EFFICIENCY IN THE BANKING SECTOR: AN EMPIRICAL INVESTIGATION OF COMMERCIAL BANKS IN KENYA

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

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ABBREVIATIONS AND ACRONYMS

ASCAs	Accumulating Savings and Credit Associations
ATMs	Automated Teller Machines
BCC	Banker, Charnes and Cooper
CBK	Central Bank Kenya
CCR	Charnes Cooper and Rhodes
CDs	Certificate of Deposit
CLT	Central Limit Theorem
CMA	Capital Market Authority
COLS	Corrected Ordinary Least Squares Method
CR4	Concentration Ratio 4
CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
DFA	Distribution Free Approach
DFIs	Development Finance Institutions
DMU	Decision Making Unit
DPF	Deposit Protection Fund
DPFB	Deposit Protection Fund Board
DRS	Decreasing Returns to Scale
ESAF	Enhanced Structural Adjustment Fund
FA	Frontier Approaches
FDH	Free Disposal Hull
FSAP	Financial Sector Adjustment Program
GDP	Gross Domestic Product
GMM	General Methods of Moments
HHI	Herfindall- Hirschman index
ICPAK	Institute of Certified Public Accountants
ICT	Information Communication Technology
IFRS	International Financial Reporting Standards
IMF	International Monetary Fund
IRTS	Increasing Returns To Scale
MOF	Ministry of Finance
M0	Base money
M1	Demand deposit + M0
M2	Time and Savings deposit + M1
M3	Foreign deposits + M2
MFIs	Microfinance Institutions
MPI	Malmquist Productivity Index
NBFIs	Non-Bank Financial Institutions
NDA	Net Domestic Assets
NPLs	Non - Performing Loans
NSE	Nairobi Stock Exchange
OLS	Ordinary least Squares
OMO	Open Market Operations

PFA	Production Frontier Analysis
PPF	Production Possibility Frontier
PPS	Production Possibility Set
PTech	Pure technical efficiency change
PWC	PriceWaterCoopers
REPO	Repurchase Agreement
ROSCAs	Rotating Savings and Credit Associations
RTS	Return to Scale
SACCOs	Savings and Credit Cooperative
SE	Scale Efficiency
Sech	Scale efficiency change
SFA	Stochastic Frontier Approach
TE	Technical Efficiency
Tech	Technology change
Teffch	Technical efficiency change
TFA	Thick Frontier Approach
TFP	Total Factor Productivity
Tfpch	Total factor productivity
TRWA	Total Risk Weighted Assets
VRS	Variable Returns to Scale
WAEMU	West Africa Economic Monetary Union

ABSTRACT

The main objective of the study is to investigate efficiency in the banking sector in the post liberalization period in Kenya. The study is in two major parts and addresses three main objectives. The first part measures efficiency scores and the productivity gains in the post liberalization period. The second part measures X-inefficiency and the factors determining X-inefficiencies in the banking sector in Kenya. Thus, three forms of efficiency are analyzed - technical, scale and managerial efficiency referred to as X-inefficiency in the study. The study is motivated by the fact that though the banking sector constitutes a large part of the financial system in Kenya, little is known about the efficiency status and factors that determine inefficiency. Further banks are awash with liquidity despite private sector credit demand indicating some inefficiency in the intermediation process in Kenya.

This study adopts a non-parametric Data Envelopment Analysis (DEA) and a parametric stochastic frontier approach to analyze measures of various aspects of efficiency in the banking sector. Malmquist Productivity Index (MPI) is used to measure productivity gains of banks in Kenya. Panel (fe) and GMM have been used to estimate the factors determining X-inefficiency in the banking sector. The study makes use of secondary annual financial data for ten years period. Input and output variables are defined to represent the intermediation role of banks.

The results show that although the banks were not fully efficient in all respects, they performed fairly well during the period under study. Banks still have reason and scope to improve performance by improving their technology, skills and enlarging their scale of operations so as to be fully efficient. Analysis of determinants of X-inefficiency shows that there was a positive relationship with variables such as profitability, asset quality, proxy for financial liberalization, capital adequacy, GDP, market structure and liquidity, whereas variables such as size and multibank holding company were negatively related to X-inefficiency. GDP shows weak significance in the models. Based on the main conclusions, the study recommends policies that will encourage competition, product diversification, risks minimization and proper supervision of banks.

CHAPTER ONE: INTRODUCTION

1.0 Introduction

The debate on finance and growth can be traced back to the days of Joseph Schumpeter. Schumpeter (1912) argued that banks play a pivotal role in economic development because they choose which firms get to use the society's savings. According to this view, the banking sector alters the path of economic progress by affecting the allocation of savings and not necessarily altering the savings rate. Thus, the Schumpeterian view of finance and development highlights the impact of banks on productivity growth and technological change.

On the other hand, vast development economics literature argues that capital accumulation is the key factor underlying economic growth (King and Levine, 1993). According to this view, better financial intermediaries influence growth primarily by raising domestic savings and attracting foreign capital. This view attributes cross-country differences in total factor productivity to differences in the level of the financial sector development. The study by King and Levine (1993) found a significant positive causal impact of financial development on real per capita growth and productivity growth.

According to McKinnon (1973), an efficient financial market is an important contributor to economic growth and development. Financial deepening (the growth of the share of financial assets in the economy) reflects an increasing use of financial intermediation by savers and investors and monetization of the economy. This allows an efficient flow of resources among people and institutions over time. Without development of the financial sector, productive enterprises are limited to self financing. Levine *et al* (1999) confirm that financial intermediary development exerts a statistically significant and economically large impact on economic growth.

Banks are the main financial intermediaries in Kenya, providing funds to the private sector as well as the government. This is particularly true in economies where equity markets are not well developed (Caner and Kontrorovich, 2004) like Kenya. Efficient functioning of the banking system can provide significant contributions to lowering the cost of capital, leading to sustained economic growth and development. In order for bank intermediation to be effective in economic growth, such intermediation should be done in an efficient manner. Therefore, a banking system that is functioning efficiently is essential for sustained economic growth.

Efficiency of the banking sector is affected by many factors, among them being ownership, size, technology and managerial ability. Cross-country comparisons have shown the benefits of foreign bank ownership for developing countries. In addition to investment in the capitalization of financial institutions, foreign banks usually bring with them better know-how and technical capacity, which then spills over to the rest of the banking system. Foreign banks impose competitive pressure on domestic banks, thus increasing efficiency of financial intermediation. They provide more stability to the financial system, being able to draw on liquidity resources of their parent banks (Claessens and Jansen, 2000).

Kenya's financial sector has undergone reforms over the last two decades.[1] In response to the reforms, the financial services sector in Kenya has undergone substantial changes, which may have impacted on efficiency, and productivity change,[2] and competition and market structure of the banking sector. The main driving forces behind these changes may be attributed to financial deregulation, development in information and communication technologies and the globalization of the financial services industry in general. The consequent changes are observable in areas such as the scope of banking operations, number of banks

[1] Reforms are discussed in the next chapter and a detailed analysis of the reforms given in the appendix.

[2] Productivity is defined as a ratio of output to input in a given production situation. However, efficiency relates the input and output in a given decision making unit with the best practice in the industry.

and bank branches, technologies used and quality of human resources in the banking industry. These changes might ultimately be reflected in efficiency and productivity gains.

Although there is a growing body of literature that focuses on efficiency and productivity gains, market structure and the performance of banking industries in other countries (see Casu and Molyneux, 2003; Chakrabarti and Chawla, 2005; Girardone *et al.*, 2004; Hondroyiannis *et al.*, 1999; Maudos and Pastor 2002), no major study has been conducted in Kenya. The combination of improvements and unfulfilled potential warrants a new look at the Kenyan banking sector.

Further, Kenya needs to go back to her fast growth path. The success in achieving broad-based economic growth will depend largely on the ability to efficiently utilize the available resources. As a developing country, Kenya has immense potential for better economic growth in both the short and long-run than it is currently recording. There is need for efficient allocation of productive resources in order to narrow the gap between the actual and potential national output. Given the strategic role that Kenya's financial sector plays, effort should be directed towards monitoring and formulation of policies that will enhance efficiency in allocating resources to different sectors of the economy.

1.1 Problem Statement

The efficiency and development of the financial system is instrumental in fostering investment and economic growth. An inefficient and weak banking sector limits the efficient collection and allocation of resources and subsequently causes waste in those sectors.

A well-functioning banking system facilitates economic growth and financial deepening through intermediation of finances in the economy. However, the

system's contribution to the economy depends on the quality and quantity of services provided and the efficiency with which it provides them. Thus, an efficient banking system reflects a sound intermediation process, and hence its contribution to economic growth. An inefficient banking system restricts efficient allocation of resources, and macroeconomic policy through monetary transmission is likely to be ineffective.

In the past three decades, several developed and developing countries have moved towards liberalization of their financial sectors. According to Demirguc-Kunt and Detragiache (1998), a principal objective of financial services deregulation is to improve market efficiency and enhance consumer choice through increased competition. Some countries eased or lifted bank interest rate ceilings, lowered compulsory reserve requirements and removed entry barriers, reduced government interference in credit allocation decisions, and privatized many banks and insurance companies all in an effort to liberalize the financial sector.

A lot of importance is attached to a proper functioning financial system for the economy in general. Specifically, the financial system's role in allocating resources to productive sectors of the economy, its function as an engine of the payments system, and also the role it plays in promoting long-term growth are the major factors motivating research in efficiency of its productive structure. Research in the recent past has focused on the evolving trends in the financial sectors of different countries as they adopt new policies to enhance stability, efficiency, and improve performance.

Demirguc-Kunt and Detragiache (1998) point out that experience from financial reform and internationalization in developed countries has shown that as financial intermediaries face stiffer competition from domestic competitors and new entrants, they learn to exploit economies of scale and scope; they reduce managerial inefficiency and make better use of advanced technology. Savers and investors

earn higher rates of return, and they have more saving instruments to choose from and more opportunities to diversify risk, as well as easier access to financial products. Those seeking funds benefit from better risk appraisal, reduced waiting time, a wider range of lending instruments, a wider range of maturities, and expanded access to funds.

Beck and Fuchs (2004) observe that although Kenya's financial system is relatively well developed and diversified (by regional standards), major structural impediments prevent it from reaching its full potential. They point out that the financial sector is characterized by high interest rate spreads that have led to lower levels of credit to the private sector, hence slowing down economic growth. They argue that high interest spreads and margins, and limited depth and breadth of financial services are the result of underlying deficiencies and impediments in the financial systems. In order to increase access to financial services and reduce spreads and margins, these underlying causes have to be addressed (Beck and Fuchs, 2004; Mitchell, 2001).

In an effort to make the financial system efficient, Kenya undertook a comprehensive financial sector adjustment programme, which was launched in early 1989. This programme included policy and institutional reforms intended to develop a more efficient and market-oriented financial system. In particular, reforms aimed to increase the efficiency of financial intermediation; remove distortions in the mobilization and allocation of financial savings; and develop more flexible monetary policy instruments. Banks dominate the financial sector in Kenya, thus the process of financial intermediation in the country depends heavily on commercial banks. What is questionable, however, is the extent to which commercial banks in Kenya are efficient. Has efficiency been accompanied by improved technology, leading to increased productivity? If efficiency has been improved, what are the factors contributing to this? Are cost curves downward sloping? Have scale economies been increasing as average bank size has

increased in the economy? These are interesting research as well as policy questions.

Efficiency studies will provide answers to some of these questions. The size of banks has also become an important issue. Because of deregulation in the banking industry, there is a trend for banks to merge with others and become larger in size in order to meet the capital requirements. These trends leave questions on the ability of banks to survive. Is it necessary that banks should be big to achieve scale economies? If economies of scale exist, is there any survival value of small banks?

Although the primary goal of deregulation and liberalization in emerging economies has been to improve bank efficiency, earlier results have been mixed. In particular, short-term effects have been discouraging (Maghyereh, 2004). The financial repression theory predicts significant gains in efficiency in the intermediation process, such that the interest rate spread between the lending and deposit rates narrows after liberalization. Recent studies on the interest rate spread in Kenya and Malawi established that the interest rate spread widened after liberalization, reflecting negatively on efficiency of commercial banks in these countries (Ngugi and Kabubo, 1998; Ndung'u and Ngugi, 2000; Beck and Fuchs, 2004; Chirwa and Mlachila, 2004).

Past studies in the Kenyan banking sector have concentrated on capital adequacy, interest rate, exchange rate, inflation and reserves (Kamau *et al*, 2004; Ngugi, 2004; Ndung'u 1993); none has attempted to measure the efficiency and productivity. Thus, this study contributes in these fronts of banking literature. It is expected that when financial institutions operate more efficiently, their profitability improves and greater amount of funds is intermediated. Consequently, the consumer may expect better prices and service quality, and greater security and soundness of financial systems (Berger *et al.*, 1993). Therefore, the economy and its people as a whole benefit from an efficient banking system.

Thus, understanding the status of banks' efficiency is useful in providing insights as to effective use of resources versus resource wastage (inefficiency) in the banking system and its impact on the economy as a whole. As noted earlier, efficiency is crucial in contemporary public policy and in a country's economic development. Empirical analysis of efficiency is a vital requirement for further policy changes.

Accordingly, a study in this area is important in the following aspects. First, improvements in efficiency in financial institutions are a vital requirement for providing a more efficient system of asset allocation in the financial services sector. Since Kenya has a bank-led financial services sector, efficiency in the banking industry is more important for providing supportive financial infrastructure for economic development. Second, improvements in efficiency may reduce the cost of intermediation, which directly affects the intermediation margins in the market.

The study recognizes that, according to existing literature, bank productivity and efficiency are greatly influenced by market structure that is, the competitive conditions in the banking market (see for example Kasekende *et al.*, 2009). However, the study focuses on bank productivity and bank efficiency only modeling market structure as one of the determinants of efficiency in the banking system. The simultaneous modeling of bank productivity, bank efficiency and bank competition will be explored in further research.

1.2 Objectives of the Study

This study seeks to establish the efficiency of the Kenyan banking sector, and identify factors that make banks efficient or inefficient in the post-liberalization period. This will be achieved by:

(i) Measuring efficiency scores for technical and scale efficiency for Kenyan banks;

(ii) Measuring X-inefficiency (Managerial inefficiency) in the banking industry and;

(iii) Analyzing the factors that drive X-inefficiency.

1.3 Hypotheses to be tested

The major hypotheses of the study include:

(i) The technical and scale efficiency of the Kenyan banking sector rose in the period under study.

(ii) The X-inefficiency levels of commercial banks in Kenya decreased gradually following liberalization.

(iii) Kenya's banking industry X-inefficiency is negatively affected by variables such as capital adequacy, labour compensation, asset quality and bank size.

1.4 Relevance of the Study

This study proposes to make significant contributions on at least three fronts. First, this will be the first micro study to investigate the efficiency of the banking sector in Kenya. Despite the significance of the banking sector towards economic development, no study has been carried out to establish the efficiency with which the banking sector is operating. Second, the period chosen is a product or a result of past major financial sector reforms and policy changes that have affected the banking system and the financial system in general.

Third, the study addresses the performance of commercial banks in terms of their effectiveness in converting inputs into expected banks' output and in facilitating the transmission of monetary policy. Consequently, it provides important implications to bank stakeholders, including investors, depositors, practitioners and policy makers. Further, important information is provided for future formulation of

prudential regulation guidelines by the Central Bank of Kenya which is the main regulator. Finally, a study of this kind is particularly relevant for the Kenyan economy given the high costs of intermediation and high degree of concentration in its banking market despite the financial sector reforms. The study adds to the banking literature available and also prompts intellectual pursuit of further research on banks in Kenya.

1.5 Methodology

The study makes use of a non-parametric model to empirically analyze bank efficiency in Kenya. Data Envelopment Analysis is used to measure the overall technical efficiency of banks. This model establishes the efficiency status of the various types of banks operating in Kenya. Efficiency will be broken down into technical efficiency and scale efficiency. An analysis will thus be made as to which banks are efficient and which ones are not, under both constant and variable returns to scale.

For informed policy making, it is not enough to establish the overall banks efficiency scores, but to also establish the managerial input into making the banking system efficient or not. Subsequently, the multi-product translog cost function is applied to specifically measure X-inefficiency in the banking firms and then analysis of factors that drive X-inefficiency. Studies of banks efficiency recently have concentrated on X-inefficiency, which investigates deviations from cost efficient frontier attributed to the fact that people and organizations work neither as hard nor as effectively as they could (Liebenstein, 1966). It is in the interest of this study to find out whether management of Kenyan banks helps minimize costs and maximize banks' outputs.

Finally, to unearth factors that drive X-inefficiency in banks, a panel model is used for regression of inefficiency index against hypothesized factors. This is an attempt

to answering the question why banks in Kenya may be inefficient and, thus, the model estimates the possible inefficiency determinants. In the panel model, liquidity is one of the regressors and the objective behind this formulation is to investigate the link between liquidity and inefficiency in the banking firms, as well as the other variables included both micro and macro.

1.6 Data

The study makes use of annual bank data for 40 banks for the 10 years during the period under study (1997-2006). The data has been gathered from the Central Bank of Kenya Statistical Bulletin and Bank Supervision Annual Reports as well as Banking Survey (Oloo, 2007). The choice of the data series to begin in 1997 was dependent on data availability. Central Bank of Kenya began receiving returns from commercial banks in 1996 and that is when CBK started keeping records of the balance sheet and profit and loss account returns for all commercial banks. Prior to this date, CBK only computed the global banking balance sheet and profit and loss returns. This study requires that data from each individual bank be obtained but, for data reasons, the study limits itself to post-liberalization period.

1.7 Organization of the Study

This thesis contains seven chapters, of which two chapters are empirical by design. The first chapter presents an introduction to the study and provides the background, problem statement, objectives, hypotheses, methodology and study outline.

Chapter Two highlights the operational environment of the banking industry in Kenya during the pre and post-deregulation period. The issues highlighted in this chapter are used to explain the trends in estimated efficiency scores in Chapter Five. This chapter consists of six sections in which the banking sector background

in Kenya is analyzed. The first section provides an introduction on the role of banks as an intermediary. The second section describes the regulation, historical background and operational environment of banks in Kenya. Section three evaluates the reforms that have taken place in the financial sector since 1970 and their impact in the banking sector. Section four describes the bank performance indicators. Section five describes the bank's balance sheet, income and expenditure and section six gives a summary of the chapter.

Chapter Three reviews literature on efficiency and productivity change and their application in the banking industry. The aim of this particular chapter is to form a theoretical framework for assessment of efficiency and productivity change of the banking industry in Kenya. Findings in this chapter have been used to formulate the analytical framework for Chapter Five.

Chapters Four describes the methodology that has been used in this study. The methodology and analytical framework followed has been chosen based on the literature survey done in Chapter Three. The study proposes to use the Data Envelopment Analysis (DEA) methodology to estimate efficiency scores in the banking sector and compute the Malmquist productivity indices to get the productivity gains in the period 2000-2007. The study further estimates the translog cost function in order to predict managerial efficiency or inefficiency existing in the banking sector. The study further uses panel estimation to get the impact of the other macroeconomic and microeconomic factors on banks' X inefficiency.

Chapter Five and Six present the findings from the estimation of equations derived in Chapter Four. Chapter Seven concludes the study by providing major findings, policy implications and limitations of the study.

CHAPTER TWO: BACKGROUND TO BANKING SECTOR IN KENYA

2.0 Overview of Kenya's Banking Industry

This chapter consists of six sections, through which background of the banking sector in Kenya is analyzed. The first section lays an introduction on the role of banks as an intermediary. The second section describes the regulation, historical background and operational environment of banks in Kenya. Section three evaluates the reforms that have taken place in the financial sector since 1970 and their impact in the banking sector. Section four describes the bank performance indicators. Section five describes the bank's balance sheet, income and expenditure and section six gives a summary of the chapter.

Financial markets involve an inter-temporal exchange of monetary resources: that is, exchange of money today for the promise of money on the same day or tomorrow. For this reason, financial markets are very fragile, for any lack of information about the counterparty or any uncertainty about the value of money tomorrow, or lack of monitoring and enforcement tools can affect the efficiency of this exchange and, thus, the efficiency of financial markets. Thus, the existence of regulatory bodies play an important role in reducing the discords that exist in the financial markets, thus making them work more efficiently. Transparency is another key element, where accounting, disclosure standards, and market discipline reduce information and monitoring costs for both borrowers and banks, thus enhancing efficiency in the financial market.

When an economy has well developed financial institutions and markets, economic growth is enhanced through improved allocation of society's scarce resources rather than through faster capital accumulation or increased savings (Beck *et a.l*, 2000). Banks play a crucial role as financial intermediaries. Effective financial intermediation allocates savings best among competing firms for funds. Competitive financial intermediation not only benefits savers but also allows capital

to flow to uses that provide the maximum value. Savings and investments are connected through security market intermediation, finance corporations, institutional investors such as insurance companies, pension funds and mutual funds, as well as bank intermediation.

In an Arrow-Debreu "complete markets" world, financing of firms, governments and households occurs via financial markets that have no transaction costs, there is full set of contingent markets/claims and there is no credit rationing. Within this framework, there is no need for intermediaries. Further, Modigliani-Miller (1958) argues that in this perfect world, financial structure is irrelevant as households can construct portfolios offsetting actions of intermediaries. Thus, intermediaries cannot add value and as a result, markets are not strong-form efficient. In reality, markets are imperfect and they incur transaction and information acquisition costs. Thus, intermediaries exist as a result of market failure. Financial intermediaries thus become relevant in the imperfect market. Banks assist market efficiency by gathering information about firms, households and allocate credit to various borrowers in the economy through contractual arrangements. Such an arrangement ensures that savers' funds are safe and investors have funds to invest and get returns (Mugume, 2006).

Securities market intermediation, at its best form, is more efficient than bank intermediation since there is no permanent middleman between the owners and the users of funds. However, banks dominate financial intermediation in all emerging financial markets, including the Kenyan market (Caner and Kontrorovich, 2004).

2.1 Commercial Banking History in Kenya

2.1.1 Legal framework of banking in Kenya

The banking industry in Kenya is governed by the Companies Act (Cap 486), the Banking Act (Cap 488), the Central Bank Act (Cap 491)[3] and other Central Bank of Kenya (CBK) prudential guidelines. The Central Bank of Kenya and the Capital Markets Authority (Cap 485A) are the main regulators of commercial banks in Kenya. The CBK is the regulating and supervising agency and the manager of monetary policy operations in Kenya. Like other central banks in the world, the principal objects of CBK are laid in the Cap 491 subsection [4] as being: (1) to formulate and implement monetary policy directed to achieving and maintaining stability in the general level of prices; (2) to foster the liquidity, solvency and proper functioning of a stable market- based financial system; and (3) Subject to subsections (1) and (2), the Bank shall support the economic policy of the Government, including its objectives for growth and employment.

In addition, one of the secondary objectives of the CBK is to license and supervise authorized dealers in the money market. The Bank also promotes a sound and stable banking system in Kenya by enforcing the requirements of the Banking Act and prudential regulations. The Bank also ensures efficiency in the banking operations and encourages high standards of customer service. The CBK also works closely with the Institute of Certified Public Accountants of Kenya (ICPAK) to ensure that the banking sector leads the other sectors in implementation of International Financial Reporting Standards (IFRS).

2.1.2 Commercial banking before independence, 1963

Commercial banking took root at the turn of the 20th century with the partitioning of Africa by European imperial powers. Leading the way into the region was the National Bank of India, which later became National and Grindlays Bank. This was

[3] These are chapters in the Laws of Kenya.

partly bought by the Kenya government to form the Kenya Commercial Bank. The remainder, which subsequently became Stanbic, opened an office in Mombasa in 1869. The Standard Bank of South Africa followed in 1910 and National Bank of South Africa in 1916. The National Bank of South Africa merged with the Colonial Bank and Anglo-Egyptian Bank Limited to form Barclays Bank (Dominion, Colonial and Overseas) in 1926. Two of the three early commercial banks were branches of British commercial banks established in London. Except for one bank - the Exchange Bank of India, registered in 1928 and operated with interruptions until 1949 - the three commercial banks dominated banking for over half a century before another set of banks entered the Kenyan banking system.

ABN-AMRO opened a branch in 1951. Two other Indian banks, the Bank of India and Bank of Baroda, entered the scene in 1953 followed by Habib Bank from Pakistan in 1956. A Turkish bank, the Ottoman Bank opened a branch in 1958. The Commercial Bank of Africa opened its branches in 1962. African Banking Corporation, a subsidiary of Standard Bank, was licensed in 1963 but never became operational.

Before the establishment of the three central banks in Kenya, Uganda and Tanzania, the East African Currency Board performed traditional central banking functions in the region. For over two decades of their presence in the region, commercial banks operated without any central bank authority. Although monetary conditions varied and affected economic activities during that time, no attempts were made to influence them.

2.1.3 Post-independence commercial banking, 1963-1995

At independence, the Government strongly felt that commercial banks and other financial institutions were not addressing the country's development needs. The Government perceived the foreign-owned commercial banks as being biased

against African farmers and businessmen, and had to intervene to remedy the situation. On 19th June 1965, the first locally-owned commercial bank, the Cooperative Bank of Kenya, was registered under the Cooperative Societies Act,[4] but licensed under the Banking Act. It began operating on 10th January, 1968.

The National Bank of Kenya, the second locally-owned bank, was established on 19th June 1968 and began operating on 30th September 1968. It took over some of the businesses of the Ottoman Bank, leaving the rest to Grindlays Bank. The operations of the National Bank of Kenya, in line with Government desires and influence, were biased towards the public sector and the cooperative movement. Grindlays Bank was operating as a retail commercial bank until 7th December 1971 when the Government acquired 40 per cent of its shares to form the Kenya Commercial Bank. Unlike the National Bank of Kenya, Kenya Commercial Bank operated more on commercial basis. Its lending and extension of network was not, however, purely commercial. A new bank, the National and Grindlays Bank International (K) Ltd, presently Stanbic Bank, assumed the merchant-banking arm of Grindlays Bank.

The Central Bank of Kenya was formed in the post-independence banking era. In May 1966, Central Bank of Kenya was established by an Act of Parliament. Its main function was to undertake national monetary control aimed at efficient operations of the monetary system. It was further entrusted with ensuring growth and stability of the financial sector in order to stimulate growth in other sectors of the economy and achieve a high economic growth rate.

The banking and financial industry was highly controlled in the period following independence in the 1960s. During the 1970s and 1980s, the financial system experienced rapid growth and diversification. This was as a result of the

[4] Until August 2008, the Cooperative Bank was under the Cooperative Societies Act. But it has since converted into a limited company and is now under the Companies Act.

government policy to encourage local participation in the financial system. The number of commercial banks increased to 15 in 1980 and by 1985, there were 23 commercial banks. Rapid expansion was also witnessed among the non-bank Financial Institutions (NBFIs). Growth of the NBFIs was facilitated by the Banking Act 1968, which eased entry and minimum capital requirements.

However, during the same period in the 1980s, the banking sector experienced crisis. Many indigenous banking institutions folded up, taking with them hundreds of millions of shillings in depositors' money. The collapse of various institutions was mainly due to various factors, principally corporate governance failures and a weak legal and regulatory framework. The early 1990s saw the collapse of more banks in Kenya. The collapse was attributed to poor management of credit risks (Oloo, 2007).

Following the banking crisis in the 1980s, a Deposit Protection Fund (DPF) was established to stabilize the banking industry. The DPF acted as a mechanism for liquidating the assets and paying off the liabilities of collapsed banks and financial institutions. Thus, its main activities were to manage the deposit insurance scheme, maintain confidence in the financial system and carry out the liquidation of insolvent institutions by repaying protected deposits and dividends, debt recovery, and winding up the institutions under liquidation.

The Government further sought to strengthen the legal and technical capacity of the Central Bank to carry out its regulatory and supervisory functions. The revised Banking Act of 1989 enhanced the role of Central Bank in the inspection of institutions, establishment of reports, auditing and provisioning requirements, capital adequacy requirement and exposure units, and assessment of penalties against non-compliant institutions. With the 1991 amendment of bank laws, Central Bank imposed stringent licensing requirements on banks and NBFIs, increased

required minimum capital requirements, and tightened control on the use of government overdraft facilities offered by the Central Bank.

Further amendments were made to the Central Bank Act of 27 October 1995. The amendments enhanced the ability of the bank to supervise the industry more effectively, protect small depositors, and foster financial prudence and discipline in the management of banking institutions. The amendments allowed locally incorporated financial institutions to expand branch networks outside Kenya, reduced credit to a single borrower to 25% of capital; harmonized the calendar year for all financial years of the various institutions; reduced the period within which to publish audited accounts to three months from six months; and granted Central Bank powers to approve external auditors.

