.072	-13385.755	47739.173
input	3	2721303.000	-115694.353	0.000	2605608.647

LISTING OF PEERS:

peer	lambda weight
7	0.001
3	0.187
4	0.276
6	0.536

2006-07(RESULTS-VRS)

APPENDIX-1:Results from DEAP Version 2.1(2006/2007)

Instruction file = \$\$TEMP\$\$\INS
 Data file = \$\$TEMP\$\$\DTA

Input orientated DEA

Scale assumption: VRS

Slacks calculated using multi-stage method

EFFICIENCY SUMMARY:

firm	crste	vrste	scale	
1	1.000	1.000	1.000	-
2	0.556	0.919	0.605	irs
3	1.000	1.000	1.000	-
4	1.000	1.000	1.000	-
5	0.974	1.000	0.974	irs
6	0.982	1.000	0.982	drs
7	1.000	1.000	1.000	-
8	0.790	0.889	0.889	drs
mean	0.913	0.976	0.931	

Note: crste = technical efficiency from CRS DEA
 vrste = technical efficiency from VRS DEA
 scale = scale efficiency = crste/vrste

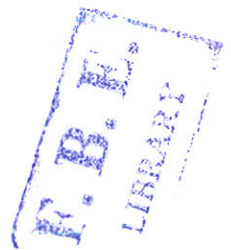
Note also that all subsequent tables refer to VRS results

SUMMARY OF OUTPUT SLACKS:

firm	output:	1	2
1		0.000	0.000
2		61725.767	16249.204
3		0.000	0.000
4		0.000	0.000
5		0.000	0.000
6		0.000	0.000
7		0.000	0.000
8		0.000	8491.734
mean		7715.721	3092.617

SUMMARY OF INPUT SLACKS:

firm	input:	1	2	3
1		0.000	0.000	0.000
2		0.000	0.000	129913.074
3		0.000	0.000	0.000
4		0.000	0.000	0.000
5		0.000	0.000	0.000
6		0.000	0.000	0.000
7		0.000	0.000	0.000
8		11938.315	4177.902	0.000



	2006-07 (RESULTS-VRS)		
3	38903.000	32879.000	2723626.000
4	21181.000	75349.000	1136354.000
5	22892.000	31550.000	1680770.000
6	51802.000	97279.000	4860547.000
7	150021.000	267548.000	33629909.000
8	34577.534	84943.265	2765669.736

FIRM BY FIRM RESULTS:

Results for firm: 1
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	201549.000	0.000	0.000	201549.000
output	2	65139.000	0.000	0.000	65139.000
input	1	31730.000	0.000	0.000	31730.000
input	2	40639.000	0.000	0.000	40639.000
input	3	2721328.000	0.000	0.000	2721328.000

LISTING OF PEERS:
 peer lambda weight
 1 1.000

Results for firm: 2
 Technical efficiency = 0.919
 Scale efficiency = 0.605 (irs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	60210.000	0.000	61725.767	121935.767
output	2	60210.000	0.000	16249.204	76459.204
input	1	24629.000	-2002.663	0.000	22626.337
input	2	41745.000	-3394.421	0.000	38350.579
input	3	1878935.000	-152782.263	-129913.074	1596239.662

LISTING OF PEERS:
 peer lambda weight
 4 0.155
 5 0.845

Results for firm: 3
 Technical efficiency = 1.000
 Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	185021.000	0.000	0.000	185021.000
output	2	139479.000	0.000	0.000	139479.000
input	1	38903.000	0.000	0.000	38903.000
input	2	32879.000	0.000	0.000	32879.000
input	3	2723626.000	0.000	0.000	2723626.000

LISTING OF PEERS:
 peer lambda weight
 3 1.000

Results for firm: 4
 Technical efficiency = 1.000

2006-07(RESULTS-VRS)

Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	120792.000	0.000	0.000	120792.000
output	2	111818.000	0.000	0.000	111818.000
input	1	21181.000	0.000	0.000	21181.000
input	2	75349.000	0.000	0.000	75349.000
input	3	1136354.000	0.000	0.000	1136354.000