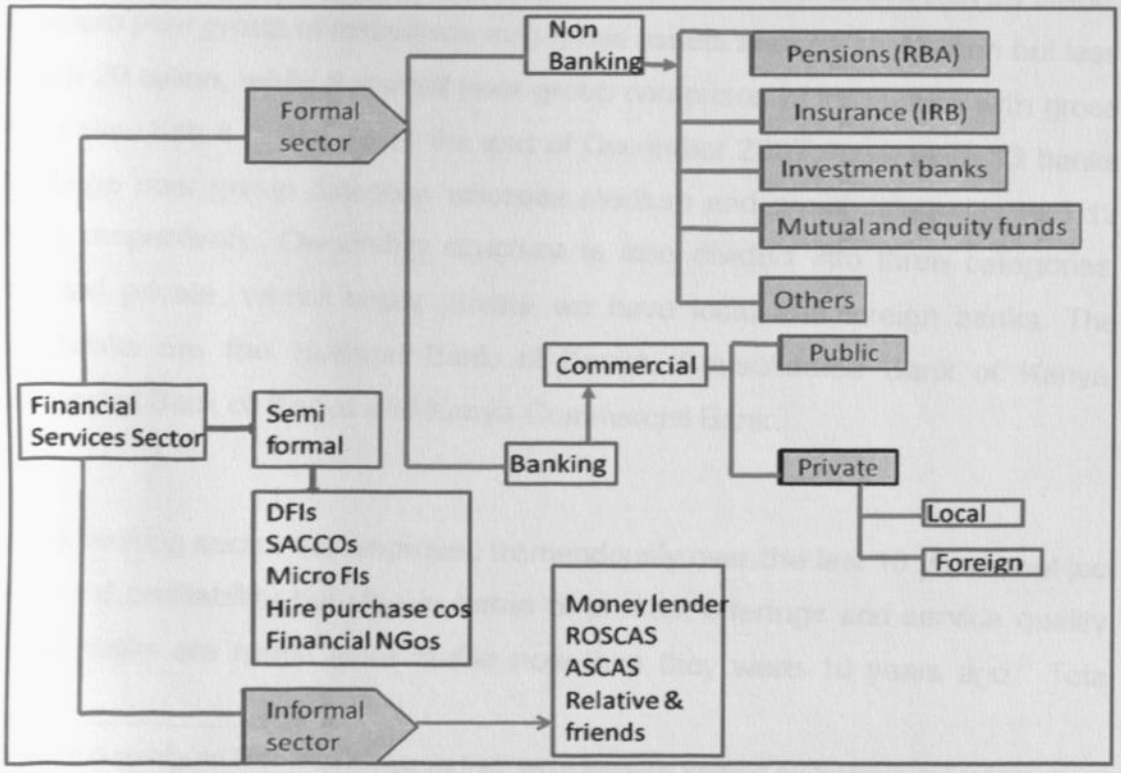
After liberalization of the banking sector and lifting of foreign exchange controls in 1993, the non-bank financial institutions have been able to compete with commercial banks, particularly because of the less restrictive regulatory framework within which they operate. On paper, NBFIs operate as merchant or investment banks. In practice, they operate as commercial banks, taking deposits and making short-term loans. In June 1994, the Central Bank instructed NBFIs to convert and operate as commercial banks. So far, 18 NBFIs have become banks and 7 have merged with parent commercial banks. In 1995, further amendments of the Banking Act were made, aimed at further strengthening supervision of the banking industry. Prudential guidelines were revised to encourage self regulation, covered codes of conduct for directors and other staff.

Kenya, already a regional leader, has one of the largest commercial banking industries in Africa. Despite the existence of a relatively developed and sophisticated financial system, Kenya's capital market is still in its infancy.

2.1.4 Banking in 1996-2007

The banking sector is the largest component of the financial sector and is the main focus of this study. The financial sector in Kenya is diversified and is divided into formal, semi-formal and informal financial services. The formal financial services include the banking and the non-bank financial institutions. The semi-formal component includes deposit-taking institutions that serve specific purposes, for example, savings or credit facilities for members only, while the informal financial sector includes money lenders and the rotating SACCOs (see organization chart 2.1 below). The Central Bank of Kenya is the main regulator of commercial banks. Commercial banks play a key role in financing credit to the private sector, particularly trade, tourism, large scale manufacturing and agriculture; NBFIs; domestic trade, small services, and real estate; building societies; housing and construction; and DFIs; long-term lending.

Chart 2.1: Organization chart of financial sector in Kenya



Source Author's analysis

Despite the expansion of the NBFI sector in the early 1980s, some were later converted to commercial banks; thus commercial banks still dominate the financial system.[5] Over the years, the commercial banking sub-sector has grown into a more complex scene of banking institutions of different types and ownership. According to statistics by the CBK, by the end of the year 2007, there were 43 commercial banks of which 4 were public financial institutions (National Bank of Kenya, Consolidated Bank of Kenya, Development Bank of Kenya, and Kenya Commercial Bank). Of the 40 commercial banks, 9 were foreign-owned and 31 were local-owned. The country had two (2) mortgage finance institutions, one (1) building society (CBK Supervision Annual Report 2007). The commercial banks and non-bank financial institutions offer corporate and retail banking services, but a small number of them offer other services, which include investment banking.

Banks in Kenya are classified into 3 categories, namely: large, medium and small. The large peer group consists of institutions with gross assets above Ksh 20 billion, the medium peer group of institutions with gross assets above Ksh 4 billion but less than Ksh 20 billion, while the small peer group comprises of institutions with gross assets below Ksh 4 billion. As at the end of December 2007, there were 13 banks in the large peer group category, whereas medium and small categories had 12 and 15, respectively. Ownership structure is also divided into three categories: public and private, where under private we have local and foreign banks. The public banks are the National Bank of Kenya, Consolidated Bank of Kenya, Development Bank of Kenya and Kenya Commercial Bank.

Kenya's banking sector has improved tremendously over the last 10 years, not just in size and profitability but also in terms of product offerings and service quality. Kenyan banks are much more stable now than they were 10 years ago.[6] Total

[5] There are currently no NBFIs in Kenya as they were formerly defined by Banking Act (1968).
[6] In the last ten years, only two institutitions have been put under CBK statutory management (Prudential Bank, and Charter House Bank). The 1980s and 1990s saw over 5 banks fail and some put under statutory management.

assets in the sector have grown from Ksh 328 billion in 1997 to Ksh 746 billion in 2006, a 132% increase in nominal terms. Similarly, profitability has grown from Ksh 15 billion in 1997 to Ksh 27 billion in 2006. Some micro finance institutions such as K-Rep Bank and Equity Bank have emerged, targeting the small traders and the rural small-scale farmers. Equity Bank, which converted to a commercial bank in 2004, now has over 2 million customers as at January 2008, more than 35% of the entire industry.

2.1.5 Stylized facts on recent developments in the banking sector

The stylized facts below serve to inform on the current environment in which Kenyan banks are operating in, and the situation under which they are being analyzed. A 2007 Pan-African banking survey by PriceWaterhouseCoopers and CBK Supervision Report reveals the following facts about Kenyan banks:

- There has been a shift of focus on the consumer with the introduction of some new retail products. There has been major expansion of lending to individuals in employment through mortgages and consumer loans.
- There has been an aggressive expansion into the retail banking sector by several banks not previously active, such as Kenya Commercial Bank (KCB), Cooperative Bank and Equity Bank. Banks are expanding their branch networks to capture lower cost retail deposits.
- Several banks (including foreign banks) are looking favorably at public sector lending because of recent improvements in the level of governance. The establishment of commercial courts over the last three years has improved the lending environment and reduced the time taken to resolve cases of default.
- There is a concentration of banks in urban areas, and rural areas were under-served. Banks have not attempted to mobilize the unbanked market majority. There has been a reluctance to lend to SMEs (small and medium-sized enterprises), although some banks such as Equity and KCB are breaking this trend.
- Industry fragmentations exist, whereby banks have not in the past worked together and have not been fully open with each other. There has been an over-emphasis on the use of collateral. Historically, banks have placed a major emphasis on physical security. On the corporate side, banks have often overlooked cash flows and the viability of projects. This is changing with a growth in unsecured lending.

- Banks have not provided transparent pricing. Comparisons have been difficult to make and banks have often adopted a homogeneous approach. It is also noted that the top ten banks compete for over 80% of the market, while the remaining group share 20% of the market. The market sectors that are highly competitive to the banking sector include: first, the corporate and retail sectors, which experience cut throat competition; and second, merchant and investment banking. The market sectors that are least competitive include internet banking, home loans and vehicle financing.

- Adopting of Basle Accord II[7] is yet to be implemented in Kenya. This will be done after the successful implementation of Basel I: Risk-based supervision. This will require considerable financial and human resources to put in place the requisite infrastructure for the implementation of the Accord. Results expected in the banking sector include a more stable banking sector as the Accord is founded on risk management.

- Islamic banking is quickly taking root in the Kenyan market. Some banks have launched strictly Islamic products and this is likely to increase competition in the banking sector. Although Islamic banks are specialized in their own way of doing business, they are likely to be a source of competition in the banking sector. The Islamic banking solutions, first introduced in December 2005, took the form of deposit products tailored in line with *Sharia* principles. Four banks – Barclays Bank of Kenya, Kenya Commercial Bank, K-Rep Bank and Dubai Bank have so far introduced Islamic banking products in the market. Competition is likely to increase with the planned entry of fully-fledged Islamic banks after the Minister of Finance opened a window for *Sharia*-compliant products in his budget speech for the 2006/2007 financial year. Promoters of Islamic banks, who have already expressed interest, are encouraged that Africa is an attractive emerging market for Islamic finance, with Kenya positioned as the gateway to East and Central Africa.

- The banking sector has witnessed re-packaging of banking and financial services to satisfy the ever changing needs of customers. This has resulted in the rapid growth of consumer banking products. More banks are increasingly offering new banking products such as unsecured personal loans, auto loans, unsecured professional loans, Safari savings accounts, Jumbo junior accounts and SME business model accounts. An increased number of institutions are offering e-banking and services for non-residents. The future portends

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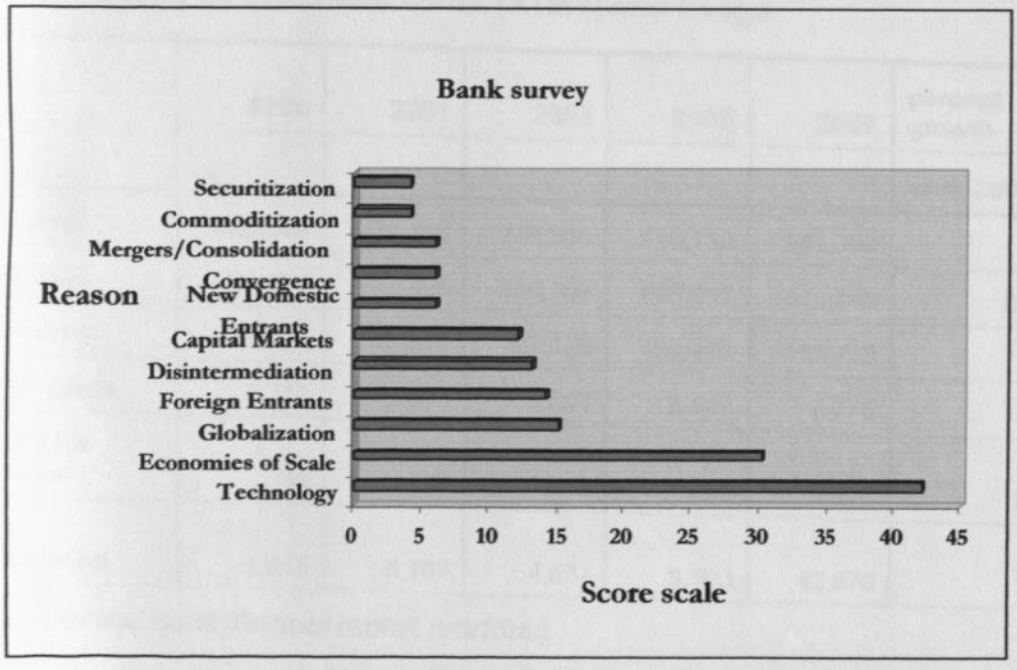
[7] Basel II is the second of the Basel Accords, which are recommendations on banking laws and regulations issued by the Basel Committee on Banking Supervision. Basel II attempts to accomplish this by setting up rigorous risk and capital management requirements designed to ensure that a bank holds capital reserves appropriate to the risk the bank exposes itself to through its lending and investment practices. Generally speaking, these rules mean that the greater risk to which the bank is exposed, the greater the amount of capital the bank needs to hold to safeguard its solvency and overall economic stability.

intensified competition in the financial sector, arising from the introduction of Islamic banking products. Financial institutions will, therefore, be expected to redefine their business strategies while leveraging on innovative and affordable products so as to capture new market segments (Extract from the Kenyan Banking Supervision Annual Report 2005, released October 2006).

Drivers of change in the Kenyan banking industry today, a study by PWC-Pan-African Institute carried out a survey on Kenyan banks concerning various issues and aspects of banking based on a sample of 10 Kenyan banks. They found that the two most important drivers of change in Kenyan banking sector are technology and economies of scale. External drivers of change such as globalization and foreign entrants are of less importance. New domestic entrants are not considered a significant driver of change.

Figure 2.1: Drivers of change in the Kenyan banking Industry based on 2006 PWC –Pan African Institute bank survey



The same survey revealed that the major threats facing the banking sector were fees and service charges erosion, followed by compliance and regulatory

constraints, and increased competition. They found the most pressing issues in Kenya to be: improving revenue growth, profit performance and retaining existing clients.

2.1.6 Bank technology

In terms of technology, the increasingly advanced levels of information technology embraced by banks have had a positive impact in the sector. The new and dynamic information systems adapted by most banks have enabled them to process data faster and efficiently at a benefit of cutting down costs. Some of the new developments in this area include introduction of new product lines and services such as e-banking, short message - banking (*Mpesa*) by some banks and use of various cards. Table 2.1 below presents the number of electronic cards in use. It is evident that the number of cards in use in 2007 is much higher than it was in 1999.

Table 2.1: Number of electronic cards (ATMS) and usage

	1999	2001	2003	2005	2007	percent growth 1999-2007
ATM cards	226,000	262,100	266,811	426,110	943,359	317.4
Debit cards	11,084	159,498	330,007	496,647	971,449	8,664.4
Credit cards	16,629	18,522	57,146	69,478	152,779	818.7
Charge cards	3,217	3,068	3,693	3,142	5,775	79.5
No. of ATM machines	86	107	215	555	1,078	1153.5
No. of transactions	4,915	5,707	4,637	9,103	42,076	756.1

Source: Central Bank Annual report (various)

All card categories have grown by over 100%, with the exception of charge cards, which has grown by 79.5% for the years 1999-2007. Debit cards have grown with the highest percentage of 8,664.4%, while charge cards show the least growth. The number of ATM machines has also been on the increase, moving from 86 in 1999 to 1,078 in 2007. The growth of ATMs is expected to decongest banking halls and reduce incidences of long queues in banking halls. This improves the efficiency of the banking system and increases funds flow for consumption and investment for both households and institutions. Further, with increased use of cards, ICT-based financial services have made a significant contribution in lowering the cost of offering financial services.

2.1.7 Mergers and acquisitions in the banking sector

The optimum scale of banking operations is a controversial issue, which has been debated among practitioners as well as researchers during the past few decades. With liberalization of financial services, it is expected that smaller banks may not be able to survive the competitive pressure from larger banks. On the other hand, larger banks are not able to utilize resources optimally. To ensure that small banks meet prudential guidelines, policy makers in some countries have encouraged mergers and acquisitions, and changes to the forms of business. In the recent years, a number of mergers and acquisitions have taken place in the banking sector in Kenya. In addition to the reason given above, some mergers have been occasioned by the need to meet the increasing minimum core capital requirements and to enhance the institution's market share in the local banking industry.

Between 1994 and 2007, there were 26 successful mergers (Appendix 1). It is anticipated that further consolidation will take place in the industry through mergers and acquisitions as institutions seek to achieve economies of scale required to effectively compete and expand in the increasingly lucrative mass market. Whether there are any productivity or efficiency gains that come with mergers and

acquisitions is an empirical question. Empirical studies as shown later on in the literature review show mixed results.

In addition to mergers, some banks have expanded their branch networks in the region. For instance, Kenya Commercial Bank has expanded regionally and opened branches in Juba and Rumbek in Southern Sudan, and has announced plans to open several additional branches in Rwanda, Uganda and Burundi. This adds onto their existing operations in Tanzania.

2.1.8 Infrastructural development in banks in Kenya

The bank branch network shows an upward trend throughout the country, even though the number of unbanked individuals still remains high in Kenya. A recent survey on financial access in Kenya 2006 reveals that only 18% of Kenyans have access to formal financial services - banks. This notwithstanding, the banking sector plays a very crucial role in Kenya in terms of provision of credit to key institutions and in transmission of monetary policy in the country. Collapse of the banking system would imply collapse of monetary policy and intermediation between borrowers and lenders, taking the country back to barter trade. Thus, there has been increased expansion of the bank branch network in the country to avail financial services to as many people as possible.

Table 2.2 shows the trends in the growth of the branch network in the country. It is evident that growth has not been stable and, in some years, the growth rate has been positive and in other years, negative. This shows that banks at times have been changing their strategies on expansion or contraction. A bank would contract if the branches are not profitable, incurring increased costs and inefficiencies in its operations. On the converse, a bank would expand if there is belief of existence of unexploited resources that would be profitable at least cost.

Table 2.2: Growth in the number of institutions in the banking sector

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Branch network	692	530	465	494	486	512	532	534	575	772
Growth rate		**-31**	**-14.**	**5.87**	**-1.6**	**5.08**	**3.76**	**0.37**	**7.13**	**25.52**
Commercial banks		67	60	60	52	50	49	45	45	45
Growth rate			-0.1	0.00	-0.1	- 0.04	- 0.02	- 0.08	0.00	0.00
Real GDP growth rate	3.29	2.28	0.60	3.80	0.60	3.00	5.10	5.80	6.11	7.0

Source: Bank Supervision Annual Report

Branch expansion in 2001-2007 has been accompanied by good macroeconomic performance, while the contraction was accompanied by hardships in the economy during 1999-2000, and 2002 as shown in Table 2.2 above. Whereas the branch networks have been on the increase, the number of commercial banks has been on a downward trend. Commercial banks have been expanding horizontally through mergers and closures (of some of the commercial banks) and not vertically in terms of increase in the number of commercial banks. This is tending to the preference of larger banks to smaller banks. Is large always efficient? Does the increased expansion in branch network imply improved scale economies and efficiencies? These are among the questions the study seeks to address.

2.1.9 Management performance

Managerial decisions directly affect the efficiency of banks. Policy makers are particularly interested in identifying how managers make decisions to cope with future uncertainty. Generally, policy makers use CAMEL (capital adequacy, assets quality, management quality, earnings ability and liquidity of banks) ratings, which mainly rely on traditional accounting measures for evaluating banks. However, traditional accounting measures are not able to provide accurate information about the quality of management, which is vital for predicting the future of a bank. Barr *et*

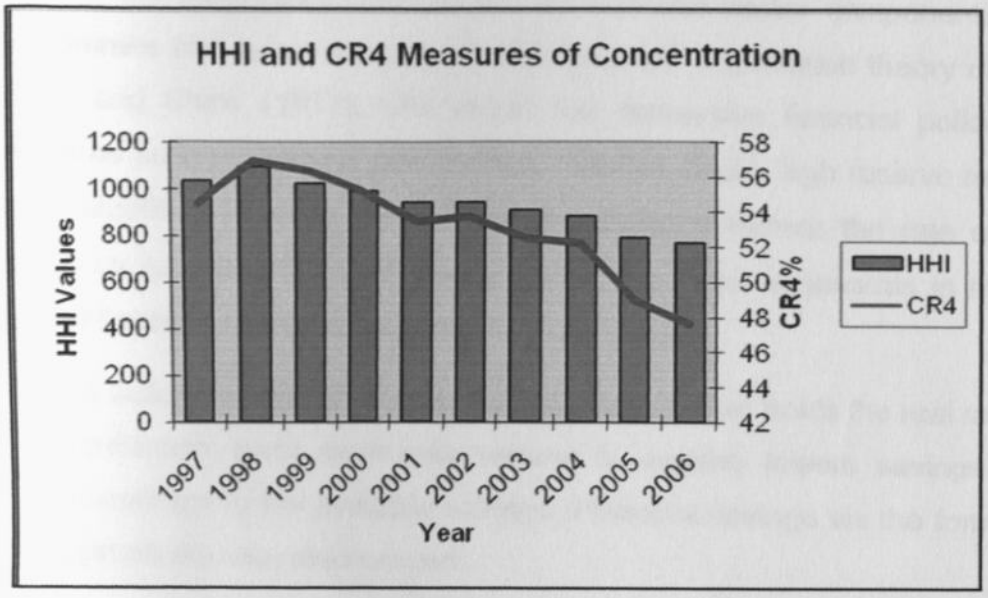
al. (1994) indicated that since managers make decisions that affect overall performance, DEA-based efficiency estimation can be used for determining managers' performance.

2.1.10 Market structure

Market structure and concentration are considered to be another research cluster focused on government policy. Market power explanations indicate a positive relationship between market concentration and profitability. The efficient structure paradigm indicates that efficient firms (in this case banks) compete more aggressively in the market and gain dominant market shares and also have high profits because of their low cost of production. Kenya's banking sector is characterized by oligopolistic market structure, which shows high concentration in the sector. Highly concentrated markets shows some form of deficiency in competitive strategies. Constructing the Hirschman-Herfindall index (HHI),[8] and the concentration ratio (CR4),[9] reveals a banking sector that is moving from high concentration to lower concentration. The CR4 and HHI show a market structure of loose oligopoly or monopolistic competition.

[8] HHI is the sum of the squares of the market shares of all firms in the market.
[9] CR4 is the sum of the market shares of the 4 largest firms in the market in question.

Figure 2.2: HHI and CR4 measures of concentration



Source authors computations

From Figure 2.2 above, the HHI and CR4 indicate that the banking market structure is tending towards less concentration and, thus, is more competitive. Increased competition puts pressure on banks to become more efficient in providing their services and products at competitive prices, so that they can remain profitable. This has a spiral effect of ensuring that prices are affordable to customers. The question one would ask is whether the market is becoming more efficient?

Kenya's banking system is an interesting sector to study given its technological developments in the recent past, its structure in terms of ownership, size, market, its products, branch network and regional expansion that are diversified; and is characterized by the advent of new forms of banking.

2.2 Financial Sector Reforms

Much of the theoretical rationale for the financial sector components of reform programmes has been provided by the Financial Repression theory of McKinnon (1973) and Shaw (1973), who argue that repressive financial policies through measures such as interest rate ceilings, directed credit, high reserve requirements and restrictions of entry into the banking industry reduce the rate of economic growth by retarding financial development. The major arguments in the literature against financial repression are outlined as follows:

- An administratively fixed nominal interest rate that holds the real rate below its equilibrium level depresses returns to savers, lowers savings and limits investment to the available savings. Financial savings via the formal financial system are also discouraged.
- With low interest rates in the formal financial system, informal or uncontrolled markets are likely to emerge with higher market clearing rates. This will in turn lead to differences in returns on investments financed in different markets.
- In the absence of rationing credit through the price system, funds are unlikely to be allocated to the most productive projects; instead they will be allocated to those with the lowest risk of default and the lowest transaction costs on loans.
- Interest rate ceilings discourage financial institutions from charging risk premiums, which may ration out a large number of potential borrowers with high-return projects.
- Selective or directed credit associated with financial repression will result in higher loan defaults, reduce flexibility and increase the fragility of the banking system.

McKinnon (1973) and Shaw (1973), among others, hence prescribe financial liberalization and development as key economic policies for promoting savings mobilization and efficient investment and accelerating growth. Financial sector

reforms are, thus, undertaken along this line of argument. By raising real interest rates and making institutions more competitive and efficient, the reforms would lead to an increase in total savings and attract funds into the banking system, which in turn would increase investment through enhanced credit availability. Higher return projects not previously funded would also be undertaken after monetary reform because competitive institutions are more efficient than the informal market in channeling funds to projects. Thus, economic growth would be enhanced. Although this theory is simple and has been highly influential, it is also quite controversial.

Up to early 1980s, Kenya's financial sector was highly repressed. Kenya's financial system was characterized by interest rate restrictions, domestic credit controls, high reserve requirements, segmented financial markets, under-developed money and capital markets, and controls on international capital flows. Kenya undertook financial sector reforms from the 1980s under the enhanced structural adjustment programme. The financial reforms were aimed at liberalizing interest rates, reducing controls on credit, enhancing competition and efficiency and productivity gains in the financial system. Furthermore, the reforms were directed towards strengthening the supervisory framework, promoting economic growth, deepening financial markets and improving the effectiveness of monetary policy through greater reliance on market forces (Brownbridge and Harvey, 1998). In general, the reforms were designed to establish a financial environment favourable to rapid and sustainable economic growth through greater savings and investment. The reforms have been gradual rather than all at once reforms.

Table 2.3 below shows the interest rates trends from 1970 to 2007. Interest rates have been controlled throughout, and at negative in real terms in most of the 1970s and early 1980s.

Table 2.3: Real lending interest rates

Year	Real interest rate	Year	Real interest rate
1966-1970	+1.90	1986-1990	+3.8
1971-1975	-7.20	1991-1995	+1.64
1976-1980	-7.74	1996-2000	+4.07
1981-1985	-0.75	2001-2005	+2.12
2006-2007	-0.006		

Source: Author's computations

Following liberalization of interest rates, positive real rates were recorded, and the spread between the lending and the deposit rates narrowed. However, this was short-lived. With the high inflationary conditions, interest rate spread widened.

The adverse consequences of financial repression for the development of the financial system, and for savings and investment in general, are well explained in the first portion of the arguments behind liberalization. As a remedy, the standard approach to reform suggests establishing positive real rates of interest on deposits and loans by, among other measures, eliminating interest rate ceilings and directed credit allocations, and pursuing price stabilization through appropriate macroeconomic and structural policies.

Since 1984, interest rates in Kenya have been structured to yield a positive real return on savings and investment. This policy was continued until July 1991 when the rates were finally decontrolled. The liberalization of the markets for bonds and bills in May 1990 also brought discount rates more in line with market conditions. Liberalization of interest rates sought to allow greater flexibility and encourage greater competition in interest rate determination through the operation of market forces. It aimed at harmonizing competitiveness among the commercial banks and

NBFIs by removing the differentials that had existed for maximum lending rates. This policy direction would enable the sector to maintain the general positive levels of interest rates in real terms in order to encourage mobilization of savings and contribute to the maintenance of financial stability. In 1989, the ceilings on savings deposit rates for both commercial banks and NBFIs were progressively raised. These moves harmonized interest rates across the institutions, allowing banks greater flexibility in varying rates according to loan maturities.

A fixed exchange rate policy was maintained during the 1960s and 1970s, with the currency gradually becoming over-valued. Exchange controls were continued until mid-1980s when the crawling peg regime was introduced in line with Structural Adjustment Programmes. The crawling peg regime lasted up to 1993. Since October 1993, the exchange rate has been freely determined in a managed floating exchange system.

The 1989-1993 Development Plan stated that "Increasing proportions of total credit to the private sector will be directed to the productive sectors of the economy, particularly agriculture and manufacturing". The plan goes further to state that "since more credit will be extended to the productive sectors of the economy, greater selective credit controls will be applied". Such controls have been applied in the case of credit to the agricultural sector since 1975. Commercial banks were required to lend at least 17% of their deposit liabilities to this sector. Issuing such credit ceilings or controls is a form of direct control, which tends to be inflexible and cumbersome to administer. Since the liberalization of the financial sector from 1989 through the Financial Sector Adjustment Programme (FSAP), the controls were removed. Commercial banks have then been free to allocate credit at their discretion and according to market needs. Part of the financial sector reforms have included revision and amendment of the Banking Act and the CBK Acts as earlier discussed. The Banking Act was amended in 1985, 1996 and 2006 (Appendix 2).

In the midst of financial sector reforms, the banking sector was faced by two banking crises. The first was in mid 1980s (1985-1986), which followed the collapse of several banks[10]. Immediately following the crisis, cash ratio was re-introduced to moderate excess liquidity within commercial banks. Furthermore, a deposit protection fund was established to protect small depositors from banking crises. The second banking crisis occurred in 1998 when five banking institutions were placed under statutory liquidity management. The bank failures were attributed to high non-performing loans (NPLs) due to poor lending practices, conflict of interest when shareholders participate in the day to day management of banks, slow recovery of NPLs, loans to non-viable projects, insider lending to directors, under-capitalization, and over-investment in speculative property market.