LISTING OF PEERS:

peer	lambda weight
4	1.000

Results for firm: 5

Technical efficiency = 1.000

Scale efficiency = 0.974 (irs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	122146.000	0.000	0.000	122146.000
output	2	69960.000	0.000	0.000	69960.000
input	1	22892.000	0.000	0.000	22892.000
input	2	31550.000	0.000	0.000	31550.000
input	3	1680770.000	0.000	0.000	1680770.000

LISTING OF PEERS:

peer	lambda weight
5	1.000

Results for firm: 6

Technical efficiency = 1.000

Scale efficiency = 0.982 (drs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	319928.000	0.000	0.000	319928.000
output	2	164826.000	0.000	0.000	164826.000
input	1	51802.000	0.000	0.000	51802.000
input	2	97279.000	0.000	0.000	97279.000
input	3	4860547.000	0.000	0.000	4860547.000

LISTING OF PEERS:

peer	lambda weight
6	1.000

Results for firm: 7

Technical efficiency = 1.000

Scale efficiency = 1.000 (crs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	1036468.000	0.000	0.000	1036468.000
output	2	1217247.000	0.000	0.000	1217247.000
input	1	150021.000	0.000	0.000	150021.000
input	2	267548.000	0.000	0.000	267548.000
input	3	33629909.000	0.000	0.000	33629909.000

LISTING OF PEERS:

peer	lambda weight
7	1.000

Results for firm: 8



2006-07 (RESULTS-VRS)

Technical efficiency = 0.889
 Scale efficiency = 0.889 (drs)

PROJECTION SUMMARY:

variable		original value	radial movement	slack movement	projected value
output	1	207913.000	0.000	0.000	207913.000
output	2	126517.000	0.000	8491.734	135008.734
input	1	52350.000	-5834.152	-11938.315	34577.534
input	2	100299.000	-11177.833	-4177.902	84943.265
input	3	3112548.000	-346878.264	0.000	2765669.736

LISTING OF PEERS:

peer	lambda weight
6	0.437
4	0.563

2002-03(COST-EFF-VRS)

APPENDIX-2:Results from DEAP Version 2.1(2002/2003)

Instruction file = \$\$TEMP\$\$\INS
 Data file = \$\$TEMP\$\$\DTA

Cost efficiency DEA

Scale assumption: VRS

EFFICIENCY SUMMARY:

firm	te	ae	ce
1	1.000	1.000	1.000
2	1.000	1.000	1.000
3	0.921	0.624	0.575
4	1.000	0.648	0.648
5	1.000	1.000	1.000
6	1.000	0.702	0.702
7	1.000	1.000	1.000
8	0.993	0.741	0.736
mean	0.989	0.839	0.833

Note: te = technical efficiency
 ae = allocative efficiency = ce/te
 ce = cost efficiency

SUMMARY OF COST MINIMISING INPUT QUANTITIES:

firm	input:	1	2	3
1		8235.000	11547.000	1076170.000
2		5887.000	5634.000	588115.000
3		6281.221	7247.011	684643.900
4		6455.432	10859.739	795498.607
5		3512.000	9723.000	331264.000
6		13097.263	19227.888	1752656.702
7		127734.000	217265.000	18942938.000
8		10854.422	14261.710	1336398.998

2003-04(COST-EFF-VRS)

APPENDIX-2:Results from DEAP Version 2.1(2003/2004)

Instruction file = \$\$TEMP\$\$\$.INS
 Data file = \$\$TEMP\$\$\$.DTA

Cost efficiency DEA

Scale assumption: VRS

EFFICIENCY SUMMARY:

firm	te	ae	ce
1	1.000	1.000	1.000
2	1.000	1.000	1.000
3	1.000	0.742	0.742
4	0.990	0.676	0.669
5	1.000	1.000	1.000
6	1.000	0.902	0.902
7	1.000	1.000	1.000
8	0.896	0.888	0.796
mean	0.986	0.901	0.889

Note: te = technical efficiency
 ae = allocative efficiency = ce/te
 ce = cost efficiency

SUMMARY OF COST MINIMISING INPUT QUANTITIES:

firm	input:	1	2	3
1		9765.000	16853.000	1275194.000
2		8475.000	6659.000	833320.000
3		10680.599	10473.444	1153076.653
4		7865.745	7826.153	702855.628
5		7087.000	9318.000	536097.000
6		20766.205	28048.507	2619482.565
7		164738.000	244144.000	22439000.000
8		14336.560	15567.267	1643767.653

APPENDIX-2:Results from DEAP Version 2.1(2004/2005)

Instruction file = \$\$TEMP\$\$\INS
 Data file = \$\$TEMP\$\$\DTA

Cost efficiency DEA

Scale assumption: VRS

EFFICIENCY SUMMARY:

firm	te	ae	ce
1	1.000	1.000	1.000
2	1.000	1.000	1.000
3	1.000	0.640	0.640
4	0.920	0.924	0.850
5	1.000	1.000	1.000
6	1.000	1.000	1.000
7	1.000	1.000	1.000
8	0.814	0.700	0.569
mean	0.967	0.908	0.882

Note: te = technical efficiency
 ae = allocative efficiency = ce/te
 ce = cost efficiency

SUMMARY OF COST MINIMISING INPUT QUANTITIES:

firm	input:	1	2	3
1		12864.000	30785.000	1627627.000
2		11544.000	10185.000	1224177.000
3		12846.601	30678.494	1623578.814
4		10213.620	14560.824	1010963.553
5		9587.000	10725.000	865168.000
6		28999.000	45792.000	2833007.000
7		185722.000	232702.000	25379000.000
8		15187.131	32945.720	1801178.628

2005-06(COST-EFF-VRS)

APPENDIX-2:Results from DEAP Version 2.1(2005/2006)

Instruction file = \$\$TEMP\$\$\$.INS
 Data file = \$\$TEMP\$\$\$.DTA

Cost Efficiency DEA

Scale assumption: VRS

EFFICIENCY SUMMARY:

firm	te	ae	ce
1	1.000	1.000	1.000
2	0.837	0.925	0.774
3	1.000	0.796	0.796
4	1.000	0.955	0.955
5	1.000	1.000	1.000
6	1.000	1.000	1.000
7	1.000	1.000	1.000
8	0.957	0.958	0.917
mean	0.974	0.954	0.930

Note: te = technical efficiency
 ae = allocative efficiency = ce/te
 ce = cost efficiency

SUMMARY OF COST MINIMISING INPUT QUANTITIES:

firm	input:	1	2	3
1		26104.000	36327.000	2176885.000
2		13043.000	13586.000	1292760.000
3		23644.193	27347.609	2764052.026
4		16595.432	18805.843	1715618.048
5		13043.000	13586.000	1292760.000
6		39918.000	60013.000	3691603.000
7		192137.000	228726.000	28149000.000
8		30575.919	42687.887	2994587.239

2006-07(COST-EFF-VRS

APPENDIX-2:Results from DEAP Version 2.1(2006/2007)

Instruction file = \$\$TEMP\$\$,INS
 Data file = \$\$TEMP\$\$,DTA

Cost efficiency DEA

Scale assumption: VRS

EFFICIENCY SUMMARY:

firm	te	ae	ce
1	1.000	1.000	1.000
2	0.919	0.936	0.860
3	1.000	0.770	0.770
4	1.000	1.000	1.000
5	1.000	0.933	0.933
6	1.000	0.936	0.936
7	1.000	1.000	1.000
8	0.889	0.708	0.629
mean	0.976	0.910	0.891

Note: te = technical efficiency
 ae = allocative efficiency = ce/te
 ce = cost efficiency