During this time, the CBK put several measures to foster a sound and stable banking system. One, the Bank, with consultation with the Ministry of Finance, raised the minimum paid up capital requirements for banks to enhance their capitalization, while the government was encouraged to progressively divest from the banking system. It was also suggested that efforts be put to improve the judiciary by providing adequate court facilities, computerization, appointment of additional judges and other necessary improvements in order to uplift the efficiency of the court process. The Bank also encouraged small banks to merge so as to ensure adequate capitalization, and bank regulations were tightened. The Banking Act was also amended to give the CBK more power to enforce banking laws and regulations, including the power to levy monetary penalties for non-compliance.

In the years following the 1998 bank failures to date (2008), there have been two institutions[11] that have been liquidated and put under the statutory management by the CBK (see Appendix 2 for a chronological analysis of reforms in the financial

[10] Some recent bank failures include: Trust Bank, Trade Bank, Reliance Bank, Heritage Bank, Bullion Bank, City Finance Bank, Pan African Credit & Finance Bank, Daima Bank and Euro Bank .

[11] Prudential Bank and Charter House Bank

sector that may have had an impact on the banking sector). In the next section, an analysis of the possible impact of the financial sector reforms is drawn.

2.2.1 Impact of financial reforms in the banking sector

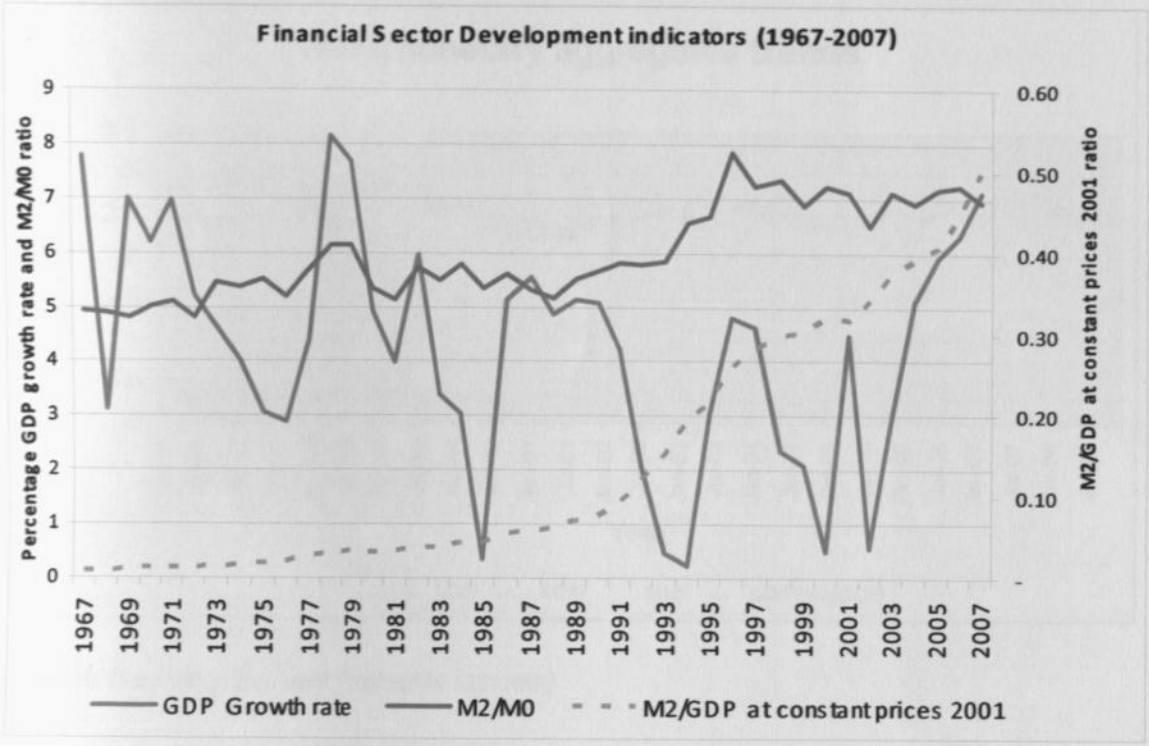
According to Edey and Gray (1996), there are three areas which reforms can influence. These are:

- The role of financial regulatory policies
- Improvements in technology used in institutions
- Changes in the cost and pricing structures of the intermediation process

Financial reforms began in the 1980s and they are still being undertaken in Kenya. One of the main aims of the reforms was to increase the efficiency and productivity gains of the entire financial services sector by promoting competition among the different types of financial intermediaries. The Kenyan financial services are still dominated by the banking industry. The deregulation/ reform process allowed more freedom for local banks to operate. Foreign banks have been encouraged to enter and to expand banking operations in Kenya.

Figure 2.3 below shows some of the financial sector development indicators. The 1970s and 1980s showed a contraction of the monetary sector, as evidenced by a decline in financial intermediation, and a loss in financial depth as measured by M2/GDP. This in part is explained by the financial sector repression that existed in the economy. As the reforms are undertaken, the sector became vibrant and we see financial deepening as evidenced by increasing M2/GDP from 1990s to 2007. The money multiplier, on the other hand, shows a general upward trend, though not smooth throughout with periods of decline in various times.

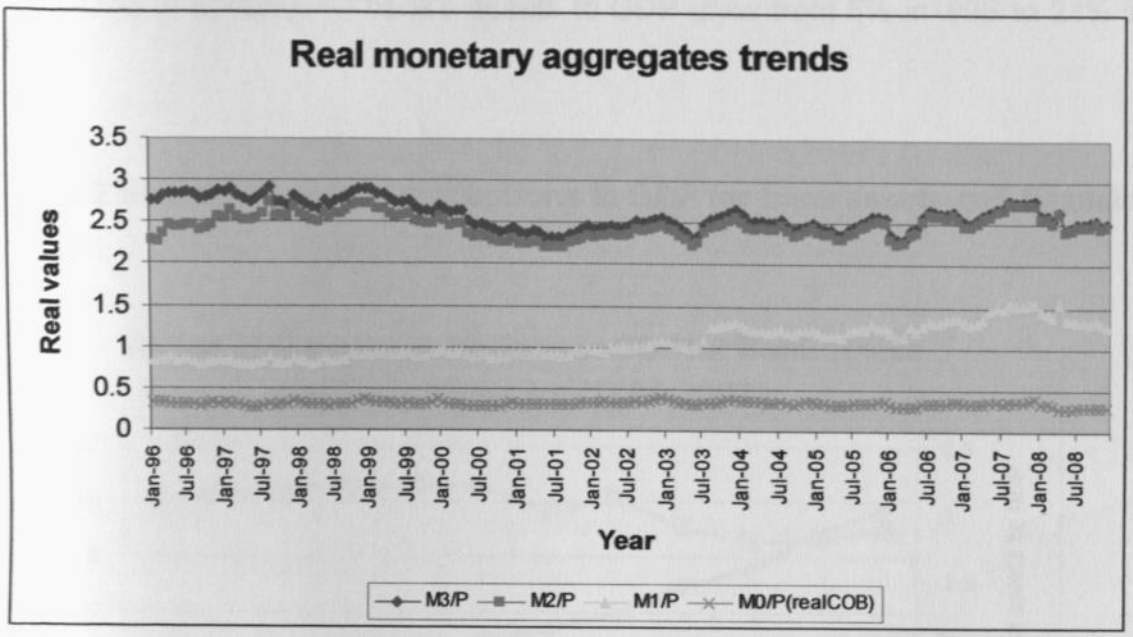
Figure 2.3: Financial sector development indicators (1967-2007)



Source: Various statistical publications

The real GDP growth has largely been below 10% for the period 1969-2007. The highest real GDP growth rate was experienced in 1977 after the coffee boom of 1976 and 1977. Immediately following the 1977 growth was the oil crisis of 1978-1979 that led to a declining trend in GDP until 1983 when it hit a low 0.35% real growth rate. The economy rebound back in 1985 and experienced growth in the years after slumping in 1994 due to severe drought. There was some element of growth in the M2/GDP in the same year, which was increased through printing of money to finance the drought at that time. The other periods that show a significant increase in M2/GDP are in 1993 and 1997, and are attributed to the Goldenberg scandal and elections, respectively. In 1992, Kenya moved from single party to multi-party political system. The political system has great impact on how the economy is run. The multiplier is stable with an upward trend in the outer years.

Figure 2.4: Movements in monetary aggregates over the years



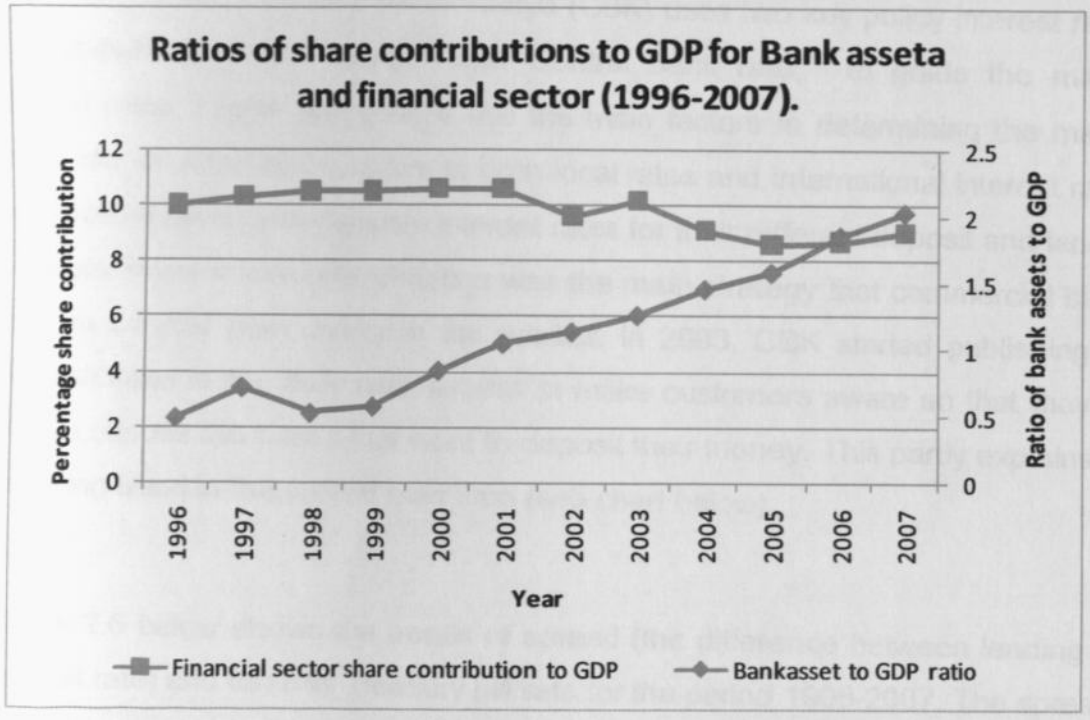
Source Banking Survey (various issues)

The changes in aggregate money supply (Figure 2.4 above) in the economy during the last 10 years reflect how the reforms process has deepened the financial system. The reforms started in 1989 when the broad money aggregate averaged about Ksh 40 billion. In 2008, the broad money aggregate averaged Ksh 753 billion in nominal terms. In real terms, the increase is marginal. The trend for broad money M3 and M2 have more or less remained the same with M1 showing an upward trend. The rapid increase in broad money in nominal terms identifies the expansion of commercial banking activities in the financial services sector. In the 1970s and 1980s, the contribution of commercial banks to broad money supply was relatively insignificant. However, by 1990s, it had become a significant portion of broad money supply. Accordingly, developments in the financial services sector have widened the market for deposits.

Figure 2.5 below shows how the total bank assets base as a ratio to GDP has increased over the years, specifically from 1998 to 2007. The evolution of the

financial services sector has increased the assets base of commercial banks. The percentage of commercial bank's assets to GDP grew from 6% in1998 to 21% in 2007.

Figure 2.5: Ratio of share contributions to GDP for bank assets and financial sector



Source Economic Survey (various issues) and Banking Survey (various issues)

This is a significant growth upwards and has indications on financial innovations that have taken place in the banking sector. Further, one of the objectives of the financial sector reforms was to deepen the activities of the financial services sector. Consequently, the sector's contribution to GDP improved from 9% in 1996 to 11% in 2001, but gradually maintained a downward trend from 2002 of 8% until 2006. In 2007, there is a slight improvement to 9%. The change has not fluctuated much and has remained constant between 8% and 10%. This implies that financial

sector services have continued to play a significant role in Kenya's economic development process.

Deposit and lending interest rates

Deregulation gave more freedom to market forces in determining interest rates by removing preferential credit schemes and by establishing a market for government debt instruments. Central Bank of Kenya (CBK) uses two key policy interest rates, repurchase agreement (repo)[12] and Central bank rate,[13] to guide the market interest rates. These policy rates are the main factors in determining the market rates. Market rates are sensitive to both local rates and international interest rates. Commercial banks use different interest rates for their different deposit and lending products. Interest rate differentiation was the main strategy that commercial banks used to counter peer rivalry in the market. In 2003, CBK started publishing the bank charges in the daily newspapers to make customers aware so that they are able to choose the banks that want to deposit their money. This partly explains the declining trend in the spread over time (see chart below).

Figure 2.6 below shows the trends of spread (the difference between lending and deposit rate) and the real Treasury bill rate for the period 1996-2007. The spread in the Kenyan banking sector has been high, averaging 12% in the ten-year period under study. In 1996, it started on a high of 16.2% and reduced to 13% in 1997. It further fell to 8% in 2005.[14] This was the time when the economy experienced drought and performed poorly, reporting negative growth rates. The banking sector

[12] The rate at which commercial banks and primary dealers invest their surplus funds in government securities sold by the CBK under short term repurchase agreements.

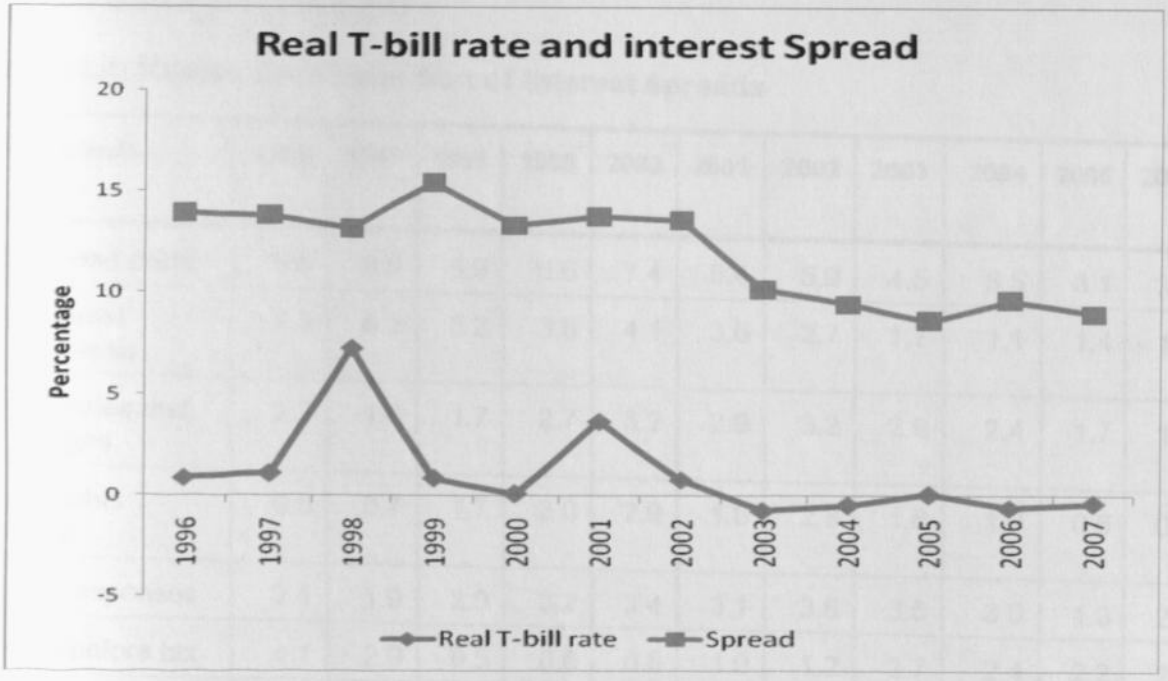
[13] A rate used by the CBK for signalling to the market the direction that the policy intends to move. A high CBK rate signals tightening of the market. Whereas a low rate signals the converse.

[14] The Minister of Finance and CBK have attempted in the past to narrow the interest rate spread and to control bank charges by enforcing Section 44 of the Bank Act, and the introduction of the in-duplum rule. However, these initiatives have been ineffective. In the 2006 budget, the Minister adopted an indirect approach to encouraging competition by encouraging banks to experiment with new products and supporting intermediation. The Minister announced plans to exempt from income tax the interest earned from listed bonds to infrastructure and asset backed securities.

also increased lending rate in line with the prevailing risks, subsequently widening the spread.

The spread, however, has been improving and has been on the decline since 2001. This is an indication that the banking sector gained some efficiency in the intermediation process, such that the spread between the lending and deposit rate reduced for the period 2001-2005. In the 1996-1998 period, the interest spread changed marginally by less than a percentage point. This was the period when efforts were being made to improve money and capital market performance and strengthen the supervisory role of the Central Bank. Monetary policy moved towards using indirect tools. However, the economy experienced instability, with a sudden outflow of short term capital as the pull factors weakened, while foreign aid was suspended (Ngugi, 2004).

Figure 2.6: Interest rate spread in Kenya's banking sector



Source: Author's calculation based on figures from Banking Survey (2007)

A basic benefit of enhanced efficiency is a reduction in spreads between lending and deposit rates. This is likely to stimulate both greater loan demands for industrial investment, and thus contribute to higher economic growth, and greater mobilization of savings through the banking system. Banks in most developing countries operate with relatively wide spreads. Although government policies and regulations are considered major causes of such wide spreads, studies on banking efficiency have pointed at operating inefficiencies as another possible source that needs to be investigated. Wide spreads affect intermediation and distort prices, thus impairing the role of the financial system in contributing to rapid economic growth.

A decomposition of interest rate spread methodology adopted from Beck and Fuchs (2004) reveals that overhead costs and the profit margin are the most important component of the interest rate spread in Kenya. A further analysis of the overhead costs is driven by interest expenses, which constitute more than 50% of the overhead costs (Table 2.4).

Table 2.4: Kenya: decomposition of interest spreads

Bank costs	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Overhead costs	9.5	8.0	6.9	6.6	7.4	6.4	5.9	4.5	3.5	3.1	3.3
▪ Interest expense	7.3	6.2	5.2	3.8	4.1	3.6	2.7	1.7	1.1	1.4	1.4
▪ Salaries and wages	2.2	1.8	1.7	2.7	3.2	2.9	3.2	2.9	2.4	1.7	1.8
Bad debts charge	0.5	0.7	1.7	3.0	2.9	1.6	2.3	1.6	1.2	0.6	0.7
Other expenses	2.1	1.9	2.0	3.2	3.4	3.1	3.6	3.5	3.0	1.9	2.2
Profit before tax	4.1	2.9	0.5	0.0	0.6	1.9	1.2	2.7	2.4	2.2	2.3
Interest rate spread	16.2	13.5	11.1	12.8	14.2	13.0	13.0	12.4	10.1	7.8	8.5

Source: Beck and Fuchs (2004)

The loan loss provision that is the bad debt charge surprisingly takes a very small portion of the risk fact or demonstrated by the share. The argument that high levels of past non-performing loans, and the notion that banks charge high lending rates on their loans to mitigate the risks associated with lending may be questionable given the details shown in Table 2.4 above. Other factors relating to costs of financial service provision in the local market include: fraud, security costs, inefficient payment system, heavy regulatory burden as illustrated by high reporting requirements, poor infrastructure, poor bureaucratic and legal framework, an inept macroeconomic infrastructure, the annual re-licensing process and licensing procedures for opening and closing branches, the high cost of bandwidth and frequent power shortages which force banks to have standby generators in their branches - all these add to the high cost of doing business (Oloo, 2007; Beck and Fuchs, 2004).

2.3 Bank Sector Performance Indicators

To fully assess the efficiency of bank operations, it is necessary to model various types of functions performed by banks, and control for the inputs necessary to provide a certain level of utility to owners and depositors (whereby the utility to owners is profits and to depositors is services) while performing those functions. There are central performance ratios that indicate banks' status at a glance, and these ratios guide practitioners and commercial bank management in making their periodic decisions.

Capital adequacy

Bank regulators place great emphasis on the regulation of bank capital, as capital plays a crucial role in such depository institutions. One objective of capital regulation has been to reduce the number of bank failures. Equity capital provides a cushion to absorb losses that would otherwise cause a bank to fail. Regulators

consider preventing failure an important goal at least in part because of concern that one bank's failure may adversely affect the stability of other financial institutions. Another objective has been to reduce the losses to depositors and the deposit insurer when a bank fails. Both equity and debt subordinated to depositors provide a cushion to reduce the losses to depositors and the deposit insurer in the event of failure. Capital also supports growth and long term fixed investment for banks and reduces moral hazard.

Section 7[15] (1) of the Banking Act 2000 states "A license shall not be granted to an institution unless the institutions meet the minimum capital requirements specified in the second schedule" Therefore, all institutions must meet minimum core capital[16] in order to operate in Kenya. Capital Adequacy is measured in terms of:

- Minimum Core Capital set by the regulators
- Gearing Ratio, that is Core Capital/Total Deposit Liabilities (Min 8%)
- Core Capital /TRWA (Min. 8%) where TRWA = Total Risk Weighted Assets
- Total Capital/TRWA (Min. 12%)

As any of these ratios gets smaller, the bank become under-capitalized and is likely that it can end up insolvent. In the Kenyan situation, institutions are required to maintain a minimum ratio of 12%. Most banks in Kenya have been able to meet

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[15]Section 7 & 17 of the Banking Act provided for capital requirements before the risk-based standards were introduced. Section 18 came with the introduction of risk-based standards, which was enacted in the Banking Act 2000.

[16] "Core Capital" (Tier 1) is as defined is Section 2(1) of the Banking Act, namely permanent shareholders equity (issued and fully paid-up ordinary shares and perpetual non-cumulative preference shares) plus disclosed reserves (additional share premium plus retained earnings plus 50% of profits after tax plus minority interest in consolidated subsidiaries) less intangible assets (goodwill and equity funded through revaluation reserves).With respect to profits after tax for the current year to date, 50% of the profits will be allowed as part of core capital. The institutions must have made adequate provisions for bad and doubtful debts, depreciation and other expenses. In arriving at the applicable figure, any proposed or interim dividends have to be taken into account.
"Supplementary Capital (Tier 2) includes 25% of asset revaluation reserves, which has received prior Central Bank's approval, subordinated debt, hybrid (debt equity) capital instruments, general loan loss provisions, or any other capital instrument approved by Central Bank. Supplementary capital must not exceed core capital.
"*Total* Capital" means core capital plus supplementary capital.

the minimum capital requirement over the years, with some surpassing the required minimum.

Theoretically, however, the stabilizing effects of capital requirements are supported by models based on the option-pricing model.[17] In this framework, an unregulated bank will take excessive portfolio and leverage risks in order to maximize its shareholder value at the expense of the deposit insurance (Benston *et al.*, 1986; Furlong and Keeley, 1989; Keeley and Furlong, 1990). Capital requirements can reduce these moral hazard incentives by making bank shareholders absorb a larger part of the losses, thereby reducing the value of the deposit insurance put option. With more capital and less risk-taking, the effect is clearly a decrease in the bank's default probability, hence higher stability in the financial sector.

Economic theory argues that when capital is relatively expensive, the forced reduction in leverage diminishes the bank's expected returns. As a consequence, the bank's owners may choose a higher point on the efficiency frontier, with higher returns and higher risks. Thus, the intended objective of capital requirements may not be met and the results could be perverse. The introduction of risk-based capital standards is an attempt to eliminate the possible perverse effects of capital requirements (Rime, 2000).

The core capital, which is monitored on a continuous basis by the Central Bank, applies to all institutions and is reviewed from time to time. Other things being equal, the greater the credit risk in a bank's portfolio, the greater the total risk weighted assets, and the greater the level of capital that the bank must hold against its portfolio. The Minimum Core Capital required is shown in Table 2.5 and must be achieved by the compliance dates indicated.

[17] Options are contracts that do not obligate the holder to transact at the contract price. The holder exercises such a right if it is in his favor/interest.

Table 2.5: Minimum core capital

Compliance date	Banks and mortgage finance companies Ksh millions	Financial Institutions Ksh millions
31-12-1999	200.0	150.0
31-12-2000	250.0	187.5
31-12-2001	300.0	225.0
31-12-2002	350.0	262.5
31-12-2003	250.0	300.0
31-12-2004	250.0	225.0
31-12-2005	250.0	225.0
31-12-2006	250.0	225.0
31-12-2007[18]	250.0	225.0

Source Bank Supervision Report

Any bank that fails to meet the minimum requirements is either urged to merge or is put under liquidation.

Bank earnings

The earnings of a bank have great implication on the soundness of its operations. Several ratios are used to define the earnings of banks. One ratio is the Net Interest Income to Average Asset Ratio. Low levels of this ratio are often questioned. However, exceptionally high values of it must be questioned as well. The issue is that when it is high, it means either the bank has got bliss or favourable interest rates, with a wide margin emanating from a high lending rates with low deposit rates. Bank interest rates are crucial prices in the economy because they allocate financial assets.

[18] In 2008, the law was amended and all banks are to raise their capital to a minimum of Ksh 1 billion by 2012.

In an efficient banking system, the market forces determine bank interest rates. Within inefficient systems, however, the rates are misaligned to market fundamentals pertaining to demand and supply conditions. Consequently, the margin between lending and deposit rate widens. Interest rate spreads, thus, reflects efficiency and profitability of the intermediation process in the banking sector. Further, they reflect economic activity in that they are used to forecast macroeconomic variables. Inefficiency in the intermediation process is attributable to the incentive problem, which includes both information and enforcement components (Ndung'u and Ngugi, 2000).

Beck and Fuchs (2004) and Ndung'u and Ngugi (2000) argue that high interest spreads and margins and limited depth and breadth of financial services are the result of underlying deficiencies and impediments in the financial system in Kenya. Widening interest spread is an indicator of the underlying weak institutional and policy set up of the financial sector.

Earnings are computed as follows:

Earnings = profit before tax/ (gross assets + contingencies)

Asset quality

The quality of credit is as important as its availability, and affects both resource allocation and growth. The models of delegated monitoring and liquidity creation emphasize precisely the role of banks in the evaluation of credit worthiness and in the resource allocation. They also point out the beneficial effects of this type of banking activity in guaranteeing stability and confidence in the payment system. As a consequence, poor credit quality, often synonymous of excessive credit risk, may cause greater volatility in the total credit, with possible backward linkages to the same banking system. Indeed, recent literature on finance and growth highlights the importance of access to financing for firms depending heavily from the external finance, even if the specific effects of the legal framework and of the structure of

financial and banking systems are not unambiguously clear (Claessens and Leaven, 2005).

Further, credit quality is a major instrument in banking competition to the extent that credit quality may lead to an efficient cost structure. Bad credit screening makes the bank's lending subject to the winner's curse (Freixas and Rochet, 1997), particularly given that credit screening is poorly correlated among an increasing number of banks. Quality of credit is then a specific signal of the soundness of the banking sector, as excessive credit risk could impair the efficient allocation of capital, and bad credit may also impair the performance of banking institutions. Indeed, some authors argue that a significant relationship is to be found between the efficiency of the banking system and economic growth, and at the same time the efficiency of the borrowing firms could influence the performance of the banking system (Lucchetti *et al.*, 2001; Lozano-Vivas and Pastor, 2003).

In Kenya, loans and advances form the largest proportion of the balance sheet of the banking sector. Asset quality is rated on the basis of the proportion of non-performing loans, net of provisions to gross loans. It involves loans and advances that are categorized into five groups depending on the time past due: normal risk, watch, substandard, doubtful and loss. Asset quality is given by the following ratio:

Asset quality = Net non-performing loans/gross loans.

High levels of non-performing loans show that the bank is experiencing some inefficiency in the process of intermediation.

Liquidity in the banking sector

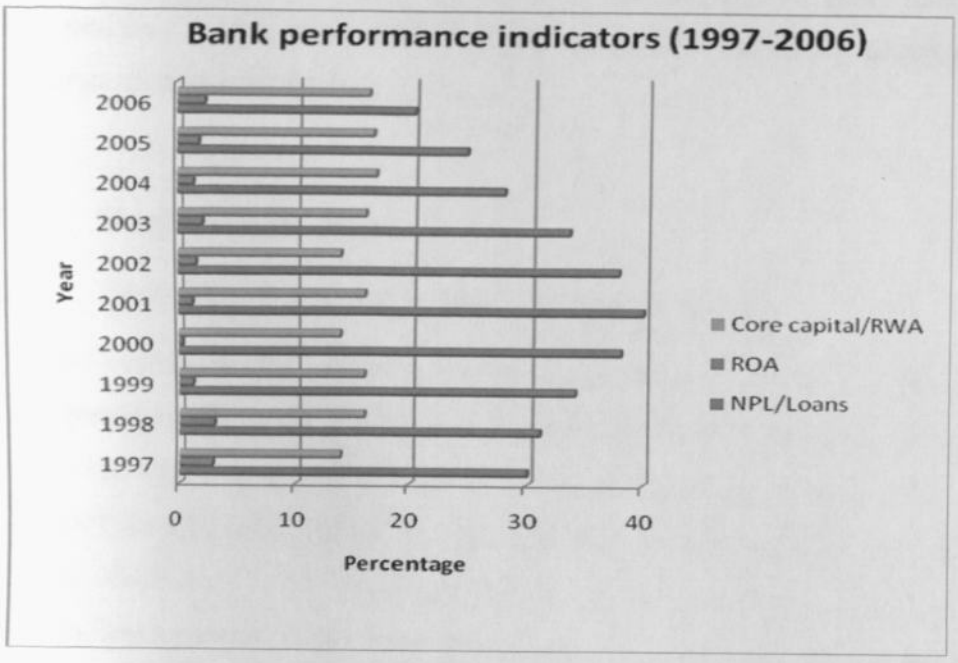
Liquidity of the banking system is measured by the ratio of the net liquid assets to total deposits. *Liquidity = Net liquid assets/Net deposit liabilities*. This ratio is high in Kenya, with banks keeping excess reserves each day. The Central Bank has to mop up liquidity in the banking system daily to a range of Ksh 1-10 billion. In a

credit needy economy such as Kenya's, it is questionable why banks would hold excess reserves unless this is pegged to inefficiencies existing in the intermediation process. Contrary to this, the Banking Supervision Department at the CBK has blamed the excess liquidity to the method used in computation of liquidity, and the low cash ratio requirement. The numerator in the formula includes liquid assets such as bonds that are considered long term.

A liquidity ratio was first imposed on commercial banks in 1969 and it was set at 12.5%. The ratio was increased to 20% in 1983 and 25% in March 1994, and then reduced to 20% in May 1997. Despite the high minimum statutory requirements, banks had excess liquidity. According to Ndung'u and Ngugi (2000), the excess liquidity may be attributed to several factors: restrictions placed on commercial banks at the discount window, coupled with a thin inter-bank market; a high reserve requirement; and purchase of government securities. High liquidity held by the banks in a much needy credit society has strong implications on the efficiency of the intermediation process.

Figure 2.7 below gives some of the trends of bank performance indicators over 1997-2006. The indicators have been discussed above and include the Capital adequacy indicator, Return on Assets and Asset quality indicator.

Figure 2.7: Some selected bank performance indicators



Source: Banking Survey (2007)

The return on assets shows an upward trend from 1997 to 2006. It begins on a high of 2.93%, dips to 0.27% in 2000 and then picks up to 2.41% in 2006. The ratio of NPL/Loans was high, at about 30% in 1997, increased to 38% in 2000 and then decreased to 20% in 2006. This trend is an indication of improvement in the banking sector as regards asset quality, and is attributed to prudent management of assets and increased provisions for loans, which is derived from increased capital requirements by the Central Bank Kenya. Core capital/TRWA has remained stable over the years, and this is an indication of soundness in the banking system in Kenya.

To supervise and regulate banks properly, the Central Bank of Kenya also assesses bank management, in addition to monitoring asset quality, capital adequacy, earnings, liquidity and profitability. Poor and incompetent management is often cited as one of the root causes of misuse of resources in production and

services. Other parameters that measure banking sector performance or indicators are: market share, lending behaviour, distribution of bank profitability, credit distribution, composition and changes in assets, liabilities, deposits, capital and reserve, profits and losses.

2.4 Bank Balance Sheet

2.4.1 Structure of asset portfolio for Kenyan banks

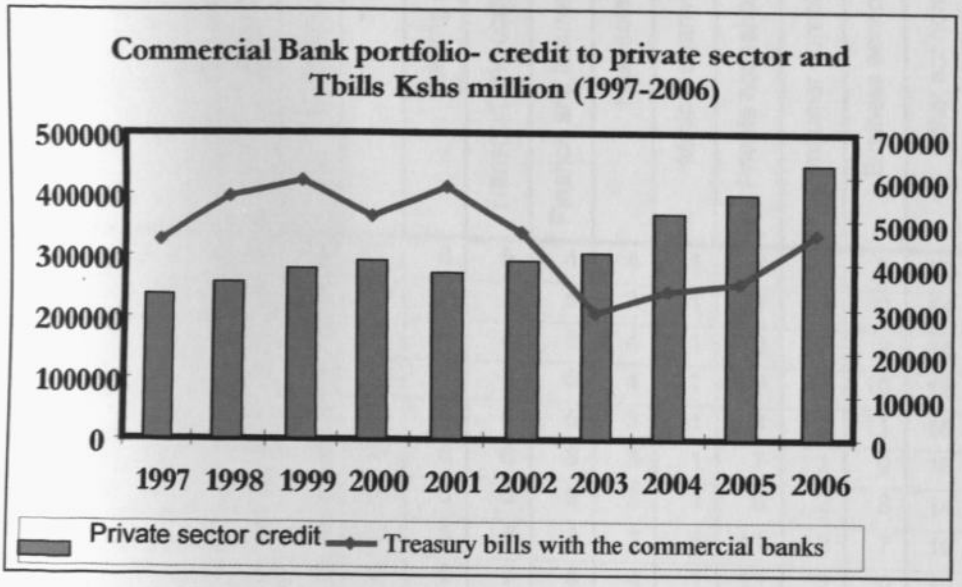
Loans dominate the asset portfolio of commercial banks, and the volume has increased as shown in the Figure 2.8 below. Private sector credit has been on the increase over the years, except for a small slump in the year 2001. The decrease in 2001 may be attributed to the uncertainty the commercial banks faced before the 2002 elections,[19] and the high levels of non-performing loans the commercial banks were experiencing then. After peaceful transition of government in 2002, the economy began to grow and so did credit to the private sector and investments in Treasury Bills. The trend for both credit to the private sector and Treasury Bills increased during the years 2004-2006, as shown in Figure 2.8 below. The cash ratio was reduced from 10% to 6% in 2003, and that led to an increase in liquidity in the banking system. Banks had enough money to trade and invest in any market, thus the T-bill rates were pushed downwards as shown in the graph (Figure 2.8) in year 2003. Other interest rates followed suit by going down.

The redistribution across sectors is a reflection of removal of credit ceiling that existed before the financial sector was liberalized. The lending rates, as shown earlier, show a declining trend with a small marginal pick in 2005. The low lending rate may have emanated from some form of increased competition in the banking sector. Low lending rates led to increased economic activity, which led to growth in the economy in the subsequent years in 2006 and 2007 of 6.1% to7.0% from 5.1%

[19] Elections in 2002 were historic in Kenya, as the government changed from 24 years rule of one president to another.

and 5.8% in 2004 and 2005, respectively. This can explain the increase in private sector credit.

Figure 2.8: Commercial bank portfolio-credit to private sector and Treasury bills.



Source: Banking Survey (2007)

Treasury Bills still remain a small share of bank portfolio investment, while credit to private sector continues to dominate the assets of commercial banks. Further, in the distribution of credit, credit to government is falling relative to total credit, though in absolute terms it is going up. Private sector credit has been on the increase in both absolute and relative terms. The distribution of credit to the private sector is given in Table 2.6. Credit to the private sector was rationed before liberalization of the financial sector in 1989. After economic liberalization and financial sector reforms, banks have been operating on business rationale, and credit to the private sector is specifically allocated to where banks themselves find business advantage. In this respect, some sectors that received large amounts of bank credit in the past two decades have realized declining shares of credit, which are aligned with the contemporary reforms in the banking sector. In particular,

agriculture sector credit that was favored by the government during the period of controls is not one of the leading sectors lent to by the banks.

Table 2.6: Percentage distribution of private sector credit from commercial banks

	Agriculture	Manufacturing	Trade	Building and	Transport and comm..	Finance and insurance	Real estates	Mining/ quarrying	Private households	Consumer durables	Business services	Other economic	
1997	8	21	17	6	5	4	4	1	3	3	8	20	100
1998	10	22	20	7	5	5	3	1	3	2	9	14	
1999	9	22	20	7	4	5	4	1	3	2	9	14	
2000	9	23	19	6	4	6	4	1	3	2	10	13	
2001	9	19	18	7	4	6	3	1	4	2	11	16	
2002	9	19	15	6	6	8	3	1	7	2	9	16	
2003	10	18	16	6	6	9	3	1	9	2	8	14	
2004	8	18	13	5	6	8	3	1	11	2	7	19	
2005	9	16	13	6	7	8	4	1	12	2	9	12	
2006	7	16	13	7	9	6	4	1	12	3	11	12	
Avg1997-2006	**9**	**19**	**17**	**6**	**6**	**6**	**3**	**1**	**7**	**2**	**9**	**15**	
													100

Source: Statistical Bulletin, Central Bank Kenya (various)

Sectors such as agriculture, manufacturing and trade that were popularly supported by the government show a declining trend from 2002. Sectors such as credit to private households, consumer durables and business service have an upward trend from 2002. The other remaining sectors stagnate on an average of 1% and 6% of credit for building and construction, transport and communication, finance and insurance sectors, and mining. During 1997-2006, agriculture received an average of 9% of the total credit extended to the private sector from commercial banks. The agriculture sector has been hard hit in the world market, with exports from Kenya facing tough competition with new players in the trade of tea and

coffee entering the world market. Manufacturing has received the largest share of credit during the period of study, 1997-2006. Kenya's manufacturing sector has been on the growth path, with new firms establishing base in Kenya. Kenya's economic growth has been fueled by production in the agriculture, manufacturing, trade and service industries.

Business services have also enjoyed a growing trend of credit from commercial banks. The service sector has been growing in Kenya, and has also contributed significantly to the growth of the economy.

Continuing growth in credit allocated to the private sector was generally perpetuated by improvement in loan performance, reduced government intervention and expansion of the banking sector. Credit growth has also been partly owing to banks' corporate clients that switched from borrowing abroad to domestically in order to escape exchange rate risk and to take advantage of falling cost of funds in the domestic market.

However, on the other side, allocation of credit has seen a high level of non-performing loans in Kenya. The ratio of non-performing loans to total loans in the bank indicates the credit quality of bank loans. Banks with the lowest non-performing loans are believed to be of better quality. This is due to their ability to evaluate risk better than their counterparts. Financial soundness requires that assets in the banking sector are of high quality, and management is of high credibility.

Deposit composition of Kenyan banks

Banks in Kenya hold both transaction (demand) and non-transaction deposits. Demand deposits are held for a short period of time, and they essentially facilitate cheque and cash transactions. Non-transactions deposits are held for a long period of time and mainly constitute savings and time deposits. These form the major source of funds to the commercial banks in Kenya. During the period 1997-2007, 44% of total deposits were non-transaction deposits, 22% were demand deposits and 33% constituted foreign deposits. Unlike the demand deposits, which either earn very little interest rates or more often a zero rate, non-transaction deposits earn interest income. They are, however, advantageous as they provide an opportunity of easy access to funds, including bank advances and overdrafts.

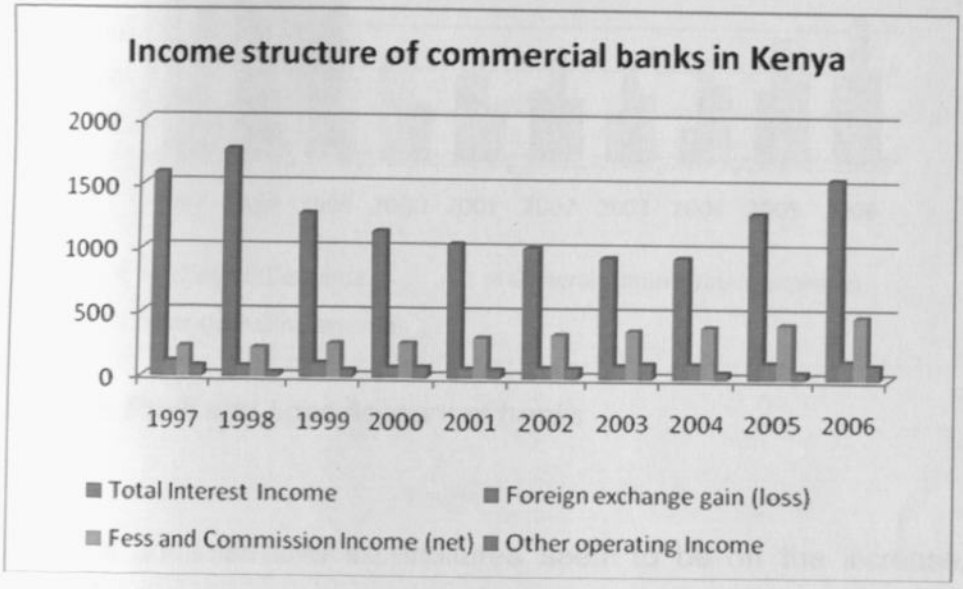
All forms of deposits, in general, over the last 10 years show an upward trend. This is a reflection of improving economic situation. In their endeavour to foster deposits mobilization, commercial banks have recently been innovative. They have made an effort to somehow cope with contemporary consolidated banking business by offering flexible and diversified services. Banks have initiated new types of specialized accounts and widened their branch networks to some non-harnessed potential business areas. Because of rising competition, commercial banks advertise and accept negotiated favourable interest rates for their prime customers. Moreover, automatic teller machines and credit card usage are now on the increase.

Income and expenditure structure

Sources of income for commercial banks are mainly from interest gained from three major sources: interest on loans and advances, interest on government securities, and interest on placements and bank balances. The income from Interest on loans and advances form the major source of income compared to the

other two interest income aforementioned. Other sources of income include foreign exchange gain\loss, fees and commission income and other operating income. The main expenditures of commercial banks come mainly from interest paid out on deposits, interest on borrowed funds, deposits and placements from other banks, other interest expenses, general administrative expenses, including staff salaries, and other operating expenses that include overheads.

Figure 2.9: Income structure of commercial banks in Kenya



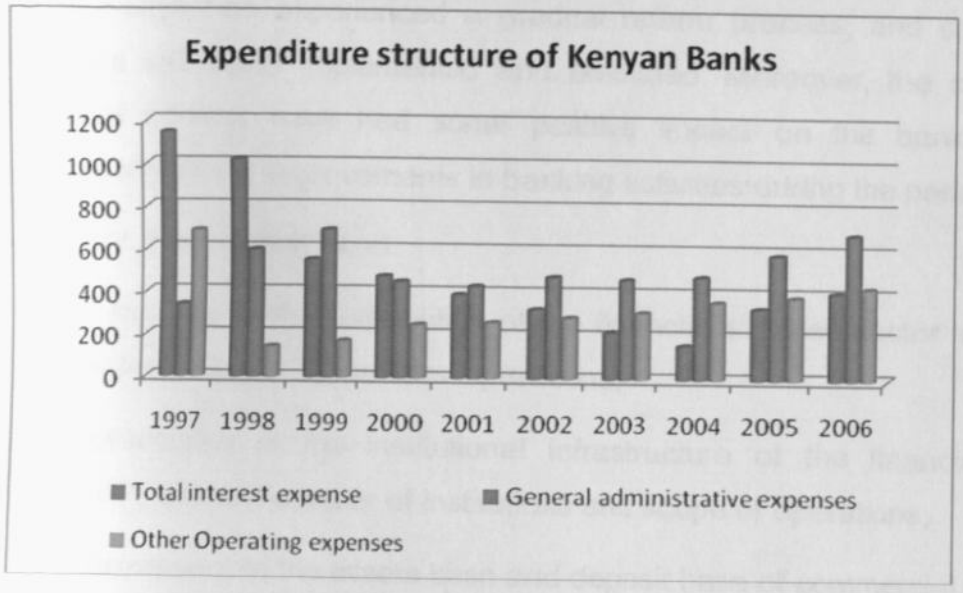
Source: Bank profit loss account

Over the years, income from interest earnings dominate the income in commercial banks. The interests show an upward trend from 1997 to 1998, then decline afterwards to a low in 2003 and increase afterwards to 2006. Fees and commissions have been on the increase for the whole period 1997-2008. This is an indication of more and more people getting banked, or an increase in the charges on fees and commissions in the banking sector.[20] The other incomes from foreign

[20] Different fees are charged for different accounts. For instance, a current account has more to offer than a savings account, and therefore attracts more charges for its operations. Different services attract different fees or commissions. Recently (2007 and 2008), the Central Bank of

exchange gain and other operating income remain fairly stable over the period under review.

Figure 2.10: Expenditure structures of Kenyan banks



Source: Profit and Loss Account of banks

General administrative expenditures seem to be on the increase, compared to other bank expenditures. In the recent past, banks have been increasing their staff as well as restructuring, thus have incurred increasing high costs. There are other factors that have been attributed to increased operating costs, such as power shortages, insecurity, credit and interest rate risks, etc. Interest expenditures have shown a downward trend, implying that banks have continuously paid less interest to deposits, hence the wide spread.

Kenya started publishing the fees and commissions charged by all the banks to ensure that customers have full information and can make their choices wisely.

2.5 Summary

This chapter has given a detailed background of the banking sector in Kenya. The chapter has chronologically analyzed the sequence in which banks have entered into the existing financial system, and also the reforms that have taken place over the years. The analysis in the chapter has highlighted that the financial services sector in Kenya has experienced a gradual reform process, and some of the reforms are still being implemented and amended. Moreover, the chapter has shown that reforms have had some positive impact on the banking sector, generating significant improvements in banking activities during the period.

In summary, the analysis found:

- An increase in the contribution of the financial services sector to GDP and the deepening of the sectors' operations;
- Improvement in the institutional infrastructure of the financial services sector, with the number of institutions and scope of operations;
- Improvement in the assets base and deposit base of commercial banks;
- Reduction in government ownership of commercial banks' assets; and
- A reduction in bank concentration.

Further, the banking sector has experienced technological and ICT-based developments, which have affected the efficiency with which the banking sector has been operating. The changes in market concentration have intensified competition not only in the banking industry, but also in the overall financial services sector. Diversification of operational activities of banking firms has changed the relative importance of the traditional sources of income of the banking sector, from reliance on interest earned to greater emphasis on fees earned.

The next chapter will review the literature related to efficiency (technical and managerial) and productivity gains and its applications in the banking industry. The

findings in the next chapter are used to form the analytical research framework for the study.

CHAPTER THREE: THEORETICAL AND EMPIRICAL LITERATURE REVIEW

This Chapter gives an overview of past empirical studies done in the area of efficiency, X-inefficiency and productivity in the banking industry.

3.0 Introduction

The very early economists had insights as to how resources would be allocated efficiently given their scarcity and wants. Adam Smith, in his invisible hand hypothesis, says that a competitive market provides a powerful invisible hand that ensures that resources find their way to where they are most valued, thereby enhancing the wealth of the nation. In Smith's view, reliance on the economic self interest of individuals and firms would result in a perhaps surprisingly desirable social outcome. This invisible hand image provides the impetus for what is called the fundamental theorem of welfare economics – that there is a close correspondence between efficient allocation of resources and the competitive pricing of these resources. Whereas the term efficiency may carry different meanings in different academic fronts (see Jollands, 2006 for an exploration on the concept and its interpretation), the focus in this study is *Economic Efficiency*.

Economic efficiency may be defined as a term that refers to the optimal production and consumption of goods and services. This generally occurs when prices of products and services reflect their marginal costs. Economic efficiency gains can be achieved through cost reduction, but it is better to think of the concept as actions that promote an increase in overall net value, which includes but is not limited to cost reductions. Efficiency may be allocative (exchange), productive or distributive efficient. Economic efficiency depends on the factors of production. Something that is technologically efficient may not be economically efficient. But something that is economically efficient is technologically efficient.

Allocative (exchange) efficiency is achieved when the value consumers place on a good or service (reflected in the price they are willing to pay) equals the cost of the resources used up in production. Condition required is that price = marginal cost. When this condition is satisfied, total economic welfare is maximized. Pareto defined allocative efficiency is a situation where no one could be made better off without making someone else worse off. This can be illustrated using a production possibility frontier (PPF) - all points that lie on the PPF can be said to be allocatively efficient because we cannot produce more of one product without affecting the amount of all other products available. Productive efficiency exists when producers minimize the wastage of resources in their production processes. The economy to be productively efficient must produce along the PPF. For distributive efficiency, the PPF has little substance because that is efficiency context, which is concerned with making sure that goods and services are supplied to those who actually need them.

The formal relationship between cost function and production function, which underlines efficiency assessment, was first established by Shepherd (1953, 1970) with assumption of theoretically known efficiency. Whereas other classical production theories had restricted analysis to single output situation, his production functions considered multiple outputs. This marked the beginning of analysis of efficiency of multiple product firms. Quantitative methods of measuring total economic efficiency (with assumption of unknown theoretical efficiency) was pioneered by Farrell (1957), who built upon the work of Debreu (1951) and Koopmans (1951) to define a simple measure of efficiency, which could account for multiple inputs and outputs. Chapter 4 gives a detailed overview of the concepts of efficiency and productivity as theoretically postulated in economics and as used in this study. The next section gives the empirical overview of past studies on efficiency and productivity in the banking sector.

3.1 Some Selected Empirical Studies

Berger et al., (1993) and Berger and Humphrey (1997) presented two literature surveys on the application of frontier-based efficiency and productivity studies in the financial services sector. An interesting observation of these literature reviews is that only a few studies have addressed efficiency and productivity issues in developing countries. Previous studies have mainly focused on evaluating efficiency and productivity gains in the developed countries. Thus, efficiency and productivity in the financial services sector in developing countries have been given a very low priority by researchers. However, with globalization of the activities of financial services sector, it is important to understand the operational performance of the sector in developing countries as well as the developed countries. The purpose of this section is to investigate the existing efficiency and productivity gains-related studies in the financial services sector, which primarily used Data Envelopment Analysis (DEA) to estimate efficiency and productivity gains.

In the literature, there is evidence of a relationship between a sound intermediation process and efficiency in the banking system. An efficient financial system removes or mitigates substantially the uncertainty and risks surrounding financial assets, consequently facilitating intermediation (Horward and Haynes, 2001). As one of the basic benefits of enhanced efficiency, for instance, commercial banks can reduce the spread between lending and deposit rates in order to stimulate loans demand for investments (Vittas, 1991). From the view point of Kenny and Moss (1998), throughout Africa, inefficient financial intermediation exacerbates and contributes to the problem of low saving and investment rates.

King and Levine (1993) assert that development of an efficient banking sector exerts a large causal impact on total factor productivity growth, which in turn causes GDP to grow. They attribute this to the high ability of efficient financial intermediaries to evaluate risk and to identify the investments with the highest returns. Such intermediaries are able to allocate credit efficiently by identifying

innovative investments and directing funds to them. This accelerates total factor productivity, which leads to greater long-term growth.

Because of the rapid growth of financial markets and financial innovations, it has become more important to measure the efficiency of financial institutions. If those financial institutions operate more efficiently, they might expect improved profitability and a greater amount of intermediated funds. Consequently, the consumer might expect better prices and service quality and greater security and soundness of financial systems (Hunter and Timme, 1986).

3.2 Productivity Studies

The concept of total factor productivity, as first discussed in the literature of the 1930s and the first explicit calculation of technical development obtained by generalizing a Cobb Douglas production function by adding an exponential time trend, is attributable to Tinbergen (1941). In the context of this study, total factor productivity (TFP) measures changes in total output relative to inputs, and the concept derives from the ideas of Malmquist (1953) and the distance function approach. Caves *et al.* (1982a) have investigated productivity indices derived from Shepherd's distance function and provided the theoretical framework for the measurement of productivity. This forms the basis for what has come to be known as the Malmquist productivity index number approach. Fare *et al.* (1985, 1994b) have shown how the Farrell's (1957) efficiency indices are closely related to Shepherd's distance functions.

Berger and Humphrey (1992) investigated productivity changes in the Norwegian banking industry for the period 1980-1989. They make use of the Malmquist productivity indices and find that productivity fell prior to the period experiencing deregulation, but grew rapidly when deregulation took place. Grifell-Ttje and Lovell (1996) investigated the sources of productivity change in Spanish banking over the

period 1986-1993 using a generalized Malmquist productivity index and found that commercial banks had a lower rate of productivity growth compared to savings banks, but a higher rate of potential productivity growth. Wheelock and Wilson (1999) used the Malmquist index to study productivity change for all US banks between 1984 and 1993 and found that productivity declined, on average, during this period because of reductions in efficiency. Alam (2001) adopts a similar approach to Wheelock and Wilson (1999) to investigate productivity change in US commercial banking over the 1980s and find a significant productivity increase between 1983 and 1984, followed by a fall in 1985, and growth thereafter.

Altunbas *et al.* (2000) did a study on productivity of European banks and found that technical change has systematically reduced European banks total cost during the 1990s, although Gjirja, M (2001) study of Swedish banks found that technical change became exhausted, with average banks catching up with industry best practice.

3.3 Drivers of Inefficiencies

Empirical studies have given mixed signals on sources of efficiency gains. Yue (1992) found that the main source of inefficiency in the largest 60 commercial banks in Missouri is technical inefficiency. The contribution of scale diseconomies is relatively low. Drake (2001) investigated the efficiency of 10 UK banks during 1984-1995. That study found increasing returns to scale in small banks and decreasing returns to scale in large banks. Consequently, Drake suggested that the banking industry in the UK suffers from scale diseconomies, particularly for the smallest and the largest banks (i.e., except medium sized banks). Darrat *et al.*, (2002) found that allocative (regulatory) and technical inefficiency (managerial) have affected the efficiency of Kuwait banks. Over the period 1990-1993, the productivity growth in US rural banks was attributed to technological change rather than the pure-technical change or scale change (Devaney and Weber, 2000).

Elyasiani and Mehdian (1990) found that during the period 1980-1985, US banks enjoyed a positive technical change.

Drake and Hall (2003) investigated technical and scale efficiency in Japanese banks using a cross-section of data to find evidence for efficiency of potential bank mergers. The result signaled that Japanese banks exhibited considerable overall inefficiency, with a sample mean for overall efficiency of 72.36%. Drake and Hall (2003) found that the main reason for productive inefficiency is pure-technical inefficiency, and the exclusion of problem loans from productivity analysis may over-estimate the potential economies of scale. In another study on Turkey, which aimed to find improvement in efficiency and productivity gains from deregulation, the main source of productivity gain was found to be catching up with the best practice banks, rather than technical progress (Isik and Hassan, 2003a). This result further suggested that domestic banks suffer from diseconomies of scale. In contemporary frontier-analysis studies, many researchers have focused on the short-run production frontiers.

Prior (2003) attempted to construct long-term and short-term cost frontiers using non-parametric methods to find the capacity efficiency in Spanish savings banks. Prior (2003) separated inputs into variable and fixed inputs, with the short-run frontier constructed by considering variable inputs and the long-run frontier constructed using both fixed and variable inputs. The difference between estimated efficiencies using long-run and short-run cost frontiers is identified as capacity efficiency. The study revealed that a significant portion of inefficiency in Spanish commercial banks arose due to capacity under-utilization. One main objective of these studies was to find an appropriate scale of operation for banking institutions. However, the results are somewhat complicated. Many studies suggested that either large banks or small banks were not able to gain the benefit of economies of scale of operations. The problem of optimum scales for banking operations is yet to be resolved.

One of the issues of efficiency studies concerns factors that drive inefficiency. Economic inefficiency is the opposite of economic efficiency. It is a general term, which refers to the situation where we could do a better job to attain the same output/results at lower cost. Some forms of inefficiencies include (a) productive inefficiency, where we could produce some given output at a lower cost or produce more output at the same cost; (b) X-inefficiency, which is a motivational inefficiency that occurs when efforts and effectiveness of the managers are low; (c) allocative inefficiency, which concerns the situation where resources allocation to alternative uses does not fit well with consumers' taste. Thus, inefficiency may be attributed to technical, operational/motivational and structural impediments.