SUMMARY OF COST MINIMISING INPUT QUANTITIES:

firm	input:	1	2	3
1		31730.000	40639.000	2721328.000
2		21181.000	75349.000	1136354.000
3		29936.749	70957.801	2972479.423
4		21181.000	75349.000	1136354.000
5		21357.868	74767.040	1162928.226
6		48501.891	72811.295	7103701.512
7		150021.000	267548.000	33629909.000
8		32928.574	61215.382	3424166.804

RESULTS FROM MALMQUIST

APPENDIX-3: Results from the Output Oriented Malmquist DEA Model

Results from DEAP Version 2.1

Instruction file = \$\$TEMP\$\$\\$.INS
 Data file = \$\$TEMP\$\$\\$.DTA

Output orientated Malmquist DEA

DISTANCES SUMMARY

year = 1

firm no.	crs te rel to tech in yr *****			vrs te
	t-1	t	t+1	
1	0.000	1.000	0.857	1.000
2	0.000	1.000	1.097	1.000
3	0.000	0.834	0.734	0.898
4	0.000	1.000	0.978	1.000
5	0.000	0.887	0.883	1.000
6	0.000	0.780	0.724	1.000
7	0.000	1.000	1.112	1.000
8	0.000	0.811	0.862	0.994
mean	0.000	0.914	0.906	0.986

year = 2

firm no.	crs te rel to tech in yr *****			vrs te
	t-1	t	t+1	
1	1.323	1.000	1.289	1.000
2	1.259	1.000	1.089	1.000
3	1.158	1.000	1.133	1.000
4	0.909	0.838	0.893	0.982
5	0.762	0.707	0.745	1.000
6	0.832	0.787	0.793	1.000
7	0.722	0.798	0.720	1.000
8	0.698	0.741	0.715	0.919
mean	0.958	0.859	0.922	0.988

year = 3

firm no.	crs te rel to tech in yr *****			vrs te
	t-1	t	t+1	
1	1.232	1.000	1.428	1.000
2	1.060	1.000	1.545	1.000
3	1.093	1.000	0.954	1.000
4	1.016	0.903	0.956	0.933
5	1.128	1.000	1.143	1.000
6	0.774	0.843	0.907	1.000



RESULTS FROM MALMQUIST

7	0.901	0.835	0.816	1.000
8	0.714	0.753	0.740	0.887
mean	0.990	0.917	1.061	0.978

year = 4

firm no.	crs	te	rel to tech in yr	vrs te
	t-1	t	t+1	
1	1.120	1.000	1.010	1.000
2	0.686	0.718	0.649	0.735
3	1.125	1.000	1.105	1.000
4	1.435	1.000	1.049	1.000
5	0.903	1.000	1.039	1.000
6	0.967	1.000	0.992	1.000
7	1.060	1.000	0.935	1.000
8	0.965	0.926	0.895	0.968
mean	1.033	0.956	0.959	0.963

year = 5

firm no.	crs	te	rel to tech in yr	vrs te
	t-1	t	t+1	
1	1.056	1.000	0.000	1.000
2	0.599	0.556	0.000	0.660
3	1.117	1.000	0.000	1.000
4	1.400	1.000	0.000	1.000
5	0.987	0.974	0.000	1.000
6	1.019	0.982	0.000	1.000
7	1.608	1.000	0.000	1.000
8	0.764	0.790	0.000	0.918
mean	1.069	0.913	0.000	0.947

[Note that t-1 in year 1 and t+1 in the final year are not defined]

MALMQUIST INDEX SUMMARY

year = 2

firm	effch	techch	pech	sech	tfpch
1	1.000	1.242	1.000	1.000	1.242
2	1.000	1.071	1.000	1.000	1.071
3	1.199	1.147	1.114	1.076	1.375
4	0.838	1.053	0.982	0.853	0.882
5	0.797	1.041	1.000	0.797	0.829
6	1.008	1.067	1.000	1.008	1.076
7	0.798	0.902	1.000	0.798	0.720
8	0.914	0.941	0.925	0.989	0.861
mean	0.936	1.053	1.001	0.934	0.986

year = 3

firm	effch	techch	pech	sech	tfpch
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RESULTS FROM MALMQUIST

1	1.000	0.978	1.000	1.000	0.978
2	1.000	0.987	1.000	1.000	0.987
3	1.000	0.983	1.000	1.000	0.983
4	1.078	1.027	0.950	1.135	1.108
5	1.415	1.034	1.000	1.415	1.463
6	1.072	0.954	1.000	1.072	1.023
7	1.047	1.093	1.000	1.047	1.144
8	1.016	0.992	0.965	1.053	1.008
mean	1.072	1.005	0.989	1.083	1.077

year = 4

firm	effch	techch	pech	sech	tfpch
1	1.000	0.886	1.000	1.000	0.886
2	0.718	0.786	0.735	0.977	0.565
3	1.000	1.086	1.000	1.000	1.086
4	1.107	1.165	1.071	1.033	1.289
5	1.000	0.889	1.000	1.000	0.889
6	1.186	0.948	1.000	1.186	1.125
7	1.197	1.042	1.000	1.197	1.247
8	1.229	1.030	1.091	1.127	1.266

mean 1.042 0.972 0.981 1.062 1.013

year = 5

firm	effch	techch	pech	sech	tfpch
1	1.000	1.023	1.000	1.000	1.023
2	0.774	1.093	0.898	0.862	0.845
3	1.000	1.005	1.000	1.000	1.005
4	1.000	1.155	1.000	1.000	1.155
5	0.974	0.988	1.000	0.974	0.962
6	0.982	1.023	1.000	0.982	1.004
7	1.000	1.311	1.000	1.000	1.311
8	0.853	1.000	0.949	0.899	0.854

mean 0.944 1.070 0.980 0.963 1.010

MALMQUIST INDEX SUMMARY OF ANNUAL MEANS

year	effch	techch	pech	sech	tfpch
2	0.936	1.053	1.001	0.934	0.986
3	1.072	1.005	0.989	1.083	1.077
4	1.042	0.972	0.981	1.062	1.013
5	0.944	1.070	0.980	0.963	1.010
mean	0.997	1.024	0.988	1.009	1.021

MALMQUIST INDEX SUMMARY OF FIRM MEANS

firm	effch	techch	pech	sech	tfpch
1	1.000	1.024	1.000	1.000	1.024
2	0.863	0.976	0.901	0.958	0.843
3	1.046	1.053	1.027	1.018	1.102
4	1.000	1.098	1.000	1.000	1.098
5	1.023	0.986	1.000	1.023	1.009

	RESULTS FROM MALMQUIST				
6	1.059	0.997	1.000	1.059	1.056
7	1.000	1.077	1.000	1.000	1.077
8	0.994	0.990	0.980	1.013	0.984
mean	0.997	1.024	0.988	1.009	1.021

[Note that all Malmquist index averages are geometric means]

APPENDIX-4: Results from the Censored Tobit Model

1) TECHNICAL EFFICIENCY

Random-effects tobit regression	Number of obs = 40
Group variable (i): id	Number of groups = 8
Random effects u_i ~ Gaussian	Obs per group: min = 5
	avg = 5.0
	max = 5
Log likelihood = 66.589813	Wald chi2(9) =
	Prob > chi2 =