3.4 X-inefficiency Studies

Leibenstein (1966) coined the term X-efficiency to describe management laxity that arises in firms with market power. In the banking cost literature, the term X-inefficiency has come to be used in a more general sense to describe any excess cost of production not caused by sub-optimal scale and scope. Depending on the methodology used, estimates of X-inefficiency range from as little as 10% to as much as 50% of costs at the average bank, with most studies finding X-inefficiencies equal to around 20-25% of costs.

Another source of inefficiency is the *agency problem*, which is a consequence of management styles (Fan, 1975). Fan shows that where firms operate under own manager control as opposed to the employee manager control, productivity increases. Here, the crucial issue is the positive contribution of incentives/bonus to affect the effort of the managers and workers.

Academic research on the performance of financial institutions has increasingly concentrated on X-efficiency (or frontier efficiency), which measures deviations in

performance from that of best practice firms on the efficient frontier, holding constant a number of exogenous market factors such as prices faced in the local market. The efficient frontier measures how well the financial institution performs relative to the predicted performance of the best firms facing the same market conditions in the industry. X-efficiency often measures cost efficiency of institutions more accurately than does standard financial ratios (De young, 1998). Comparing the financial ratios of different banks is not appropriate, unless the banks are nearly identical in terms of product mix, bank size, market conditions and other characteristics that can affect the costs of the banks. Thus, statistical-based "efficient cost frontier" approaches would measure efficiency more accurately.

Empirical studies of X-inefficiency in banks find that banks of similar size and product mix incur widely divergent costs that vary by amounts for larger than the savings available from scale and scope economies. Pi and Timme (1993) found that X-inefficiency in large, publicly-traded commercial banks decreased as the Chief Executive Officer (CEO) stock ownership increased, as long as the CEO was not also the chairperson of the board of directors. When the two positions (CEO and Chairperson) were consolidated, concentrating power in the hands of the CEO led to increase in X-inefficiency, with the percentage of the firm owned by the CEO.

Grabowski et al. (1993), used DEA to analyze differences in organizational form across banks. They found that X-inefficiency is larger in multi-bank holding companies than in branch banking organizations. The authors concluded that to the extent that multi-bank holding companies are organizational arrangements designed to circumvent product and geographic market restrictions, removal of regulatory barriers will improve efficiency in banking markets by reducing X-inefficiency. In contrast, Newman and Shrieves (1993) found that multi-bank holding company organizations have about 2% cost advantage over branch banking organizations. Evidence shows that increasing bank branches and other regulatory restrictions prevent banks from operating as efficiently as possible.

Evanoff and Israilevish (1991) found that X-inefficiency in large banks is greater in regions characterized by more restrictive state level regulation, and also that X-inefficiency in these banks decreased after financial deregulation of the early 1980s. Evidence is mixed regarding the relationship between X-inefficiency and commercial bank size. X-inefficiency may decrease with bank size if large banks face greater pressure from shareholders, or if larger banks are better able to attract capable managers, or because large banks tend to be located in intensively banked, densely populated metropolitan areas where competitive pressure may be greater and branch offices are more likely to operate at efficient scale.

Kirkpartrick *et al* (2008) use cost efficiency and profit efficiency approach to measure the degree of X-inefficiency for a panel of 89 banks in nine Sub-Saharan African countries. The study covered eight years from 1992-1999. The determinants of X-inefficiency are then modeled in terms of bank specific factors and general macroeconomic variables. The findings showed that the degree of cost X-inefficiency was exacerbated by bad loans, high capital ratios and financial liberalization. In contrast it was shown that larger banks are more efficient and that the level of foreign bank penetration reduced X-inefficiency. The findings were found to be important for bank managers in Sub Saharan Africa.

Empirical evidence linking X-inefficiency and market power was originally posited by Leibenstein (1966). Edwards (1977) found that banks in highly concentrated markets tend to hire more labour and pay them higher wages than banks in less concentrated markets. In contrast, Rhoads (1980) found no consistent (and in a few cases a negative) relationship between concentration and expense levels in banks, and rejected the expense preference framework for bank managers. Berger and Humphrey (1992) regressed an ordinal measure of X-inefficiency on a set of variables that included market concentration and found no relationship between concentration and X-inefficiency.

3.5 Financial liberalization and efficiency

Past empirical studies postulate that financial liberalization enhances the efficiency and productivity of banks by creating a competitive and flexible environment in which banks have more control over their operations. Bhattacharyya *et al.* (1997) report that deregulation and liberalization had a major impact on productivity and efficiency increases in various industries, and the banking sector in some Eastern and Central European countries, as well as China. Although the primary goal of liberalization and deregulation has been to improve efficiency, earlier results have been mixed; in particular, the short term effects of liberalization have been discouraging.

Leightner and Lovell (1998) measure total factor productivity growth of Thai banks during 1989-1994 to evaluate the financial liberalization of the late 1980s. Using two alternative input-output models, one based on commercial banks' objective to generate revenue and the other based on central bank's objective to intermediate funds, they construct a Malmquist total factor productivity index for Thai banks. Leightner and Lovell (1998) find that productivity of banks improved after liberalization. Using a similar approach, Gilbert and Wilson (1998) also find that financial liberalization in Korea had positive impacts on productivity of the Korean banking industry during the early 1990s.

In contrast, Hao *et al.* (2001) use a parametric Stochastic Frontier Approach (SFA) to measure the efficiency of Korean banks and do not find any positive relationship between the measured efficiency and financial liberalization. Isik and Hassan (2003) employ DEA to construct a Malmquist total factor productivity index for Turkish banks during 1980-1990, and suggest that the performance of banks improved after implementation of financial liberalization. In contrast, Yildirim (2002)

analyses the technical efficiency of Turkish banks between 1988 and 1999 using non-parametric DEA and find that Turkish banks did not achieve any sustained efficiency gains over the sample period.

There are a number of studies done on bank efficiency in the US, and they have made use of panel data. These studies (Gilbert, 1984; Berger et al., 1993; Clark and Speaker, 1996; Mitchell and Onvural, 1996; Berger and Humphrey, 1997) overall conclude that US banks average cost curve is relatively flat when compared to European banks. Most of empirical work on European banks has focused on cost functions using data from single bank or country. They find a U-shaped average cost and, to some extent, scope economies exist (Parisio, 1992; Berger *et al.*, 1993; Altunbas *et al.*, 2000; Drake and Simper, 2002).

Kasekende L. *et al* (2009), analyze the broad financial sector reforms in four largest economies in Africa in the context of globalization and internal factors that may have influenced their form and impact. The study examined the sector's transformation caused by movement towards financial consolidation in large economies such as South Africa and Nigeria by way of bank wide mergers and alliances. The study considers the likelihood of consolidation extending across segments of the sector given the potential synergies between the banking securities and insurance sectors, and the impact this would have on enhancing competitive conditions in financial services in African economies. The idea was that competition stimulates productivity growth either through general technical progress or through improved efficiency, or both. They found that the models and approaches these countries adopted (for example South Africa's gradualist approach) in terms of financial restructuring worked. These were good lessons for other countries in Africa.

3.6 Kenyan Studies

In their analysis of the structural issues in the financial system in Kenya, Beck and Fuchs (2004) observe that there are large differences in productivity across different ownership groups of Kenyan banks. They report that, compared to banks in other sub-Saharan Africa countries, and other emerging countries, Kenyan banks seem to be over-staffed, and their employees less productive. They find State-owned banks in Kenya to have twice as many employees relative to their assets, loans and deposits as foreign-owned banks. The higher productivity of foreign-owned banks compensates for the higher wage costs of these banks, compared to domestic banks. Private domestic banks are less productive and more over-staffed than foreign-owned banks, but more productive and less over-staffed than state-owned banks. They emphasize that disparity across ownership groups indicates significant potential gains from increased competition, and the resulting efficiency improvements. Further, the analysis of the overhead costs shows that they are driven by wage costs, which constitute 50% of total overhead costs), fraud, security costs, the inefficient payment system and a heavy regulatory burden. The study makes use of financial and accounting ratios to make the comparisons and analysis.

3.7 Synthesis of the Literature Reviewed

This chapter has provided a brief review of empirical literature on efficiency and productivity studies, with special reference to the banking industry and DEA-SFA-based studies. Several important issues needing further attention are identified and outlined below. The empirical studies have mixed evidence on the outcomes of financial liberalization. While some countries have enjoyed positive outcomes, some other countries have not been able to maintain previous gains, which they had before liberalization. Therefore, it is difficult to derive a conclusion about the outcome of financial liberalization in a particular country based on studies made in other countries.

Efficiency studies on banks and other financial institutions have been conducted in developed and developing countries. However, majority of studies conducted concentrated on financial sectors in the US and Europe. These studies estimated efficiency levels of different sizes of banks and bank branches, and made comparisons between them. Existing research has shown that financial institutions are less than fully efficient and have quantified the apparent extent of this deficiency. The literature also indicates that development and efficiency of financial intermediaries are important determinants of economic growth. Past studies in Kenya point to the fact that Kenya exhibits low efficiency of financial intermediaries as evidenced by the high interest rate spreads in the banking sector. However, little has been done on the examination of the level of efficiency and trends in efficiency of commercial banks in Kenya.

Overall, this survey has highlighted that financial services sectors in developing countries have not been adequately researched. In-depth analysis of these markets is essential to formulate the required policies. The findings in other countries are probably irrelevant to a particular country. Not only are differences in the social, political and economic environments important but the geographical environment may also have a significant influence over efficiency and productivity gains. Therefore, it is essential to do a country-specific analysis.

The next three chapters will use this literature to form an analytical framework for analysis of efficiency and productivity gains, and to measure banks X-inefficiency and identify factors affecting the banks' X-inefficiency.

CHAPTER FOUR: ANALYTICAL FRAMEWORK AND METHODOLOGY

4.0 Introduction

This chapter lays out the analytical framework and the methodology to be used in this study. The first section introduces various concepts and theoretical foundations on productivity and efficiency. The second and third sections discuss the approaches that can be applied for measuring productivity in a business unit in a given industry. The first three sections set out the analytical framework in which the sections that follow extend the models to analyze the efficiency and productivity changes in the Kenyan banking industry. Section four, therefore, justifies methodologies adopted in estimating efficiency. Section five lays down the methodology adopted for the translog cost function and the last part discusses the methodology adopted in analyzing the factors determining the X-inefficiency in the banking sector.

4.1 Concept of Efficiency and Productivity

Productivity is generally defined as the relation between output (produced goods) and input (consumed resources) and can be regarded as one of the most vital factors affecting competitiveness of a business firm (Robert, 1998). A firm can achieve productivity gains by producing either a greater output from a given level of inputs or by using a minimum amount of inputs to produce a given level of outputs (Coelli *et al.*, 1998). In this context, productivity can be defined as the ratio of the output(s) to the input(s) used.

Firms use technology to convert inputs into outputs. Thus, efficiency is determined by, among other things, the technology that a firm uses in production. The technology of a firm may be represented by production frontiers, profit functions, cost functions or by distance functions. Focus is given to the production frontier here. From a theoretical stand point, let us suppose the production inputs of a production unit are represented by the input vector $\mathbf{X}=(X_1,.....X_k)\in\Re^{K+}$ and the

outputs are denoted by the output vector $Y= (Y_1,.....Y_j) \in \Re^{J+}$. We further assume that inputs prices are represented by price vector $\mathbf{W}= (W_1,.....W_k) \in \Re^{K+}$, where the production possibility set (PPS) of this production unit is a set S of the vector space $\Re^{K+J}$. The production unit or Decision Making Unit (DMU) may select any input-output combination (X, Y) $\in$S in its production process (Fare and Grosskopf, 2004).

The PPS can be represented in two ways: by output possibility set and by input requirement set. By output possibility set $P(X)$ = (Y: X *can produce* Y) $\in$S, which maps **x** in to the subset $P(\mathbf{x})$. That is, the output producible set $P(\mathbf{x})$ denotes all output **y** that can be produced by input vector **x**. By the input requirement set $L(\mathbf{y})$ = (**x** : **x** *can produce* **y**) $\in$S, which maps **y** into the subset $L(\mathbf{y})$ of inputs. In other words, the inputs set $L(\mathbf{y})$ denotes all input vectors **x** that yield output **y** (Fare *et al.*, 1994; Coelli *et al.*, 1998). Both output producible set $\mathbf{y} \in P(\mathbf{x})$ and input requirement set $\mathbf{x} \in L(\mathbf{y})$ are equivalent presentations of the technology, that is, $\mathbf{y} \in P(\mathbf{x}) \Leftrightarrow (\mathbf{x},\mathbf{y}) \in S \Leftrightarrow \mathbf{x} \in L(\mathbf{y})$.

The axioms below must hold for output producible set $P(X)$ and input requirement L(Y)

(a) $P(\mathbf{x})$ is convex, implying that if two combinations of outputs can be produced with a given input vector **x**, then any average of these output vectors can also be produced by **x**—this implicitly requires continuous divisibility of commodities.

(b) $0 \in P(\mathbf{x})$, nothing can be produced out of a given set of inputs.

(c) Non-zero output levels cannot be produced from zero levels of inputs.

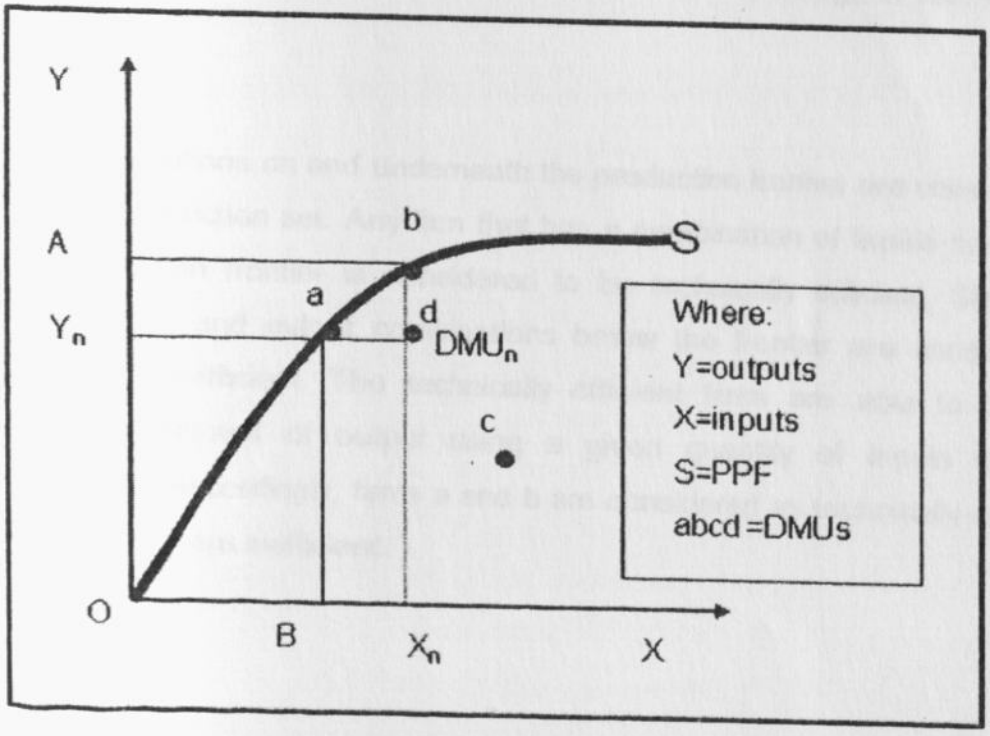
(d) $P(\mathbf{x})$ satisfies strong disposability of both inputs and outputs.

(e) $P(\mathbf{x})$ is bounded for each $x \in \Re^{K+}$, implying unlimited levels of outputs cannot be produced from a limited amount of inputs (*This axiom is the only exception for the input requirement set*).

(f) $P(\mathbf{x})$ is closed (see Kumbakhar and Lovell (2000), Coelli *et al.*, 1998).

This may be illustrated graphically below (Figure 4.1). In this, case we use the input and output efficiency measures in a single input (x) and single output (y). The thick line represents the efficient frontier of the production possibility set S. The *n*-th Decision Making Unit (DMU), or firm or bank, is said to be technically efficient if its input-output combination (Xn,Yn) lies in the boundary of set S. The Farrell output-oriented technical efficiency measure is read from the vertical axis *y* as *OA / OYn* —that is the length of line segment OA divided by length of line segment OY*n*. Similarly, the Farrell input-oriented technical efficiency measure is read from the horizontal axis *x* as *OB / OXn*. These efficiency measures also have an attractive dual interpretation in terms of economic efficiency. Given corresponding output and input price vectors, the revenue efficiency of n-th DMU is the ratio of the maximum revenue obtainable by inputs of n-th DMU to the actual obtainable revenue. Similarly, the cost efficiency of n-th DMU is the ratio of the minimum cost of producing output of DMU n to the actual observed cost (Coelli *et al.*, 1998).

Figure 4.1: Production possibility frontier



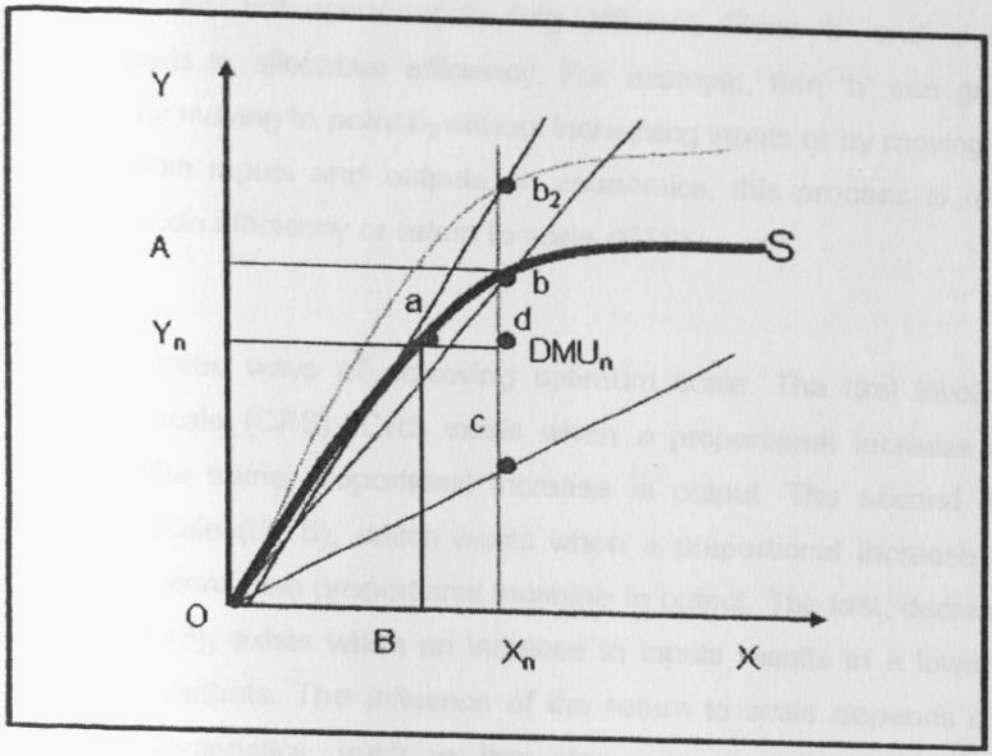
Source: An extension of Coelli et al. (1998: 4)

Having gone through the meaning of PPS of the n-th unit, S, input requirement set $L(\mathbf{y})$ and output possibility set $P(\mathbf{x})$, efficiency may now be defined as follows. According to (Kumbakhar and Lovell, 2002), a production unit or a DMU with an input-output configuration $(\mathbf{x},\mathbf{y}) \in S$ is efficient if there is no $(\mathbf{x}^*,\mathbf{y}^*) \in S$, $(\mathbf{x}^*,\mathbf{y}^*) \neq (\mathbf{x},\mathbf{y})$ with $\mathbf{x}^* \leq \mathbf{x}$ and $\mathbf{y}^* \geq \mathbf{y}$. From the input requirement set $L(\mathbf{y})$ perspective, an input vector $\mathbf{x} \in L(\mathbf{y})$ is technically efficiency if and only if $\mathbf{x}^* \notin L(\mathbf{y})$ for $\mathbf{x}^* \leq \mathbf{x}$. Correspondingly, from the output producible set $P(\mathbf{x})$, an output vector $\mathbf{y} \in P(\mathbf{x})$ is technically efficient if and only if $\mathbf{y}^* \notin P(\mathbf{x})$ for $\mathbf{y}^* \geq \mathbf{y}$.

The terms efficiency and productivity are not precisely the same thing. Coelli *et al.* (1998) used a simple production process, which produces a single output using a single input to illustrate the difference between efficiency and productivity based on the diagram reproduced above (Figure 4.1). The curve S in Figure 4.1 above depicts the production frontier, which indicates the maximum possible level of output that can be attained using inputs with maximum efficiency. Accordingly, the production frontier reflects the current state of the technology in the industry under review.

The combinations on and underneath the production frontier are considered as the feasible production set. Any firm that has a combination of inputs and outputs on the production frontier is considered to be technically efficient. Similarly, firms having input and output combinations below the frontier are considered to be technically inefficient. The technically efficient firms are able to produce the maximum amount of output using a given quantity of inputs with existing technology. Accordingly, firms a and b are considered as technically efficient firms while c and d are inefficient.

Figure 4.2: Production possibility frontier II



Source: An extension of Coelli et al. (1998)

Figure 4.2 illustrates the difference between efficiency and productivity. Since productivity is defined as the ratio of outputs to inputs, the slope of the ray drawn from the origin to a particular data point can be used to measure productivity. If firm 'c' wants to achieve the technically efficient output level enjoyed by firm 'b', firm 'c' must be able to gain a higher level of productivity than before. Even firm 'b', which is operating as an efficient firm, can gain a higher level of productivity by achieving the current production level of 'a'. Since firm 'a' has the highest output to input ratio, that point is regarded as the point that exhibits the optimum scale of production. This implies that any firm which is operating at any point other than point 'a' has lower productivity. Thus, economically, efficient firms should lie on the point that indicates the optimum scale of operation in the production frontier. All other firms on the production frontier are technically efficient but not allocatively efficient. As indicated in Figure 4.2, only firm 'a' is operating at optimal scale. The

other firms, 'b' and 'c', are technically efficient but not efficient in scale. Therefore, those firms are not economically fully efficient. Firms 'b' and 'c' should seek improvements in allocative efficiency. For example, firm 'b' can gain economic efficiency by moving to point b_2 without increasing inputs or by moving to point c by reducing both inputs and outputs. In economics, this process is referred to as obtaining scale efficiency or return to scale (RTS).

There are three ways of achieving optimum scale. The first involves constant returns to scale (CRS). CRS exists when a proportional increase in all inputs results in the same proportional increase in output. The second is increasing returns to scale (IRTS), which exists when a proportional increase in all inputs results in a more than proportional increase in output. The last, decreasing returns to scale (DRS), exists when an increase in inputs results in a lower percentage increase in outputs. The influence of the return to scale depends on the firm's/ bank's characteristics, such as firm size, nature of the industry and overall environment of the economy. As indicated by Coelli, *et al.* (1998), the RTS can be investigated by estimating the total elasticity of production.[21]

The consideration of scale moves firms from the short-run to the long-run, where all inputs may be varied. In the long-run, productivity improvements are expected to stem from both increases in technical efficiency and technical change. Technological change produces an upward shift of the production frontier. Allocative efficiency exists when a firm is able to select an input mix to produce an output mix at a minimum cost. Allocative efficiency `and technical efficiency collectively contribute to economic efficiency (Coelli *et al.*, 1998).

Productivity measurement may be limited to single physical units or may involve prices of factors and outputs. The concept of productivity is linked closely with the

[21] The total elasticity of production measures the proportional change in output resulting from change in inputs.

issue of efficiency and encompasses several efficiency elements, such as price efficiency, allocative efficiency, technical efficiency and scale efficiency. The overall productivity level of an organization depends on all these elements.

Improvements in efficiency and productivity gains can be considered as one of the goals of a firm in a competitive market. Therefore, measurements in efficiency and productivity gains provide supplementary information about the firm's performance. These measurements can be considered as non-financial performance indicators as they consider all of the contributors to the firm's performance. In any organization, whether it is profit-oriented or not, measurements of productivity help to analyze the efficiency of resource use in the organization. Moreover, productivity indices help to set realistic targets for monitoring activities during an organizational development process by highlighting bottle-necks and barriers to performance.

Productivity can be measured by using either partial-factor productivity, which is the ratio of output (measured in specific units) to any input (also measured in specific units), or total factor productivity (TFP), which is the ratio of total outputs to total inputs used in production. Partial measures can be defined for specific operational attributes such as total revenue per labour unit, expenses as a percentage of total assets, and return on assets. In contrast, TFP measures the overall effectiveness of utilization of inputs to produce the outputs. Production frontier analysis (PFA) and index number approaches can be used to estimate TFP. The main PFA approaches that are used for estimating TFP are explained in the Section 4.2.

The index number approach is an alternative method that can be applied for estimating total productivity. Grifell-Tatje and Lovell (1996) identified the Tornqvist Index, the Fisher Ideal Index (which is geometric mean of the Laspeyres and Paasche Indices) and Malmquist Productivity Index (MPI) as the main indices that can be used in productivity analysis. The popularity of Tornqvist and Fisher ideal

indices result from two desirable features they share (Gritell-Tatje and Lovell, 1996). First, both can be calculated directly from price and quantity data, and it is not necessary to recover the structure of the underlying best practice production frontier, and how it shifts over time whether by using econometric techniques to estimate the parameters of functions characterizing the frontier or by using mathematical programming techniques to construct the frontier. Second, both are consistent with flexible representation of the frontier; that is both are superlative indices (Caves *et al.*, 1982).

The popularity of the Malmquist index stems from three quite different sources. First, it is calculated from quantity data only, a distinct advantage if price information is unavailable or if prices are distorted. Second, it rests on much weaker behavioural assumptions than the other two indices, since it does not assume cost minimizing or revenue maximizing behaviour. Third, provided panel data is available, it provides decomposition of productivity change into two components. One is labeled technical change, and it reflects improvement or deterioration in the performance of best practice manufacturing industries. The other is labeled technical efficiency change, and it reflects the convergence toward or the divergence from best practice on the part of the remaining banks. The value of the decomposition is that it provides information on the source of overall productivity change in the banks. In this study, the Malmquist index is implemented by solving a series of linear programming problems to construct the distance function that make up the Malmquist index. These distance functions characterize the best practice frontier at any point in time, and they also characterize shifts in the frontier over time as well as movements towards or away from the frontier.

4.2 Frontier Approaches

Majority of researchers have relied on relative productivity measures based on Frontier Approaches (FA). Those studies have used observed data to construct the production frontier for estimating efficiency and productivity gains. Both

econometric (parametric) approaches and linear programming (non-parametric) approaches can be applied to construct a production or cost frontier. The econometric approach uses pre-specified functional forms such as 'the translog production or cost function' (Coelli *et al.*, 1998). The relative efficiency and productivity gains of the firms in a given industry have been measured using the production frontier. Berger and Humphrey (1997) identified two advantages of using frontier analysis as a tool for measuring efficiency and productivity gains. The first is that FA allows an analyst to select the best performing firms (or branches) within a given industry (or within the branches in the same firms) by measuring relative productivity. The second is that it allows management to objectively identify areas of best practice within complex service operations.

4.2.1 Parametric approaches

There are three parametric approaches, namely stochastic frontier approach (SFA), distribution free approach (DFA) and the thick frontier approach (TFA). SFA is also known as the econometric frontier approach, which specifies a functional form for the cost, profit or production relationship among inputs, outputs and environmental factors. SFA allows for random error. DFA uses more flexible functional forms and is based on no strong assumptions about the specific distributions of error term. TFA specifies a functional form and assumes that deviations from predicted performance values within the highest and lowest performance quartiles of observations represent random error, while deviations in predicted performance between the highest and lowest quartiles represent inefficiencies. Favero and Papi (1995) presented the following arguments against the parametric approaches in general:

- Parametric approaches use a specific functional form. Therefore, the shape of the production frontier is pre-supposed;
- Parametric approaches need to specify assumptions about the form of the production function;

- It becomes impossible to implement diagnostic checking on the fitted model based upon the estimated residual due to the assumptions;
- It is difficult to implement in multi-input multi-output settings. The outcome of the parametric approaches is significantly influenced by the size of the sample. If the sample is not able to provide an adequate number of observations to be applied for estimating the variables for constructing the production frontier, the estimated econometric model may provide misleading information.