effscor	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
roa	.1833276	.1558447	1.18	0.239	-.1221224	.4887776
asset	-2.71e-11	1.59e-11	-1.71	0.088	-5.81e-11	4.03e-12
nbr	-.0056457	.0030919	-1.83	0.068	-.0117058	.0004143
gprof	-5.29e-10	2.90e-10	-1.83	0.068	-1.10e-09	3.89e-11
loans	9.90e-11	5.66e-11	1.75	0.080	-1.20e-11	2.10e-10
nmfis	-.0071204	.0076027	-0.94	0.349	-.0220215	.0077807
dep	4.38e-11	2.43e-11	1.80	0.072	-3.84e-12	9.15e-11
logroe	.0089502	.0236628	0.38	0.705	-.037428	.0553284
logloans	-.288825	.1344649	-2.15	0.032	-.5523713	-.0252787
logasset	.1416116	.1053026	1.34	0.179	-.0647777	.3480009
logcap	.0863984	.0632724	1.37	0.172	-.0376132	.21041
lognbr	.2138299	.1046014	2.04	0.041	.0088149	.418845
logdep	-.0470717	.0397034	-1.19	0.236	-.1248889	.0307456
_cons	2.825321	1.084623	2.60	0.009	.6994998	4.951142
/sigma_u	1.86e-20	.0081459	0.00	1.000	-.0159657	.0159657
/sigma_e	.0457903	.0051195	8.94	0.000	.0357562	.0558243
rho	1.64e-37	1.44e-19			0	1

Observation summary: 0 left-censored observations
 40 uncensored observations
 0 right-censored observations

2) ALLOCATIVE EFFICIENCY

Random-effects tobit regression
 Group variable (i): id

Number of obs = 40
 Number of groups = 8

Random effects u_i ~ Gaussian

Obs per group: min = 5
 avg = 5.0
 max = 5

Log likelihood = 36.827198

Wald chi2(13) =
 Prob > chi2 =

effscor	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
logroa	.5825237	.2905989	2.00	0.045	.0129602	1.152087
logloans	.6791105	.3455421	1.97	0.049	.0018604	1.356361
logasset	.1320668	.3645747	0.36	0.717	-.5824865	.84662
lognbr	-.539509	.2377057	-2.27	0.023	-1.005404	-.0736144
loggprof	-.6064238	.2695919	-2.25	0.024	-1.134814	-.0780334
loginfl	-.0902132	.1014377	-0.89	0.374	-.2890273	.108601
logm2gdp	-.1110082	.3110075	-0.36	0.721	-.7205716	.4985552
logdep	.0173136	.0861286	0.20	0.841	-.1514955	.1861226
roe	-2.996054	8.467734	-0.35	0.723	-19.59251	13.6004
roa	-.6297783	.9059614	-0.70	0.487	-2.40543	1.145873
cap	1.33e-09	4.33e-10	3.07	0.002	4.81e-10	2.18e-09
asset	-6.95e-11	4.13e-11	-1.68	0.093	-1.51e-10	1.15e-11
nbr	.013961	.0074053	1.89	0.059	-.000553	.0284751
gprof	2.95e-09	9.04e-10	3.26	0.001	1.17e-09	4.72e-09
loans	-4.08e-10	1.61e-10	-2.53	0.011	-7.24e-10	-9.25e-11
rgdp	2.66e-11	1.03e-11	2.58	0.010	6.43e-12	4.68e-11
nmfis	-.0877859	.0445821	-1.97	0.049	-.1751651	-.0004066
dep	-1.39e-11	5.23e-11	-0.27	0.790	-1.16e-10	8.86e-11
_cons	-3.249868	2.560411	-1.27	0.204	-8.268182	1.768446
/sigma_u	1.39e-19	.0163575	0.00	1.000	-.0320602	.0320602
/sigma_e	.0963644	.0107739	8.94	0.000	.075248	.1174808
rho	2.09e-36	4.90e-19			0	1

Observation summary: 0 left-censored observations
 40 uncensored observations
 0 right-censored observations