4.2.2 Non-parametric approaches

Contrary to the parametric approaches, non-parametric methods are not based on a pre-specified functional form. DEA and free disposal hull (FDH) are the two main non-parametric approaches used for measuring productivity. DEA provides benchmark indices for evaluating the relative productive efficiency of DMUs in a given industry or sub-units in a firm. Different forms of DEA models have been developed based on different perspectives (Table 7). DEA was first used for comparing the performance of a matched set of school districts (Charnes *et al.*, 1997). Since then, DEA has been widely used for analyzing efficiency and productivity gains in many industries, including the service sector. It integrates multiple inputs and outputs into one productivity indicator using a linear programming technique (Reynolds and Thompson, 2002). The linear programming technique allows both controllable and uncontrollable variables and produces a productivity index which relates all units under comparison. The FDH model is an alternative specification of the DEA model in which the points on the line connecting the DEA vertices are not included in the frontier.

In general, non-parametric approaches have the following features/assumptions:

- A specific functional form is not used (Drake and Hall, 2003);
- No measurement error in constructing the frontier (Drake and Hall, 2003);

- No scope for 'luck' to temporarily give a DMU an apparently better measured performance one year than the next; and
- No inaccuracies created by accounting rules that would make measured outputs and inputs deviate from economic output and inputs.

However, non-parametric approaches also have some inherent weaknesses. These weaknesses reduce the usefulness of the non-parametric methods to some extent. Some of these weaknesses are listed below (Berger and Mester, 1997):

Non-parametric approaches:

- Do not allow for random error;
- Ignore price information;[22]
- Estimate technical efficiency only and do not account for allocative efficiency;
- Lead to a comparability problem on the heterogeneity of product mixes of DMUs;
- Make it difficult to find out whether the output being produced is optimal without value information on the outputs; and
- Focus on technological rather than the economic optimization.

Efficiency of a DMU is influenced by three different phenomena (Fried *et al.*, 2002), namely the efficiency with which management organizes production activities, the environment in which production activities are carried out, and the impact of 'good and bad luck'. The deterministic nature of DEA ignores the above phenomena when estimating efficiency of DMUs. Further, Berger and Mester (1997) argue that the parametric approach overcomes many of the shortcomings of non-parametric approaches, and showed that the parametric approach can accommodate different definitions of efficiency, such as cost efficiency and profit efficiency. However, both parametric and non-parametric techniques suffer from drawbacks. In many

[22] In 1998, Coelli introduced an element of Cost DEA.

empirical studies, a large number of DMUs classify as efficient (Griffin and Kvam, 1999). As such, the ranking of DMUs becomes difficult. Neither technique accounts for the distribution of DMU values in the input/output space that typically distinguish smaller firms from larger ones. Furthermore, efficiency scores for all DMUs are stated with equal confidence, even if some of the DMUs are divergent in terms of input and output values.

Both parametric and non-parametric approaches have advantages as well as disadvantages. There is no specific set of criteria to select the most relevant approach for constructing the production frontier. Tortosa-Ausina (2002) pointed out that the choice of technique, either non-parametric or parametric, is somewhat arbitrary, depending on the aims pursued. Coelli and Perelman (1999) applied both parametric approaches and non-parametric approaches to estimate the production frontier of European railways. That study used the corrected ordinary least square method (COLS), the parametric linear programming method and DEA. The three approaches, which were used in that study, reported similar findings on the relative productive performance of the DMUs. Coelli and Perelman (1999) showed that researchers can safely select one of the PFA approaches without too much concern about their choice having a large influence upon results. However, they stressed that the use of a parametric approach allows analysts to test their hypotheses. All of the methods are not able to provide robust estimation of the relative efficiency of DMUs. Therefore, they suggested using the geometric average of the efficiency indices identified using alternative approaches.

4.3 Data Envelopment Analysis and the Different Specifications

DEA is a performance analysis technique, which is not based on a pre-defined functional form. It measures the relative productivity of the DMUs. Productivity indeces for each unit are determined by using actual data. The original Charnes *et al.* (1978) formulation (called the CCR model) determines the relative efficiency measure for a DMU by maximizing the ratio of weighted outputs to inputs based on

the condition that similar ratios for all DMUs are less than or equal to one. Therefore, each efficient DMU has a weight equal to unity and inefficient DMUs should have a weight less than one. The CCR model and Banker *et al.* (1984) model (called the BCC model) are the two basic DEA formulations, which have been commonly used in empirical studies. The CCR model uses an optimization method of mathematical programming to generalize the single output/input technical measure to the multiple outputs/multiple inputs case. It is based on CRS when enveloping the actual data to determine the shape of the production frontier. Contrary to the CCR model, the BCC model uses variable returns to scale (VRS) for identifying the envelopment surface.

As stated above, CCR ignores the relative size of the DMUs when estimating efficiency. It is assumed that an increase in output is always proportional to an increase in inputs and, thus, the scale of production is ignored. On the other hand, BCC models give precedence to the scale of operation in estimating efficiency. Therefore, efficiency estimated using BCC refer to pure-technical efficiency while estimates using CCR refer to technical efficiency. The difference between estimated CCR and BCC efficiency scores is denoted as scale efficiency. DEA uses three projection paths of inefficient units to the envelopment surface for measuring the efficiency, namely: input-oriented, output-oriented and additive. The input-oriented model identifies technical inefficiency as a proportional reduction in input usage for a given level of output. Contrarily, the output-oriented model identifies technical inefficiency as a proportional augmentation of output for a given level of input. Additive models combine both effects of input utilization and output augmentation (Coelli *et al.*, 1998).

The traditional DEA limits the efficiency scores of efficient units to 100% in both input-oriented models and output-oriented models. DEA scores for inefficient units are lower than 100%. Both input-oriented and output-oriented models recognize

the same DMUs as efficient. However, scores assigned to the inefficient units are not the same in the two projection modes (Lovell and Rouse, 2003).

Since the publication of the CCR model, DEA techniques have emerged as the most used methodology for efficiency analysis. Several alternative DEA models have been formulated and presented by various researchers to overcome problems and weaknesses of the initial DEA specification. Table 4.1 below summarizes some basic DEA models that have been used in empirical studies of banking and the financial services sector.

Table 4.1: Forms of DEA models

Model	Contributor	Major Features
CCR	CCR (Charnes, Cooper and Rhodes,1978)	Input-oriented and Constant returns to scale
BCC	BCC (Banker Charnes and Cooper,1984)	Input-oriented and Variable returns to scale
Categorical Variable model	Banker and Morey (1986)	Variables previously measured on a constant return to scale are now incorporated as present – not present variables in the analysis.
Super efficiency model	Anderson and Peterson (1993)	Allows ranking of efficient DMUs
Stochastic DEA	Sengupta (2000)	Allows incorporation of random error in input-output data
Equivalent Standard DEA	Lovell and Rouse (2003)	Allow outlier identification, sensitivity analysis and inter-temporal analysis.

4.3.1 Selection of the DEA model

The DEA model constructs a production frontier by piecewise comparison of DMUs in the sample and does not use a pre-specified functional form. However, the model requires a specified set of outputs and inputs, and choice of appropriate returns to scale and an appropriate method of efficiency projection. Incorrect choices in relation to these features are likely to diminish the value of analysis (Smith, 1997). This problem is complicated because the DEA model does not provide diagnostic tests to judge the suitability of a chosen model as do econometric frontier estimation models. Therefore, even though no functional form is specified in DEA, model specification must be a central concern.

Different DEA models address different issues of productivity. These models have attempted to overcome the limitations of initial DEA models. Mainly, CCR and BCC models have been applied for estimating efficiency of financial institutions. A number of analysts have measured technical efficiency based on input-oriented DEA models. Some studies have used output-oriented models, as the regulatory environment does not restrict the flexibility of managerial decision making.

Selection of returns to scale setting is another critical issue in DEA-based studies. Berg *et al.* (1993) emphasizes that VRS is the most appropriate assumption since the scale classification in banking is a classical issue. They proposed that the efficiency scores given by the VRS (BCC) model are more robust to mis-specifications. On the other hand, CRS allows comparison of large banks with much smaller banks. Thus, CRS (CCR) avoids the over-estimation of efficiency of small DMUs in the target sample. However, simultaneous use of CCR and BCC DEA-models allows analysts to decompose technical efficiency into scale and pure-technical efficiency. Therefore, the majority of studies on financial institutions have used both CCR and BCC models. The use of both approaches permits analysts to decompose the efficiency estimation into overall technical efficiency, pure-technical efficiency and scale efficiency.

Homogeneity of DMUs is one of the assumptions behind DEA. Lack of homogeneity among the firms (size, forms of organization) in the industry and the geographical locations of firms have influenced the model specification. The homogeneity assumption does not hold when there are outliers in the sample. The outliers may significantly over-state or under-state the estimated efficiency scores. In many empirical studies, the outliers have been removed from the study sample to avoid possible distortions in estimated efficiency scores. Brown (2001) study on Australian banks revealed that the efficiency estimation may be distorted if the heterogeneous features are not recognized. As an alternative way of addressing heterogeneity, a categorical variable approach can also be used. Categorical variables can be introduced to DEA models as inputs or outputs to recognize the various features inherent to DMUs, which may influence the estimated efficiency (Banker and Morey, 1986). This strategy is mainly used in cross-country comparisons of efficiency.

4.3.2 Malmquist Productivity Index, Scale efficiency and technological change

The MPI originally developed by Caves *et al.* (1982) has been used in previous studies to decompose various components of estimated productivity improvements and efficiency. A variant of MPI has been used to decompose scale efficiency from technical efficiency. In DEA-based efficiency studies, efficiency losses from scale and managerial decisions have been identified using the MPI (Coelli *et al.*, 1998). Scale efficiency is measured using BCC-DEA and CCR-DEA models. The estimated efficiency using the CCR-DEA model is identified as technical efficiency. Similarly, the estimated efficiency using BCC-DEA is identified as pure-technical efficiency (Cooper *et al.*, 2000).

DMUs with estimated efficiency scores of '1' for both CCR-DEA and BCC-DEA models are considered as fully efficient (Banker *et al.*, 2004). If there is a difference in the CRS and VRS estimated efficiency for a particular firm, it is not regarded as

a fully efficient DMU (Coelli et al., 1998). The difference between CCR and BCC estimated efficiencies is regarded as scale inefficiency. It can be decomposed by dividing the technical efficiency estimated by CCR by the estimated efficiency using BCC. However, the estimated scale efficiency may distort the real scale efficiency when the sizes of DMUs under consideration are significantly different (Dyson *et al.*, 2001).

4.3.3 Inputs and outputs restrictions and specifications

There are two important aspects when it comes to DEA input and outputs choice. One is the restrictions and the other specifications of inputs and outputs. There are two main issues to be addressed in the specification for inputs and outputs in productivity analysis. Firstly, inputs and outputs need to be defined. Secondly, suitable measurements of inputs and outputs need to be used.

On the restrictions, the number of inputs and outputs is always restricted by the number of DMUs in the sample. The ability of DEA to discriminate between efficient DMUs and inefficient DMUs depends on the number of inputs and outputs that are incorporated in the DEA model. Therefore, the product of the number of inputs and the number of outputs should not exceed the number of DMUs in the sample (Cooper et al., 2000). As a rule of thumb, Dyson *et al.* (2001) proposed that the product of the total number of inputs and outputs should be no more than 50% of the number of units under investigation to achieve a reasonable level of discrimination.

On the other hand, limiting the number of variables may also under-state the relative efficiency estimations. Cinca *et al.* (2002) investigated sensitivity of the estimated efficiency to various approaches of input-output specifications and pointed out that two institutions in a given industry may achieve the same efficiency but under different management strategies. These differences are reflected in

different weight structures for inputs and outputs. They estimated the efficiency of Spanish savings banks by employing a variety of input-output mixtures. The estimated efficiency scores were derived by using principal component (PC) analysis. They found that the way deposits are treated in the model specification is a vital factor in deciding efficiency scores. Following Avkiran (2000), Cinca, et al. (2002) suggested that the efficiency of DMUs should be estimated using alternative specification methods and should rely on the average estimated efficiency.

A fundamental problem in relation to input and output specification arises due to different treatment of deposits. A significant portion of the loan and investment portfolio of a bank is sourced from deposits. On the other hand, commercial banks offer deposit products with various features such as integrated deposit accounts, checking accounts, and accounts linked to loan plans to enhance the banks' competitive positions (Leong and Dollery, 2002). Mester (1987) highlighted two approaches (production and intermediation), which are mainly used in banking literature. Leong and Dollery (2002) identified the production, intermediation and assets approaches as three approaches for recognizing banking output. However, Favero and Papi (1995) had previously identified five approaches for input-output specification in the banking industry: the production, intermediation and assets approaches, which are directly linked to operational functions of banks, plus the user cost and value-added approaches, which are not directly linked to the operational functions of banks. These two approaches mainly consider the nature and significance of banking activities.

Sealey and Lindley (1977) first attempted to develop a positive theory for the behaviour of financial institutions. They highlighted two different views, namely the technical view and the economic view of financial institutions. They pointed out that the transformation process for a financial firm involve borrowing of funds from savers (surplus spending units) and lending those funds to borrowers (deficit spending units), i.e. financial intermediation. Therefore, outputs of banks in a

technical sense are a set of financial services to depositors and borrowers. Accordingly, banks provide three categories of services, namely administration of the payments mechanism for demand deposit customers, intermediation services to depositor and borrowers, and other services such as trust department activities and portfolio advisory services.

As explained by Sealey and Lindley (1977), both borrowers and depositors have received some utility from the banking services. Therefore, they suggested the value addition to each input and output should be considered when defining the firm's products in an economic sense. Based on the theory of the firm, they emphasized that firms must consider the output of economic production to be priced higher when compared with input prices. Further, market prices should be used to value products. Therefore, some services, which are considered as outputs in financial institutions, in technical sense do not have market prices; they cannot be considered as output in the economic sense.

The production approach treats banks as producers of services, which use labour and capital to generate deposits and loans (Avkiran, 2000). Under this framework, deposits are included among the outputs because they are viewed as part of the banking services offered (Golany and Storbeck, 1998). Commercial banks provide intermediary services in the financial system, and thus satisfy the expectations of both borrowers (deficit holders) as well as savers (surplus holders). The success of a bank depends on its ability to serve both parties. Banks use loan products to satisfy borrowers and deposit products to satisfy savers. Therefore, the production approach considers services provided to both parties as outputs. Contrary to the production approach, the intermediation approach regards deposits as an input, which is used for producing the other banking outputs. It is based on the assumption that the main role of banks is to arrange a meeting place for the savers and borrowers to make financial transactions. Banks collect deposits from savers and use these savings to produce loans and other products, such as investments.

Favero and Papi (1995) indicated that the intermediation approach is most appropriate for banks where most activities consist of turning large deposits and funds purchased from other financial institutions into loans and financial investments. Elyasiani and Mehdian (1990) stressed that the production approach can be applied only when functional cost analysis data are available. Since data on the number of deposits and loan accounts are available only as a part of the functional cost analysis, the ability to use the production approach appears to be limited. On the contrary, the intermediation approach allows the use of the value of the input and output variables. Elyasiani and Mehdian (1990) highlighted the following advantages of the intermediation approach over the production approach:

- The intermediation approach is more inclusive of total banking costs. These expenses constitute a substantial portion of banks' total costs and their exclusion may distort the empirical results.
- . Since deposits are used for making loans and investments with other inputs, they should be considered as inputs.
- By using the currency value of the input output data, the intermediation approach reduces the potential quality problems of input-output data.

The assets approach is similar to the intermediation approach (Camanho and Dyson, 2004). Outputs are strictly defined by assets and mainly by the production of loans. This approach recognizes labour, capital, deposits and other liabilities as inputs. The user cost approach considers the net contribution of the banking revenue when determining input and output. The opportunity cost of each asset and liability item is compared with the financial cost and return. If the opportunity cost of a liability is greater than the financial cost, the item is recognized as an output, otherwise it should be considered as an input. Similarly, if the opportunity cost of an asset is greater than the financial return, it should be recognized as an input, otherwise it should be considered as an output. Under the value-added

approach, items in the balance sheet with a substantial share of value-added are considered as outputs. This approach considers both deposits and loans as outputs of banks.

Berger and Mester (1997) introduced a variation to the value-added approach called the profit approach for recognizing input and output variables to measure profit efficiency. According to them, profit efficiency allows measurement of how close a bank is to producing its maximum possible profit given a particular level of input prices and output prices. Thus, the standard profit function specifies all revenues as output variables and all expenses (mainly variable costs) as input variables. That is, the profit dependent variable allows for consideration of revenues that can be earned by varying outputs as well as inputs. As stated above, there is no general agreement about the components of banking inputs and outputs. Many studies have applied either the intermediation or the production approaches. Some studies have sought alternative ways of defining inputs and outputs. A summary of input and output variables used in previous studies is presented in Tables 8. Nevertheless, the differences in input and output definition have reduced the general ability of findings from efficiency studies in the financial services sector.

Table 4.2: Table of inputs and outputs used in previous studies

Authors	Policy issue discussed	Approach	Inputs	Outputs
Elyasiani and Mehdian (1990)	Technological change	Intermediation	Deposits (saving and time), labour, capital	Real estate loans, commercial and industrial loans, other loans and investments
Berg *et al.*(1993)	Cross country comparison	Alternative approach	Labour and capital	Total loans, total deposits and number of branches
Barr, et al.(1994)	Bank failure	Production approach	Full-time equivalent employees, salary,	Core deposits, earning assets, and total interest income

			premises and fixed assets, other non-interest expenses, total interest expenses and purchase funds	
Favero and Papi (1995)	Scale efficiency and influence of input-output specifications	Assets	Labour (number of employees), capital (book value of fixed assets and premises), loanable funds, and net funds from other banks (and financial capital)	Loans to other banks and non-financial institutions, investment and security and non-interest income
Berger and De Young (1997)	Problem loans and cost efficiency	Intermediation approach	Operating expenses	Commercial loans, real estate loans, transaction deposits and fee-based income
Bauer *et al.*(1998)	Methodological/ policy issues	Production	Labour, physical capital, small denomination time and savings deposits, and purchased funds	Demand deposits, real estate loans, commercial and industry loans and installments loans
Barr *et al.* (1999)	Efficiency performance/ Methodological	Integrated	Salary expenses, premises and fixed assets, other non-interest expenses, interest expenses	Earning assets, interest income and non-interest income
Sathye (2001)	Productive efficiency gained on reforms	Intermediation	Net worth, borrowing, operating expenses, number of employees, number of banks	Deposits, net profits, advances, non-interest income, interest spread
Casu and Girardone	Performance comparison	Intermediation	Labour costs, deposits and	Total loans and other

(2002)				
Isik (2003)	Deregulation	Intermediate Value-added approach	physical capital Labour (number of full time employees), capital (book value of fixed assets), banking funds, labour, capital and funds	earning assets Short-term loans, long-term loans, other earnings assets and risk adjusted off-balance sheet activities
Maghyereh (2004)	Productivity improvements	Intermediation	Labour, capital and deposits	Loans and liquid assets, investments, other income
Sufian . (2007)	Relative efficiency between the domestic and foreign banks in Malaysia	Intermediation	Total deposits, labour and fixed assets	Total loans, income
Jamal and Alkhowry (2008)	Relative efficiency in Jordian banks	Intermediation	Total assets, net operating expenses, Number of employees	Net operating income, demand deposits, net direct credits
Hamin *et al.* (2008)	Technical efficiency of Islamic banks and Islamic windows	Intermediation	Total deposits, total overhead expenses	Total earning assets

Note: For more references see Appendix 6

The second major problem related to the input and output specification arises when selecting a suitable method of measurement. There are three main measurement approaches for banking outputs and inputs that could be used in productivity analysis. They are: flow measures (the number of transactions processed on deposits and loan accounts), stock measures based on money value (the real or constant monetary values of funds in the deposit and loan accounts), and stock measures based on the number of deposit and loan accounts serviced (Humphrey, 1991). The majority of productivity studies on banks have applied stock measures based on monetary values due to the more ready availability of the required information. However, the use of monetary value-based stock measures may distort estimated efficiency. For instance, Drake and Hall (2003) signaled that

the use of personnel expenses rather than employee numbers could result in some bias against those banks that hire quality workers at a higher cost. Some banks hire high caliber banking professionals and pay relatively higher salaries. Since a high personnel cost could be a result of employing high quality labour, analysts have to be mindful of the objective of the research, as there is a possibility of bias results.

The specification of inputs and outputs in productivity analysis may have a significant influence on the estimated efficiency. However, there is no general agreement with regard to specification of banking inputs and outputs. Discussion in the previous studies has provided the following implications, which may be useful for future research in banking and financial services:

- The production and the intermediation approaches are the methods most widely used.
- The production approach is more appropriate when evaluating productive performance among branches of the same bank.
- The input and output specification may directly affect the outcome of the analysis.
- It is useful to apply more than one input and output specification before making an inference from the results.
- The difficulty of collecting accurate data restricts the use of some approaches, such as user cost and value added approaches.
- Traditional input and output specification has ignored the quality aspects.
- Analysts can select input and output combinations to represent their expectation in efficiency evaluations.

The lack of statistical evidence for the significance of estimated efficiency is one of the main criticisms of the DEA. The majority of empirical studies have used

descriptive statistics to make inferences from estimated efficiency. However, these explanations have been inadequate to get clear evidence of the reliability of estimated efficiency. Therefore, some researchers have attempted to explore alternative ways of making statistical inferences from estimated efficiency. To overcome this disadvantage, some studies have employed statistical methods such as the central limit theory (CLT), and non-parametric bootstrapping (Alam, 2001). CLT assumes that the distribution of time means (averaging over firms at a point in time) become asymptotically normal in a sample with a large number of firms. The appropriate confidence intervals can be found using the student 't' distribution. However, they indicate that the CLT cannot be applied when the sample is not large.

The efficiency frontier model assumes that all commercial banks operate in an identical environment, and that all resources that are available to the banks are fully employed in the production process. However, it is noted that in Kenya, as in most developing countries, the assumption of full employment level may not be appropriate.

One main task of evaluating efficiency is to identify the most efficient production units in a given industry. DEA assigns equal scores (100% efficient) for all firms on the estimated production frontier. Thus, all DMUs located on the production frontier are given equal ranking in terms of performance. Since these DMUs may not operationally have the same strength, ranking them equally may mislead the users of these indices. Therefore, ranking the DMUs, which are considered to be equally efficient, is an unsolved problem associated with traditional DEA models (such as CCR, BCC and Additive).

To overcome this problem, some studies have applied super-efficiency DEA models (Fethi *et al.*, 2002; Lovell and Rouse, 2003). These models allow estimating the super-efficiency scores for the DMUs, which are considered to be

equally efficient by conventional DEA models. Super-efficiency scores can be used for ranking of efficient DMUs into extremely efficient and non-extremely efficient DMUs, observing the sensitivity of efficiency classifications, identifying outliers, overcoming the truncation problem, and calculating and decomposing a MPI. However, these super-efficiency models have not been tested to a great extent in the financial services sector. One such study has been done by Fethi *et al.* (2002) using data from the Turkish banking industry. This study indicated a wide variation of estimated efficiency using traditional DEA models and the stochastic DEA model.

Productivity measurement has an important role in applied economics. Past empirical works on productivity have focused considerably on overall effects. While aggregate studies are useful, efforts to unbundle efficiency effects can offer important insights into the sources of productivity. This can assist better understanding of the role of economic agents and policy making. Efficient banks are defined as those operating on the cost or production frontier, while inefficient banks are those operating above the cost or below the production frontier. The amount by, which a bank lies below its production or profit frontier, or the amount by which it lies above its cost frontier, can be regarded as the measure of inefficiency.

4.3.4 Comparing estimated efficiency and productivity indices with alternative methods

The existence of alternative methods together with traditional rating-based performance evaluation methods raises an important question about the most reliable efficiency and productivity estimation approach. Since different productivity estimation approaches are based on different sets of assumptions, the estimated efficiency from different approaches may not be the same. Bauer *et al.* (1998) examined the properties of different frontier analysis methods based on six

consistency conditions. These consistency conditions indicated the minimum requirements for simultaneous use for efficiency rankings derived from various frontier methods in order to be useful in policy analysis. Different researchers have applied these consistency conditions in various contexts to examine the comparability of productivity indices estimated using varying approaches. Bauer *et al.* (1998) found that main frontier productivity assessment methods (parametric and non-parametric) tend to yield the same distribution of efficiency.

Roughly, all methods identified the same banks in the best practice group and in the worst practice group. Compared to other methods, DEA reported low estimated efficiency. Overall, this study found that all parametric approaches provide efficiency and productivity estimations that are consistent with one another, while DEA does not. Another study in Taiwan (Huang and Wang, 2002,) where four of the Bauer *et al.* (1998) consistency conditions were applied to find the consistency of estimated efficiency based on three frontier methods (DEA, SFA and DFA) found different evidence from Bauer *et al* (1998). Huang and Wang's evidence indicated a similar distribution pattern in estimated efficiency with all three methods. However, results indicated different rankings of DMUs when using parametric and non-parametric methods. Estimated efficiency with parametric methods showed less variation across the periods and indicated closer correlation with traditional measures than with the non-parametric methods.

Leong *et al* (2002) used these consistency conditions to examine the observable differences in estimated efficiency indices using different model specification with DEA productivity estimations. They reached a similar conclusion to Bauer *et al* (1998) about the distribution of estimated efficiency indices. However, different DEA models showed an inconsistent trend throughout the study period. Resti (1997) found that the efficiency and productivity estimations did not differ dramatically when using the same data and conceptual framework. However, results derived using allocative DEA (ADEA) and SFA (based on a translog flexible

form) provided dissimilar explanations about the scale of the large banks. Even though the SFA results provided evidence of increasing returns to scale for large banks, the estimated result on BCC-DEA and CCR-DEA indicated that most large banks had decreasing returns to scale. Even though efficiency scores estimated using the two approaches reported a high correlation, their distributions were not similar.

Weill (2004) applied a similar approach to find the comparability of estimated efficiency using SFA, DFA and DEA using data from five European countries. Weill found that the different frontier approaches do not give comparable efficiency indices. The longitudinal efficiency analysis approach used by Barr *et al* (1999) found strong and consistent relationships between estimated efficiency indices using DEA and traditional methods. This study suggested that the estimated DEA scores have a positive relationship with variables such as non-interest income to average assets, interest income to average assets, earning assets to average assets, and return on assets. It also indicated negative relationships with bank size, salary expenses to average assets, other non-interest expenses to average assets, interest expenses to average assets, fixed assets to average assets, non-performing loans to average assets and loans to average assets. A similar approach was applied by Leong and Dollery (2002) to examine the productive efficiency of Singaporean banks.

As stated above, the empirical studies provide dissimilar evidence about different efficiency and productivity evaluation methods, even when the same dataset is used. Based on the above discussion, the following implications can be identified:

- Different methods provide different efficiency estimation, even though the same dataset is used, because of differences in assumptions that have been used for each method. DEA ignores the potential for random error when estimating efficiency. On the other hand, SFA or econometric approaches are based on pre-specified functional forms and allow for

random error. VRS and CRS models suggest the shape of the frontier. These assumptions are reflected in the differences in estimated efficiency.

- Even though individual efficiency estimations are not similar in many cases, the average efficiency estimation with different approaches is often similar. However, distributions of efficiency estimates from different approaches are not similar.
- There are no clear guidelines to identify the most appropriate methods for any particular study.

4.3.4.1 Other alternative methods of measuring efficiency

Banking Productivity per Employee Hour: Banking productivity per hour is estimated basing on productivity statistics on various sectors, collected by government agencies. This measure may not provide an accurate estimate of efficiency due to modern practices in the banking industry, which include trends towards outsourcing of back-office operations to holding company affiliates and service bureaus. Adongo *et al* (2005) argue that failure to account either for the labour or capital used elsewhere in the holding company but effectively working for the bank could bias government productivity measures towards an inaccurate finding of productivity arising from the change in output per employee labour hour because of the incorporation of total labour hours worked by employees and non-employees.

Minimum Reserves: This measure is based on an assessment of actual reserves (both required and excess reserves) held against the regulatory minimums as an alternative measure of efficiency. A high ratio of actual reserves over the regulatory minimum signifies financial repression and inefficiency.

Monetary Aggregates: This approach is based on monetary aggregates to measure efficiency. The aggregates include the ratio of bank credit granted to the

private sector to GDP, as an explanatory variable in the growth model (King and Levine, 1993). This measure assumes that the size of the financial system is closely related to quality of financial services or efficiency, which forms a major setback. It is argued that the level of bank credit may simply reflect the demand for bank services, which may have nothing to do with the banking sector's own efficiency.