. 3) COST EFFICIENCY

Random-effects tobit regression
Group variable (i): id

Number of obs = 40
Number of groups = 8

Random effects u_i ~ Gaussian

Obs per group: min = 5
avg = 5.0
max = 5

Log likelihood = 26.024445

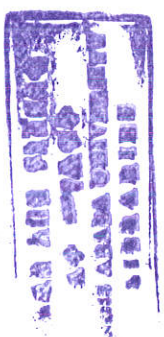
Wald chi2(7) =
Prob > chi2 =

effscor	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
roe	-10.68767	6.126015	-1.74	0.081	-22.69444	1.319097
roa	.5619329	.519897	1.08	0.280	-.4570466	1.580912
cap	9.26e-10	5.10e-10	1.81	0.070	-7.41e-11	1.93e-09
asset	-8.47e-11	4.01e-11	-2.11	0.035	-1.63e-10	-6.15e-12
nbr	.0018891	.0029748	0.64	0.525	-.0039415	.0077196
gprof	1.24e-09	7.46e-10	1.66	0.096	-2.21e-10	2.70e-09
loans	-1.30e-10	9.52e-11	-1.37	0.171	-3.17e-10	5.64e-11
rgdp	2.27e-11	1.32e-11	1.72	0.085	-3.10e-12	4.85e-11
infl	-1.235325	1.326713	-0.93	0.352	-3.835635	1.364985
m2gdp	-.0262001	.9863169	-0.03	0.979	-1.959346	1.906946
nmfis	-.0852079	.0573372	-1.49	0.137	-.1975867	.0271709
dep	3.82e-11	2.98e-11	1.29	0.199	-2.01e-11	9.66e-11
_cons	1.485427	.796085	1.87	0.062	-.0748712	3.045725

/sigma_u	3.11e-20	.0211263	0.00	1.000	-.0414068	.0414068
/sigma_e	.1262426	.0141144	8.94	0.000	.098579	.1539062

rho	6.08e-38	8.26e-20			0	1

Observation summary: 0 left-censored observations
 40 uncensored observations
 0 right-censored observations



4) SCALE EFFICIENCY

Random-effects tobit regression
Group variable (i): id

Number of obs = 40
Number of groups = 8

Random effects u_i ~ Gaussian

Obs per group: min = 5
avg = 5.0
max = 5

Log likelihood = 46.317635

Wald chi2(10) =
Prob > chi2 =

effscor	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
roe	-5.417175	5.956785	-0.91	0.363	-17.09226	6.257909
roa	.8768333	.6838842	1.28	0.200	-.4635551	2.217222
asset	-9.96e-12	2.67e-11	-0.37	0.709	-6.23e-11	4.24e-11
nbr	.0103197	.0052284	1.97	0.048	.0000722	.0205672
gprof	-8.27e-10	4.87e-10	-1.70	0.089	-1.78e-09	1.27e-10
loans	-4.60e-11	1.02e-10	-0.45	0.652	-2.46e-10	1.54e-10
nmfis	.0096276	.0126219	0.76	0.446	-.0151109	.0343661
depl	4.16e-12	4.06e-11	0.10	0.918	-7.54e-11	8.37e-11
logroe	-.0869526	.042768	-2.03	0.042	-.1707764	-.0031288
logloans	.4530745	.2358823	1.92	0.055	-.0092464	.9153953
logasset	-.3984635	.2888835	-1.38	0.168	-.9646647	.1677378
logcap	.0835845	.2238924	0.37	0.709	-.3552366	.5224055
lognbr	-.3581018	.1736504	-2.06	0.039	-.6984504	-.0177532
logdepl	.0132571	.0671227	0.20	0.843	-.118301	.1448151
_cons	-1.513689	1.951331	-0.78	0.438	-5.338228	2.310849
/sigma_u	2.04e-19	.0190913	0.00	1.000	-.0374183	.0374183
/sigma_e	.0760108	.0084983	8.94	0.000	.0593545	.0926671
rho	7.21e-36	1.35e-18			0	1

Observation summary: 0 left-censored observations
 40 uncensored observations
 0 right-censored observations



Declaration

I, the undersigned, declare that this is my original work and has not been presented for a degree in any other University, and that all source of materials used for the project have been duly acknowledged.

Declared by:

Name: Haftu Girmay

Signature: [Handwritten Signature]

Date: July 4, 2008



Confirmed by Advisor:

Name Mahmud M. Yesuf

Signature: [Handwritten Signature]

Date: July 08, 2008

Place and Date of Submission Economic Department July 4, 2008