Interest Spreads and Margins: The most common macroeconomic measure of efficiency is the interest spreads. It is a direct measure of banks' mark-up over cost. The justification for using interest spreads to measure efficiency derives from the understanding that financial intermediation affects the net return to savings, and the gross return for investment (Adongo *et al.*, 2005). Interest spreads can either be *ex-ante* (calculated from the contractual rates charged on loans and rates paid on deposits) or *ex-post* (based on the difference between a bank's actual interest revenues and actual interest expenses). Each of the approaches to measuring interest spreads has its own disadvantages. *Ex-ante* interest spreads pose a problem arising from the fact that differences in perceived risks are reflected in the *ex-ante* yields, which tend to distort spread comparisons. Since interest income and drawdowns from the loan loss provisions materialize in different time periods, this may lead to *ex-post* spreads, reflecting efficiency differences due to differences in non-performing loans and monitoring costs associated with loan quality (Demirgüç-Kunt and Huizinga, 1998).

Accounting Ratios: Some microeconomic studies use accounting ratios such as return on assets (ROA), return on investment (ROI) and return on equity (ROE) to represent efficiency (Ikhide, 2000). Akhavein *et al.* (1997) argue that accounting ratios are limited as measures of efficiency. Since they do not control for output mix or input prices, they do not enable the determination of whether X-efficiency or scale and scope efficiency are the source of variation in bank performance.

4.4 Data and Methodology of Estimating Banks' Efficiency and Productivity Changes

Data used in estimation is for ten years from 1997-2006 for 40 banks. Kenyan banks are 43 in total but the study uses 40 banks in estimation because three bank series does not run for ten years. In 2004 and 2006, three microfinance institutions were converted into banks. The data sources include Banking Survey, Central Bank Supervision Reports and various issues of the Economic Survey. The study will make use of parametric and non-parametric approaches in measuring the efficiency and productivity in the banking sector. The parametric approaches involve econometric estimation of a pre-specified stochastic cost function discussed in the second section of this chapter. Non-parametric DEA does not require the specification of a particular functional form for the frontier. Instead, the production frontier is constructed through a piecewise linear combination of the actual input-output correspondence set that envelopes the input-output correspondence of all the firms in the sample as seen from the literature.

The DEA process has the capacity to incorporate multi-inputs and multi-outputs in its assessment, and allows the progressive assembling of production frontiers without using a pre-specified functional form. For these reasons, this study adopts DEA methodology. Either input-oriented or output-oriented, DEA models can be used to estimate efficiency. Input-oriented models measure cost efficiency (input efficiency) aimed at cost minimization. Similarly, output-oriented models measure profit efficiency (output efficiency) based on revenue maximization. In this study, the orientation used is output and the cost element is captured in the translog cost function. The output orientation does not capture cost element. Financial reforms, as well as development in information and communication technologies, have effectively expanded operational activities of the banking industry during the last two decades.

The banking sector, in this regard, has a series of characteristics that make it particularly suitable for study through DEA: its multi-input and multi-output nature, the non-linearity of its input-output relationships, the non-physical nature of some fundamental resources and products, and the impossibility of drawing on market prices for some of them. Before proceeding to explain the DEA methodology, it is necessary to define the approach that will be used in the DEA methodology. The role of commercial banks is generally defined as collecting the savings of households and other agents to finance the investment needs of firms and consumption needs of individuals.

As stated in Chapter Three, previous studies have used a number of approaches of input and output specification, namely production, intermediation, and assets, user-cost and value-added. However, there is no apparent consensus evident in the literature to identify the most appropriate approach. This study uses three inputs and two outputs specifications to recognize the significance of intermediary roles in the banking industry in Kenya. The main reasons to restrict this study to the above model are explained below:

- Availability of required data: data for this study are gathered through secondary sources. Therefore, specification of input and output is limited to available information.
- Discriminating power of the specific DEA models: DEA discriminatory power is controlled by the number of inputs and outputs in the model and the number of DMUs under observation. Inclusion of more input and output variables into a model reduces the DEA's discriminatory power. As such, use of a few models with different input and output variables may permit the assessment of efficiency under different perspectives.

The intermediation approach is, in fact, complementary to the production approach and describes the banking activities as transforming the money borrowed from

depositors into the money lent to borrowers. This transformation activity originates from the different characteristics of deposits and loans. Deposits are typically divisible, liquid and riskless while, on the other hand, loans are indivisible, illiquid and risky. In this approach, inputs are financial capital, the deposits collected and funds borrowed from financial markets, and outputs are measured by the volume of loans and investments outstanding. The modern approach has the novelty of integrating risk management and information processing into the classical theory of the firm. This approach is not used, and therefore discussion is not dwelt on here.

DEA's model formulation is as follows (following notations by Seiford *et al.*, 1994). The basic DEA model is based on a productivity ratio index, which is measured by the ratio of weighted outputs to weighted inputs. DEA extrapolates Farrell's (1957) single-output to single-input technical measure to a multiple-output to multiple-input technical measure. This model assumed that j^{th} DMU uses a *'m'* dimensional input vector, x_{ij} $(i = 1, 2,...m)$ to produce a *'k'* dimensional output vector, y_{rj} $(r = 1,2,...,k)$. The DMU under evaluation is denoted by '0'.

$$w_o = \frac{\sum_{r=1}^{k} u_r y_{rj0}}{\sum_{i=1}^{m} v_r x_{ij0}} \qquad [1]$$

where w_0 is the relative efficiency, x and y are the input and output vectors respectively, and u_r and v_i are the weights of output r and input i. The above ratio accommodates multiple inputs and outputs in efficiency estimation and measures the relative efficiency based on input and output weights. However, a unique set of weights for all DMUs may be difficult to identify, because different DMUs have different input and output combinations (Charnes *et al.*, 1978). The CCR proposed the use of a set of weights that accommodates those differences. They suggested that each DMU should assign weights that allow it to be shown more favourably, compared with all other DMUs under comparison. Thus, the respective weights for each DMU should be derived using the actual observed data instead of fixing in advance (Cooper *et al.*, 2000). CCR introduced the following fractional

programming problem to obtain values for input weights and output weights. Basis CCR formulation:

$$Max\ w_o = \frac{\sum_r u_r y_{rj0}}{\sum_i v_r x_{ij0}}$$

Subject to

$$\frac{\sum u_r y_{rj}}{\sum v_r x_{ij}} \leq 1, \text{ for each j=1,....,n} \qquad [2]$$

$u_r, v_i \geq 0$ r=1,.....,k. i=1,.....,m

where w_0 is the relative efficiency, x and y are the input and output vectors respectively, u_r and v_i are the weights of output r, and input i, n, m and k denote the number of DMUs, inputs and outputs, respectively. The above fractional programming problem is based on the objective to estimate the optimum input and output weights for each DMU under evaluation. It measures the relative efficiency of DMU_0 based on the performance of the other banks in the industry. For that, the weighted input and output ratio is maximized subject to given constraints. The first constraint of the model limits the estimated efficiency of the DMUs to one. The second constraint in the above model indicates that all variables, including input and output weights, are non-negative. Estimated input and output weights are used to find the efficiency index '*w*'. The fractional programming problem can be transformed into a linear programming model (CCR), as illustrated in equation 3.

Basic CCR formulation (Multiplier form):

$$Max\ w_o = \sum_r u_r y_{rj0}$$

Subject to

$$\sum_r v_r x_{ij0} = 1$$

$$\sum_r u_r y_{rj} - \sum_r v_i x_{ij} \leq 0 \text{ for } j=1,2,...n \qquad [3]$$

$$u_r \geq 0 \text{ for } r= 1,2,....k$$

$$v_i \geq 0 \text{ for } i=1,2,...m$$

The above linear programming problem aims to maximize the sum of weighted outputs of DMU_0 subject to virtual inputs of DMU_0, while maintaining the condition that virtual outputs cannot be exceeded by virtual inputs of any DMUs. Both the fractional programming problem and the linear programming problem have the same objective function. CCR-inefficient firms are given an efficiency ratio $W_0 < 1$. Efficiency indices of efficient firms are equal to '1'. Furthermore, there is at least one efficient unit that is used as the referencing unit for estimating relative weights for the inefficient units. Both linear programming problems outlined above can be used to directly estimate 'θ'

Basic CCR formulation (Dual problem/envelopment form):

Min θ

Subject to

$$\theta x_{ij} - s_i - \sum_j x_{ij}\lambda_j \text{ for } i = 1,2,...m$$

$$-s_r + \sum_j y_{rj}\lambda_j = y_{rjo} \text{ for } r = 1,2,....k \qquad [4]$$

$$s_i, s_r, \lambda_j \geq 0$$

where y_{rj} is the amount of r^{th} output produced by DMU j using x_{ij} amount of i^{th} input. θ denotes the CCR efficiency of DMU j. Both y_{rj} and x_{ij} are exogenous variables and λ_j vector of weights (intensity variables) assigned to each DMU under observation. Variables s_i and s_r represent input and output slack. The weights determine the combination of technologies of each firm to construct the production frontier. Thus, each weight is a decision variable determined by the solution of the

linear programming model identified as Equation 4. The first constraint of the above model implies that the combination of the input of the firm *j* is less than or equal to a linear combination of inputs in the firm on the frontier. Similarly, the second constraint ensures that the observed output of firm *j* is less than or equal to a linear combination of inputs in the firm on the frontier. The last constraint ensures that the main decision variable θ_J (efficiency of j^{th} firm) lies between one (1) and zero (0) by limiting the values to equal or greater than zero (CCR).

The values given under slack variables indicate the scope for improving the DMUs' operations without affecting the current level of operations. DMUs in an optimal scale of operation have zero values for s_r and s_i. In other words, if the optimal value θ is equal to unity and both input slack s_r and output slack s_i .are equal to zero in a unit under review, further efficiency improvements cannot be expected in such units. However, there may be some DMUs with slack variables with non-zero values. This signals that additional efficiency improvements can be gained by reducing (increasing) specific input (output). Non-zero slack variable in a particular DMU indicates that the DMU is not operating at the optimum scale.

The original CCR model assumed that all DMUs under consideration were operating on an optimum scale. The BCC-DEA formulation relaxed the assumption of optimum scale. The CCR model estimated the TE. BCC accommodates the scale effect by relaxing the constant return to scale assumption by incorporating a third constraint to the efficiency evaluation model. Generally, it relies on the convex combination of the efficient units, instead of the linear combination, as in the case of the CCR. Accordingly, this can be achieved by adding another constraint to the original CCR model ($\sum \lambda_j = 1$). The efficiency estimation of these two models can be used to identify the two components of efficiency: technical, under both constant and variable returns to scale and scale efficiency. The BCC-DEA formulation is given below.

Basic BCC formulation (Dual problem/envelopment form):

$$\text{Min } z_0 = \theta - \varepsilon \sum_i s_i - \varepsilon \sum_r s_r$$

Subject to

$$\theta x_{ij} - s_i - \sum_j x_{ij} \lambda_j = 0$$

$$-s_r + \sum_j y_{rj} \lambda_j = y_{rjo}$$

$$\sum \lambda_j = 1$$

$$s_i, s_r, \lambda_j \geq 0$$

[5]

Objective functions of the above linear programming models set the input combination of *i* at a minimum level to produce an output that is equal to the output of firm *j*. Therefore, the optimization solution to the above models determines the lowest fraction of inputs needed to produce output at least as great as that actually produced by firm *j*. Thus, this process says that θ_J is equal to or less than one. If θ_J is equal to one, then firm *j* is as efficient as the other firms in the frontier. On the other hand, if θ_J is less than one, the firm is not as efficient as the firm in the frontier.

This study estimates the SE for each DMU based on the estimated efficiency in the BCC and CCR models. This analysis has helped to identify the effectiveness of existing scales of operation.

Thus, in general, technical change experienced by a bank is measured through its ability to produce more or less with a given vector of input quantities in period t in comparison to the levels feasible in period s. Technical change is measured

relative to a given input and output vector. For instance, given two vectors (**y**, **z**), such that there is at least one non-zero output vector associated with the input vector, **y**, under the technologies of periods s and t. Technical change measure is a function of the choice of **y** and **z**. In practice, the most obvious choices are the observed input and output vectors in periods s and t. These two choices result in two measures and an average of these two measures is usually taken. Making use of output distance functions, we measure technical change by comparing the radial projection of the output vector, z onto the frontiers of Ss and St.

Thus, TC - technical change is given by:

$$TC_0^{s,t} = (y_s z_s, y_t z_t) = \left[\frac{d_0^t(y_s z_s)}{d_0^s(y_s z_s)} X \frac{d_0^t(y_t z_t)}{d_0^s(y_t z_t)} \right]^{0.5} \qquad [6]$$

A numerical value for the TC measure of greater than 1 implies that there is technical progress.

Technical Efficiency of an observed pair of inputs and outputs, from an output orientation, is measured by the extent to which the observed output vector could be radially expanded to be on the frontier of the production possibility set associated with the input vector. Thus, $d_0^s(y_s z_s)$ and $d_0^t(y_t z_t)$ are measures of technical efficiency in periods s and t, respectively. Then technical efficiency change, TEC, is measured by:

$$TEC_0^{s,t} = (y_t, z_t, y_t, z_t) = \frac{d_0^t(y_t z_t)}{d_0^s(y_s z_s)} \qquad [7]$$

The distance involved is computed with respect to the observed production technologies in periods s and t.

Scale efficiency of a given bank is measured using the output distance of the observed input-output vectors relative to the variable returns to scale (VRS) frontier and from the constant returns to scale (CRS) technology that is generated from the

observed VRS technology. Thus, output oriented scale efficiency measure in period t is defined as:

$$SE_0^t = (y,z) = \frac{TE_{tCRS}(y,z)}{TE_{tVRS}(y,z)} = \frac{d_0^t(y,z)}{d_0^s(y,z)} \qquad [8]$$

This is what will be used to derive SE in the study.

4.5 Malmquist Total Productivity Index (MPI)

MPI has been widely used in previous research to measure productivity improvements in the banking industry after government policy changes (Berg *et al.*, 1992; Casu and Girardone, 2005; Grifell-Tatje and Lovell, 1996; Isik and Hassan, 2003; Sturm and Williams, 2004). Two alternative methods—base period method and adjacent period method—have been used to estimate MPI. The adjacent period method estimates productivity change in two consecutive periods and on a yearly basis, while the base period method estimates productivity changes using a pre-specified base period. Thus, the adjacent period method is more suitable for studies based on unbalanced panel data. Therefore, this study applies the adjacent period MPI to investigate productivity improvements.

The MPI uses a distance function approach to measure productivity improvements. Caves *et al* (1982) first introduced the idea of using a distance function approach to analyze changes in productivity based on a general production function. DEA-based MPI was first introduced by Fare *et al.* (1994) in a study of productivity improvements in Swedish hospitals using the conceptual basis provided by Farrell (1957) and Caves *et al* (1982).

Following from the previous section on DEA, if inefficiency does exist, the movements of any given bank over time will depend on both its position relative to the corresponding frontier (technical efficiency) and the position of the frontier itself (technical change). These enable us to distinguish between improvements

emanating from the bank's catch up to the frontier and that resulting from the frontier shifting up over time. For this purpose, the output-oriented Malmquist index is used to assess the sources of factor productivity change in banks. The index decomposes total factor productivity change into efficiency change and technological change. Malmquist index is written as follows:

$$M_o^{t+1}(y_t, x_t, y_{t+1}, x_{t+1}) = \left[\frac{D_0^t(y_{t+1}, x_{t+1})}{D_0^t(y_t, x_t)} X \frac{D_0^{t+1}(y_{t+1}, x_{t+1})}{D_0^{t+1}(y_t, x_t)} \right]^{1/2} \quad [9]$$

where M denotes Malmquist productivity index of the most recent production point (y_{t+1}, x_{t+1}), using period t+1 technology relative to the earlier production point (y_t, x_t), using period t technology. Subscript 0 indicates output orientation, D are output distance functions, while y and x are outputs and inputs, respectively.

The productivity change in a given two consecutive period contains two components, namely change in technical efficiency (catching up effect) and change in production technology (frontier shift effect). Fare *et al.* (1994) showed that MPI can be decomposed into two elements to find the catching-up effect and frontier shift by reproducing the above equation as follows:

$$M_o^{t+1}(y_t, x_t, y_{t+1}, x_{t+1}) = \left[\frac{D_0^t(y_{t+1}, x_{t+1})}{D_0^t(y_t, x_t)} \right] X \left[\frac{D_0^t(y_t, x_t)}{D_0^{t+1}(y_t, x_t)} X \frac{D_0^t(y_{t+1}, x_{t+1})}{D_0^{t+1}(y_{t+1}, x_{t+1})} \right]^{1/2} \quad [10]$$

Total productivity change = Efficiency change X Frontier shift

The first element of the equation on the right hand side stands for the efficiency change, and the second element stands for the frontier shift between time period 't' and 't+1'. Based on the above equation, two separate equations have been constructed to estimate the efficiency change and impact of frontier shift (Fare *et al.*, 1994).

$$\textit{Efficiency shift} = \left[\frac{D_0^t(y_{t+1}, x_{t+1})}{D_0^t(y_t, x_t)} \right] \quad [11]$$

$$\text{Frontier shift} = \left[\frac{D_0^t(y_t, x_t)}{D_0^{t+1}(y_t, x_t)} X \frac{D_0^t(y_{t+1}, x_{t+1})}{D_0^{t+1}(y_{t+1}, x_{t+1})} \right]^{1/2} \quad [12]$$

If productivity of a DMU has improved between two periods, the MPI reveals a value greater than one. Conversely, an MPI less than one indicates declining productivity between two periods. Productivity improvements from technological changes and efficiency changes are also interpreted in a similar manner (Coelli *et al.*, 1998). Both parametric and non-parametric approaches have been applied in previous studies to estimate MPI. This study relies on a non-parametric DEA approach. Respective MPIs are estimated using 'DEA-Solver software' developed by Coelli *et al* (1998). Respective MPIs are estimated from individual year data to facilitate the estimation of productivity and technical and technological changes.

The idea of Malmquist index originates from use of distance functions in productivity analyses, as developed by Caves *et al* (1982) in a general production function framework. They introduced two types of productivity, namely an output-based and input-based index. Caves *et al* (1982) defined productivity as a geometric mean of two Malmquist indices expressed in distance functions. The component distance function then are equivalent to the reciprocal to Farell's (1957) measures of technical efficiency. Building on this work, Fare and his colleagues (1990, 1992 and 1994) developed empirical models to directly calculate the Malmquist index using Farell's (1957) efficiency measures.

Contrary to Caves *et al* (1982) their models do not require any assumptions on the economic behaviour of production units. That means there is no need to assume that the firms are cost-minimizing or revenue-maximizing. There is also no requirement on the resource prices. This is a distinct advantage when prices information is unavailable or when prices are distorted. Again, in contrast to Caves *et al.* (1982), Fare *et al's* (1985) productivity index can be decomposed into two components, one measuring the change in efficiency (the catching up effect), the

other measuring the technological change (the frontier effect). This is important contribution in that it provides insight into the measurable sources of productivity change.

Translog Cost function

Whereas DEA will give us efficiency scores on how certain decision-making units are efficient as compared to the best practices, they will not give us the causes for inefficiencies in the respective DMUs. Thus, the assessment of scale, scope and technical efficiency of financial institution is necessary but not sufficient. There is another aspect to this measurement, and that is the managerial efficiency. The question here is whether people really work as they should do. With increased demand in the banking sector, salaries are raised but what is unclear is the performance reflection of these salaries. Consumption of perquisites, shirking, poor economic management, inadequate skills and irresponsibility are common features in organizations, especially in developing countries. These, among other factors, account for high costs in firms and therefore leading to X-inefficiency, thus the need to estimate a parametric (econometric model) and find out the factors that cause deviations from the frontier.

In this study, we estimate a multi-product translog cost function to specifically measure X-inefficiency in the banking firms, and then the analysis of factors that drive X-inefficiency follows. Studies of banks efficiency recently have concentrated on X-inefficiency, which investigate deviations from cost efficient frontier attributed to the fact that people and organizations work neither as hard nor as effectively as they could (Leibenstein, 1966). It is in the interest of this study to, therefore, investigate the extent of this assertion in Kenyan banks. The focus is on whether managements fulfil their roles to minimize cost and to maximize banks outputs. After a decade of liberalization, has it had any impact on management practices?

Having discussed DEA, we now turn to Stochastic Frontier approach (SFA). SFA regression approach includes a normally distributed error and an inefficiency component assumed to follow a one-sided distribution (exponential, gamma). SFA is stochastic, but requires the choice of a functional form and an ad-hoc assumption about the distribution of the inefficiency component (Mugume, 2006).

Literature on bank efficiency argues that X-inefficiency is an operational concern and it outweighs scale and scope inefficiencies in terms of proportion of cost it accounts to banks (Berger *et al.*, 1993). Modeling X-inefficiency requires construction of cost inefficiency variable which, alternatively, can be made from estimation of Stochastic Frontier (SF) model. The SF model regresses total cost of the bank against input prices and output variables. In order to estimate this type of inefficiency in Kenyan banks, a stochastic efficient methodology of Aiger *et al* (1977) is used. The cost frontier, that is lowest cost frontier with the most efficient mix of inputs, is employed in estimation of X-efficiency indices. A standard multi-product transcendental logarithmic (translog) cost function is specified and deviations from the cost frontier are estimated based on this function. The standard translog function is given by the following:

$$\text{Ln}\ TC_{ti} = \alpha_0 + \sum_{\kappa=1}^{2}\beta_\kappa \ln(y_{\kappa ti}) + \sum_{l=1}^{3}\alpha_l \ln(p_{lti}) + 0.5\sum_{\kappa=1}^{2}\sum_{j=1}^{2}\beta_{\kappa j}\ln(y_{\kappa ti})\ln(y_{jti}) + \beta_{\kappa j}=\beta_{j\kappa}$$

$$0.5\sum_{l=1}^{3}\sum_{h=1}^{3}\alpha_{lh}\ln(p_{lti})\ln(p_{hti}) + \sum_{\kappa=1}^{2}\sum_{l=1}^{3}\partial_{lk}\ln(y_{\kappa ti})\ln(p_{lti}) + x_{ti} + \mu_{ti} \qquad [13]$$

where x_{ti} represents the X-(in)efficiency factor and μ_{ti} is the random error. Ln TC is the natural logarithm of total cost; the α_0 is the intercept; current specification assumes $y_{\kappa ti}$ is two bank outputs and p_{lti} is three input prices. β_κ, $\beta_{\kappa j}$, α_l, ∂_{lk} and α_{lh} are the coefficients to be estimated; $\beta_{\kappa j}=\beta_{j\kappa}$ while $\alpha_{lh}=\alpha_{hl}$ (the symmetry

restrictions); subscripts j and k denote each of the two outputs, and subscripts l and h denote each of the three input prices.23

Table 4.3: Definition of variables

Variable	Description	Type
Cost	Total cost (includes profit share (dividend), and expenses on personnel, commissions, fees and so on.) Ksh millions.	Dependent variable
P1	Price of funds (%) (total interest expenses/total customer deposits (demand, savings and time deposits)	Price independent variable multiplied by the input X1.
P2	Price of labour (%) (total personnel expense/total assets)	Price independent variable multiplied by the input X2.
P3	Price of physical capital (non-interest expenses/average assets)	Price independent variable multiplied by the input X3.
*Y1	The Ksh value of total aggregate loans and advances.	Output
*Y2	The Ksh value of total earning assets (short term investment, equity and other investment and public sector securities)	Output
*X1	Customer deposits excluding foreign deposits. Ksh millions	Input
*X2	Labour expenses Ksh millions	Input
*X3	Net shareholders funds. Ksh millions	Input

*The same inputs and outputs are used in the DEA estimation.

Equation 13 is estimated using Stata 10.0 or Limdep 8.0 and X-inefficiency scores are predicted. If a bank systematically incurs relatively higher costs than the other banks in a competitive environment, it is considered X-inefficient.

[23] Share equations may be estimated jointly with the translog cost function to enhance parameter efficiency scores by reducing their variances. The study however does not use the share equations and care must be taken in interpreting the results.

Factors Determining X-inefficiency

The performance of banks depends upon the strengths, weaknesses, opportunities and threats they are facing. Those forces originate from both external and internal environments of the firm. Therefore, both firm-specific and environmental factors may influence the efficiency of a bank. Consequently, banks with sound internal and external environments may perform better than other banks in the industry. Thus, the investigation of factors that influence firms' X inefficiency is important.

Various factors have been attributed to affect X-inefficiency in banks. The factors may be divided into three, mainly: microeconomic, macroeconomic, and other factors. Microeconomic factors have limited influence over particular industry segments and include endogenous factors such as product lines, capital employed, input utilization, people, the organization and system, work methods, and management styles—all of which a firm's management can control. Microeconomic factors also include exogenous factors such as market share, which may not be quite so susceptible to control through managerial decisions. Macroeconomic factors such as per capita income of the consumer population, inflation, gross national product, economic growth rates and population may influence efficiency and productivity gains of all industries in general. Other factors include all non-economic factors. The following factors have been used in various studies. Size, profitability, capital ratio, non-performing loans to total loans, fixed assets to total assets, problem loans risk, purchased funds, liquidity, market power, per capita income, inflation, stock market capitalization, liberalization, specialization, location, ownership, number of branches, bank branch concentration; and population (Favero and Papi, 1995; Pastor, 2002; Barr *et al.*, 1999; Leong and Dollery, 2002; Maghyereh, 2004).

Prior studies have applied three techniques for investigating factors affecting inefficiency in the banking sector:

- multivariate regression analysis (generalized least square methods, Panel and Tobit)
- longitudinal graphical approach; and
- DEA itself

The first approach, multivariate regression analysis, uses estimated efficiency or inefficiency scores as dependent variables and a range of other factors as the explanatory variables. The second, longitudinal approach examines the general trends of estimated productivity within a longer time period and uses graphical representation to exhibit the relationship between estimated productivity and each factor. The third approach uses the DEA technique, together with Malmquist type indices, to find the aggregate effect of other (non-production) variables on estimated efficiency (Pastor, 1999; 2002).

Both DEA techniques and the longitudinal approach do not provide sufficient information to test hypotheses. However, the statistical significance level provided with the estimated coefficient for each explanatory variable included in the model allows analysts to test the hypotheses when using regression techniques. Accordingly, previous studies employed this approach to test the hypotheses. On the other hand, the longitudinal approach has been used to identify the influence of factors that may lag over a longer time period, such as the impact of policy changes on productivity (Barr *et al.*, 1999). In contrast, DEA-based approaches have been used in cross-country comparison of estimated efficiency to separate country-specific environmental influences from estimated efficiency to find the true efficiency. The main advantage of multivariate regression analysis over other approaches is its ability to test the hypotheses. Accordingly, this study uses the regression method to investigate determinants of banks' inefficiency.

The regression uses panel and GMM approach to get the determinants of inefficiency in the banking sector. The GMM is estimated to check on the feedback mechanisms, whether lagged inefficiency or past inefficiency affects current inefficiency. All models are specified with X-inefficiency as the dependent variable and other factors affecting the dependent variable.

Consideration is given to the fixed effects versus random effects specification for the panel, and the study follows fixed effects approach where the error terms are treated as bank-specific. The general specification is given as follows:

$$y_{it} = \alpha_i + \beta' x_{it} + \varepsilon_{it} \qquad [14]$$

Where y_{it} indicates the dependent variables while the α_i are fixed effects, x_{it} are bank-related variables, and ε_{it} is the residual representing inefficiency provided it is normalized to fulfill the non-negativity requirement.

Further, the dynamic form of fixed effects model is represented as follows:

$$y_{i,t} = \gamma y_{i,t-1} + x_{i,t}'\beta + \eta_i + \varepsilon_{i,t} \qquad [15]$$

Where η_i is a fixed effect, $x_{i,t}$ is a (K-1)x1 vector of exogenous regressors and $\varepsilon_{i,t} \sim N(0, \alpha_\varepsilon^2)$, is a random disturbance. The following is assumed:

$$\begin{aligned} &\alpha_\varepsilon^2 \geq 0, \\ &E(\varepsilon_{i,t}, \varepsilon_{j,s}) = 0 \\ &E(\eta_i, \varepsilon_{j,t}) = 0 \\ &E(x_{i,t}, \varepsilon_{j,s}) = 0 \end{aligned} \qquad [16]$$

Several estimators have been proposed to estimate Equation (15) when T is not large. Anderson and Hsiao (1981) propose two instrumental variable procedures. To remove the fixed effect, they first difference Equation (15) to obtain

$$(y_{i,t} - y_{i,t-1}) = \gamma(y_{i,t-1} - y_{i,t-2}) + (x_{i,t} - x_{i,t-1})'\beta + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \qquad [17]$$

In the differenced equation, however, the errors $(\varepsilon_{i,t} - \varepsilon_{i,t-1})$ are now correlated with the one of the independent variables $(y_{i,t-1} - y_{i,t-2})$, and they recommend instrumenting for $(y_{i,t-1} - y_{i,t-2})$ with either $y_{i,t-2}$ or $(y_{i,t-2} - y_{i,t-3})$, which are uncorrelated with the disturbance in (17) but correlated with $(y_{i,t-1} - y_{i,t-2})$. Arellano (1989) shows that using the lagged difference as an instrument results in an estimator that has a very large variance. Arellano and Bond (1991) confirm the superiority of using the lagged level as an instrument with simulation results. Given the dimension of the panel as N x T, the Anderson–Hsiao estimator employed in the study is:

$$\partial_{AH} = (Z'X)^{-1} Z'Y \qquad [18]$$

Where Z is a K x N (T-2) matrix of instruments, X is a K x N (T-2) matrix of regressors and Y is an N(T-2) x1 vector of dependent variables. Let $\Delta y_{i,t} = y_{i,t} - y_{i,t-1}$ Then,

$$Z_i = \begin{bmatrix} y_{i,1}\Delta x_{i,3} \\ \\ y_{i,T-2\Delta x_{i,T}} \end{bmatrix} X_i = \begin{bmatrix} \Delta y_{i,2}\Delta x_{i,3} \\ \\ \Delta y_{i,T-1\Delta x_{i,T}} \end{bmatrix} Y_i = \begin{bmatrix} \Delta y_{i,3} \\ \\ y_{i,T} \end{bmatrix} \qquad [19]$$

$$Z = \begin{bmatrix} Z_1 \\ \\ Z_N \end{bmatrix} X = \begin{bmatrix} X_1 \\ \\ X_N \end{bmatrix} Y = \begin{bmatrix} Y_1 \\ \\ Y_N \end{bmatrix} \qquad [20]$$

Two other GMM estimators are suggested by Arellano and Bond (1991). The Anderson-Hsiao estimator can be considered a special case of the GMM procedures, which also removes the individual effect by differencing Equation (15) to obtain Equation (17). The GMM procedures, however, gain efficiency by exploring additional moment restrictions. They use all available lagged values of the dependent variables, plus lagged values of the exogenous regressors as instruments. The GMM estimators take the form:

$$\partial_{GMM} = (X'Z^{*}A_{N}Z^{*'}X)^{-1}X'Z^{*}A_{N}Z^{*'}Y \qquad [21]$$

Where X and Y are defined above, but Z_i^{*} is a block diagonal matrix whose sth block is given by $(y_{i,1}.....y_{is}.x_{i1}.....x_{i(s+1)})$ for s=1,.....,T-2. Then $Z^{*} = (Z_1^{*},.....Z_N^{*})'$

Two different choices for A_N result in two different GMM estimators. A one step estimator, GMM1, can be found by using

$$A_N = \left(\frac{1}{N}\sum_{i}^{N} Z_i^{*'} H Z_i^{*}\right)^{-1} \qquad [22]$$

Where H is a T-2 square matrix with twos in the main diagonals, minus ones in the first sub-diagonals, and zeros otherwise. A two step estimator, GMM2, is found by letting:

$$A_N = \left(\frac{1}{N}\sum_{i}^{N} Z_i^{*'} \Delta\hat{e}_i \Delta\hat{e}_i' Z_i^{*}\right)^{-1} \qquad [23]$$

Where $\Delta\hat{e}_i = (\Delta\hat{e}_{i3},..... \Delta\hat{e}_{iT})$ are the residuals from a consistent one step estimator of Δy_i (use GMM1)

Therefore, in general parameterized form the model to be estimated is stated below:

X-Ineff = f(CAP, AQ, LIQ, PRT,SZE, MKT, MBH, R, GDP) [24]

X-Ineff = β_0 + β_1CAP + β_2AQ + β_3LIQ + β_4PRT + β_5SZE + β_6MKT + β_7MBH+ β_8R+ β_9GDP + μ [25]

Where X-ineff denote X-inefficiency predicted from the multi-product translog cost function. CAP is capital adequacy measure; MKT is market structure measured by (HHI and CR4), AQ is a proxy for asset quality, LIQ is excess liquidity variable constructed while PRT profit is earnings measured by the profits of the banks. SZE is a bank size, MBH multi-bank holding company is proxy for ownership of bank, R is real interest rate and GDP is gross domestic product per capita.

4.6 Summary

In this chapter, the analytical framework and the methodology used in the study is presented. This study adopts a non-parametric Data Envelopment Analysis (DEA) and a parametric stochastic frontier approach (SFA) to analyze measures of various aspects of efficiency in the banking sector. Malmquist Productivity Index (MPI) is used to measure productivity gains of banks in Kenya. The study uses more than one approach because, as highlighted in the literature review, each approach is selected on the basis of the specific research question for which the method is best suited. For example the translog cost function approach is selected for measuring pricing (or cost) efficiency in the financial intermediation process. However, any limitation of the selected method implies that care must be taken in the interpretation of the results. Panel and GMM will be used to estimate the factors determining X-inefficiency in the banking sector. The next two chapters (five and six) present the results of the analyses using the methodology described in this chapter.

CHAPTER FIVE: ANALYSIS OF TECHNICAL AND SCALE EFFICIENCY, AND PRODUCTIVITY

5.0 Introduction

This chapter investigates efficiency and productivity improvements or gains in Kenya in the post-liberalization period. Discussion in this chapter is based on Objective One, where efficiency scores of banks using non-parametric Data Envelopment Analysis (DEA) are measured to investigate whether there are resource losses in the intermediation process.

Analysis of commercial banks efficiency is discussed with a special focus on the main bank categories consisting of size in three groups (large banks, medium banks and small banks) and ownership between foreign and local banks. Local banks are then divided into public and private banks. It is important to note that with the exception of one bank that is fully a corporate bank, all the other commercial banks are mainly retail, with some business in corporate banking. The Malmquist indices will be computed to determine the productivity of the banking sector. In this section, we present results of the non-parametric measures of bank efficiency in Kenya.

Data series is collected from various banking surveys and Central Bank of Kenya Returns for all the 43 banks annual series for a period of ten years, 1997-2006. The inputs used for production purposes are capital (fixed assets), deposits and labour, while the outputs considered are investments and advances as discussed in the methodology chapter. Efficiency in the intermediation process is considered here. MPI are derived from DEAP 2.1 and discussed at the end of the chapter.

The Data Envelopment Analysis program (DEAP) of Coelli version 2.1 is used to compute productivity and efficiency measures presented in this first section. The Multistage DEA is used to compute the efficiency measures such as overall

technical efficiency (OTE), pure technical efficiency (PTE) and scale efficiency (SCE) measures.

5.1 Overall Commercial Banks Efficiency

This section presents results and discussion of an analysis of estimated efficiency scores. First, it presents mean values, standard deviations and correlation coefficients of inputs and output variables used in the efficiency analysis. Second, it produces the results and discussion of efficiency analysis using the intermediation approach.

5.1.1 Mean and standard deviation of input and output variables

Table 5.1 presents descriptive statistics of all input and output variables used in this study. These statistics indicate that all the inputs and outputs have increased in their mean terms from 1996 to 2006. This has implications on the growth, developments and depth in the banking sector. Deposits have more than doubled in the period 1996-2007 as more and more people are becoming banked.

Fixed assets (FA) have increased marginally by Ksh. 1.1 billion from 1997 to 2006, whereas advances have increased greatly. Further, the variables indicate high standard deviations. The Kenyan banking industry comprises few big banks, and a number of medium and small scale banks. Thus, the recorded differences in value of observed variables result from those scale differences. However, the methodology used allows assessment of efficiency and productivity improvements of DMUs, ignoring their scale of operations (Batesse *et al.*, 1992).

Table 5.1: Descriptive statistics of inputs and output data (Kshs million)

YEAR	ITEM	ADVNS	I	Dep	LC	SHH
1997	Mean	5086.63	1521.23	6383.60	538.83	1230.18
	Standard Deviation	8950.37	3226.55	11738.57	1208.75	2007.41
1998	Mean	6292.98	1577.18	6721.23	542.08	1332.05
	Standard Deviation	11545.93	3218.04	12228.82	1210.89	2143.51
1999	Mean	6752.70	1625.10	7163.93	642.00	1326.45
	Standard Deviation	12732.56	3209.50	12809.57	1481.46	2003.37
2000	Mean	6543.50	2423.55	7476.23	450.45	1323.73
	Standard Deviation	12021.25	7470.55	12893.77	881.22	2129.62
2001	Mean	6351.93	2244.78	7950.18	432.15	1411.70
	Standard Deviation	11629.53	4690.46	13496.01	809.16	2261.91
2002	Mean	6300.70	2540.85	8824.90	477.00	1349.88
	Standard Deviation	11203.33	5067.49	15236.44	944.72	1889.22
2003	Mean	6702.25	3417.68	9815.55	466.33	1537.63
	Standard Deviation	11873.64	6430.82	16378.60	854.82	2079.92
2004	Mean	8254.68	3025.38	11019.68	480.75	1699.18
	Standard Deviation	14090.70	5398.92	17807.81	821.07	2388.04
2005	Mean	9819.28	3148.03	12462.53	584.85	2015.00
	Standard Deviation	16309.95	5001.78	18930.14	981.76	2862.50
2006	Mean	11348.33	3873.50	14708.15	682.48	2391.93
	Standard Deviation	17832.59	6490.87	21860.49	1136.75	3236.15

Table 5.2 identifies correlations among various potential inputs and outputs variables. As explained by Avkiran (1999), correlations among input and output variables can be used to show the appropriateness of use of the variables in estimation. The recorded high correlation coefficients between input and output variables, except in a few cases, confirm that selected input and output variables for performance evaluations are appropriate. For instance, the ADVNS and DEP variable have a positive correlation coefficient of 97% and that of DEP and GS have a significantly high positive correlation of 94%. Other observations that show

high correlation are GS and ADVNS of 87%, FA and ADVNS of 76%. LC and ADVNS has positive correlation coefficient of 77%. In this case ADVNS and GS are considered as outputs and FA, DEP and LC are considered as inputs. The remainder of this section presents the estimated efficiency scores.

Table 5.2: Correlation of input and output variables

	GS	I	ADVNS	FA	DEP	INT	SHHD	LC	TI	OE
GS	1									
I	0.5188	1								
ADVNS	**0.8769**	0.4369	1							
FA	0.6897	0.5045	**0.7634**	1						
DEP	**0.9459**	0.5179	**0.9749**	**0.7878**	1					
INTt	0.1668	0.1847	0.358	0.6061	0.3098	1				
SHHD	0.9336	0.4836	0.942	0.7078	0.9663	0.2548	1			
LC	0.745	0.5436	**0.7716**	**0.6952**	**0.7922**	0.3216	0.7448	1		
TI	0.7647	0.4245	0.8326	0.6618	0.8262	0.3175	0.7973	0.9486	1	
OE	0.6804	0.4257	0.7932	0.6832	0.7745	0.3851	0.7166	0.935	0.9652	1

Definition of variables: GS is Government securities, **I** is investments, **ADVNS** is advances, **FA** is fixed assets, **DEP** is deposits, **INT** is accrued interest, **SHHD** is total shareholder fund, **LC** is labour costs, **TI** is total income and **OE** is operating expenses.

Table 5.3 below gives a summary of the results of efficiency scores for all the commercial banks in Kenya. Appendix 3 gives the detailed summary of efficiency scores of all the commercial banks. In general, the performance of the commercial banks in Kenya in the period 1997-2006 has been above 45% efficient for most of the banks. The findings show that most of the commercial banks have been operating at the decreasing returns to scale part for the same period. That means that when inputs increased in the period, the output increased by less than proportionate increase in the inputs. This means that commercial banks have been operating on the rising part of the average long run cost curve.

This is indeed supported by evidence gathered in a recent banking survey conducted in Kenya in 2007 (Oloo, 2007). The survey revealed major impediments to growth of the banking sector in Kenya to include high cost structure of the

banking sector and high infrastructural costs. Other reasons given included: non-performing loans that increase the cost of banking services; insecurity, poor infrastructure, poor bureaucratic and legal framework - all adding to the high cost of doing business. All these factors have increased the costs in the banking sector. This explains why banks continue operating in rising part of average long run cost curve.

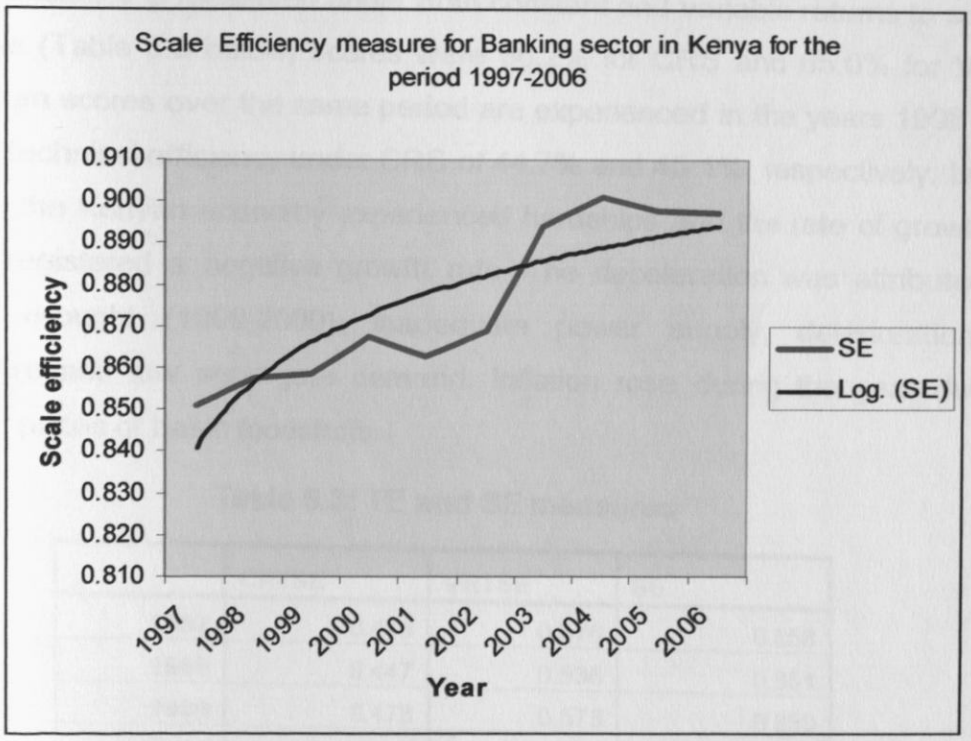
Further, banks in Kenya hold excess funds than they should. It is evident that Kenyan banks' liquidity averages 40%, which is 20% above what they are required to hold. Holding of these idle funds has implications on the efficiency of the intermediation process. There is a definite need for credit in the economy and retaining it in the banks not only increases cost in the banks but undermines the development and growth process of the economy by not availing funds. In general, the overall average efficiency in the banking sector is about 56% for the technical efficiency under the constant returns to scale, 65% efficient under the variable returns to scale, and 87% under scale efficiency. The scale efficiency level of 87% shows that commercial banks are 13% scale inefficient. The technical efficiency of 56% and 65% under the constant returns to scale and variable returns to scale imply that commercial banks in Kenya could have increased outputs by 44% and 35% in the ten years period under study, had they been 100% efficient.

Whereas it is not correct to compare efficiency scores for banks in one country to another, it is important to mention them for the necessity of seeing that the scores attained in other country studies are fairly large. The findings on efficiency of commercial banks in Kenya are not so different from the results found in other African countries. A study done in Uganda by Peiris and Hauner (2006) found efficiency scores of 0.99 for both CRS and VRS, while those in Tanzania done by Aikaeli (2007) were found to be on average 98 and 99 for CRS and VRS, respectively. There are also other studies that show lower efficiency scores. For instance, Kablan (2006) found average efficiency score over 1996-2004, in West

Africa Economic Monetary Union (WAEMU) countries to be 0.76 with CRS and 0.85 with VRS. Further, a study on the Thai banks by Leigthner and Lovell in 1998 found efficiency to be 0.62 and 0.59 for CRS and VRS.

Below is a graph indicating efficiency measure for commercial banks in Kenya for the period 1997-2006.

Figure 5.1: Scale efficiency measure for banking sector in Kenya for the period, 1997-2006



From Figure 5.1, we note an upward trend line, implying efficiency in the banking sector is improving over the years with a slight decline in 2001. The scale efficiency was 86.7% in the year 2000, declined slightly in the year 2001 to 86.3%. The plausible reason for this decline would be the lagged impact of the year 2000 drought and low GDP growth experienced. Scale efficiency picks up in 2002 and continues on an upward trend until 2005 but falls slightly in 2006. The fall in 2006

may be attributed to the elections' expectations in the following year 2007. The pick up in scale efficiency may be attributed to the new entrants into the banking sector. In year 2004, two microfinance institutions were converted into full fledged banks, thus expanding banking operations in the country. The two have been able to build a large customer and deposit base in a short time and expand size in terms of scale of operations country wide. An example is Equity Bank which has the largest client base and wide operational network as at end of 2008. This may have led to some increase in scale of production, thus increased efficiency in the banking for that period.

5.2 Technical Efficiency and Scale Efficiency

Technical efficiency is measured under both constant and variable returns to scale. On average (Table 5.3 below) scores were 56.2% for CRS and 65.0% for VRS. The minimum scores over the same period are experienced in the years 1998 and 2000, with technical efficiency under CRS of 44.7% and 45.1%, respectively. In the year 2000, the Kenyan economy experienced hardships and the rate of growth of real GDP registered a negative growth rate. The deceleration was attributed to prolonged drought (1999-2000), inadequate power supply, deterioration of infrastructure and low aggregate demand. Inflation rose during the year due to increase in prices of basic foodstuffs.

Table 5.3: TE and SE measures

	CRTSE	VRTSE	SE
1997	0.476	0.576	0.858
1998	0.447	0.536	0.851
1999	0.478	0.573	0.859
2000	0.451	0.530	0.867
2001	0.490	0.577	0.863
2002	0.650	0.752	0.869
2003	0.689	0.776	0.894
2004	0.652	0.731	0.901
2005	0.650	0.733	0.898
2006	0.633	0.718	0.897
Mean	**0.562**	**0.650**	**0.876**

All these had a negative impact on the banking sector and the efficiency with which the banking sector carries out its intermediation process. When the economy is experiencing a slump, the financial sector is also experiencing a slump.

The technical efficiency divergence from the efficient point is 44% and 35%, respectively, under the CRSTE and VRSTE. These imply that banks could produce the same amount of outputs with approximately 44% fewer resources under constant returns, and 35% fewer resources under variable returns than they actually employed. This finding reveals that the overall inefficiency in Kenyan commercial banks would be mainly as a result of technical inefficiency rather than scale inefficiency.

Bias corrected results are presented below

One of the main drawbacks of non-parametric techniques is their deterministic nature. This is what has traditionally driven economic literature to describe them as non-statistical methods. Further, due to the complexity and multidimensional nature of the DEA estimators, their sampling distributions are not easily obtainable. The bootstrap provides us with a suitable way to analyze the sensitivity of efficiency scores relative to the sampling variations of the calculated frontier by avoiding the drawbacks of asymptotic sampling distributions. The bootstrap is based on the idea that the known bootstrap distribution will mimic the unknown sampling distribution of the estimator of interest. Through the bootstrap, the bias of the original estimator can be calculated, and the original estimator corrected for the bias. In particular, as earlier mentioned, output oriented DEA is used in the study, and these scores are a higher bound of the true efficiency scores. A bias corrected estimator of the true value of the DEA score is computed using the bootstrap.

Figure 5.2: CRTE bootstrap bias corrected

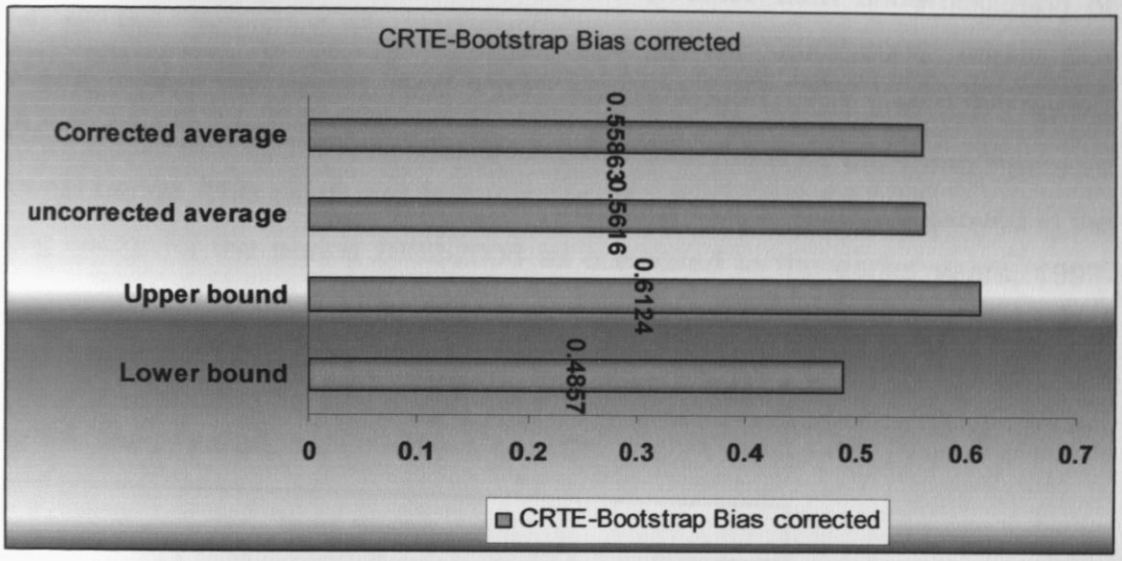


Table 5.4: Bootstrap correct average efficiency scores

	CRTE-bootstrap bias corrected	VRTSE-bootstrap bias corrected	SE-bootstrap bias corrected
Lower bound	0.4857	0.5738	0.8624
Upper bound	0.6124	0.7029	0.89
Uncorrected average	0.5616	0.6502	0.8757
Corrected average	0.55862708	0.64990976	0.87432075

The conclusions reached with the scores adjusted for bias using bootstrap are similar as before, though with lower efficiency scores as shown in Table 5.4 and figure 5.2.

Slack values

It is observed for the summary of input slacks that technical inefficiency arose more from the inefficient use of labour and deposits, rather than underutilization of capital in the intermediation process. The period 2002-2006 shows an improvement from the period 1997-2001, moving from 1003.3 and 225.2 in the case of deposits and labour, as compared to 824.4 to 159.6 for the same inputs for the former period. This reinforces the earlier findings that efficiency improved in the banking sector for the period 2002-2006 as compared to the earlier years, 1997-2001.

Table 5.5: Slack value

	Input Slacks		
Year	Deposits	Capital	Labour
1997-2001	1003.339	89.012	225.226
2002-2006	824.449	101.783	159.659

The years 1997-2001 show that the rate of accumulation of deposits exceed the rate of loan given out for the period, hence the high value of 1003.3. Prior to that period, banks had loaned out a lot of money and the non-performing loans were large. From 1999, we see banks changing their lending strategy and start stringent screening processes for loans that dropped many deserving Kenyans from the credit worthy bracket, hence the accumulation of deposits/liquidity in the banking sector. In the case of labour, there is an indication of under-utilization of that factor in production in the period 1997-2006, thus undermining the efficiency of the commercial banks. The results reflect situations where workers in the banking sector are not fully utilized and commercial banks keep excess liquidity than is necessary for efficient service provision. The under-utilization of workers and production input leads to low output per worker.

5.3 Efficiency by Types of Banks

In this study, we classify banks by size and ownership. Classification on the basis of size is done based on asset size of the banks. Large banks have asset base of Ksh 20-120 billion, medium banks have an asset base of Ksh 4-20 billion and small banks have asset base less than Ksh 4 billion. Ownership is mainly in the two categories, foreign and local. Local is further divided into private and public. It is assumed that banks in the same group are homogenous in nature and portray the same characteristics. Further, it is important to highlight *apriori* that in the category of large banks, 5 out of the 12 are foreign-owned. A majority of banks are local-owned, be it local-private or local-public. The state-owned banks (government-owned banks) are 3 and they fall in the category of large.

From the results, Table 5.6, the general finding is that medium banks in Kenya are most efficient followed by the large banks and finally the small banks. Two (2) of the 12 banks in the category of large banks operate at the efficient frontier and these are the best practice banks. DEA efficiency scores are relative efficiency based on the best practice banks in the industry. A score of 1 shows that the bank is efficient operating at constant returns to scale at the frontier.

Table 5.6: Efficiency measure by size category (1997-2006)

	No. of banks	CRSTE	VRSTE	ScaleE
Small banks	15	0.536509	0.638633	0.840089
Medium banks	13	0.536896	0.590802	0.908758
Large banks	12	0.523872	0.587707	0.891383

Table 5.7: Mann-Whitney test scores – Efficiency by size of bank

	CRS	VRS	SE
Large vs Small	573 (-3.22**)	544 (-3.58**)	696 (-2.39**)
Large vs Medium	462 (-4.47**)	979 (-0.74)	348 (-5.3**)
Medium vs Small	1264 (-0.7)	764 (-4.02**)	994 (-2.43**)

*Note: z scores are given in parentheses. ** indicates that test scores are significant under 5% level.*

The two banks are foreign-owned, implying foreign banks set the pace for the Kenyan case in terms of efficiency in running their banks. Small banks are mainly local-owned, and show the lowest efficiency measures in the categories of banks based on size. In terms of scale-efficiency, the small banks show the largest deviation from the efficiency frontier. Scale inefficiency means under-utilization of productive capacity or a situation where production is taking place at a point below scale efficient frontier. Scale inefficiency for the banks is approximately 10%, 11% and 16% for the medium-sized banks, large banks and small banks, respectively. In terms of returns to scale, these banks are supposed to catch up by exhausting the remaining capacity to achieve full efficiency. Similar results with similar conclusions are found for banks with large branch networks. Large banks have the largest branch networks, with the largest customer base followed by medium banks and small banks.

Many of the large banks have been expanding their networks and now have a broad branch network all over the country. Some of them refrain from retail banking to do corporate banking. Thus, such banks will tend to be more efficient than those undertaking retail banking, which explains partly the high scale efficiency level. For all categories of banks large, medium and small banks, there are some of them operating on the increasing returns to scale and constant returns to scale portions. Thus, these banks have room for improving their efficiency by expanding their branch networks, launching new products to attract a variety of customers, and adopting new technology to enhance production. Small banks in this sector are mainly the most inefficient and need to catch up. Many reasons may be attributed to this, given that a majority of them are small and local-owned. The huge capital required to invest in the latest kind of technology may be weighing on these banks. Some of them are required to pool resources to provide services such as Automated Teller Machines (ATMs). Such joint efforts lead to certain inefficiencies in the production process and provision of services.

From theory, it is expected that the size of the production firm matters positively with regard to economies of scale and, thus, increasing possibility for large banks to rank high in performance analysis. This is fairly true in the Kenyan banking sector for the period analyzed. The medium banks, which are second to large banks, are more efficient than the small and large banks. This implies a majority of the medium sized banks operate closely to the frontier, and this is attributed to availability of resources to adopt new/latest technology, thus leading to efficiency in production. Further, medium banks can benefit from economies of scale emanating from large/medium scale production.

The Mann Whitney test scores on the efficiency on intermediation are carried out to validate the findings of this study. The Mann-Whitney test is a non-parametric t-test (distribution-free) used to compare two independent groups of sampled data. This test is an alternative to the independent group t-test, when assumption of normality or equality of variance is not met. This, like many non-parametric tests, uses the ranks of the data rather than their raw values to calculate the statistic. Below are the results of the Mann-Whiney tests.

The estimated Mann-Whitney test statistics for the efficiency scores given in Table 5.7 indicates that differences between scores in all three measures are significant in the case of large banks as compared to small banks. However, the differences in estimated efficiency scores of large and small banks has narrowed in the latter years, indicating improved efficiency in the entire commercial banks. In the case of large and medium banks, the statistics presented indicate that there are significant differences in estimated CRS and SE scores between large and medium sized banks. However, estimated VRS scores are not significantly different. The small differences in asset and deposit base may have impacted on the differences in estimated efficiency scores. The Mann-Whitney test scores indicate that there is no significant difference in CRS between the recorded performances of the medium and small banks. However, the differences in VRS and SE are significant.

In terms of ownership structures, foreign banks seem to be most efficient followed by local private, then local public. A number of reasons can be given for difference between foreign and local banks; such as access to technology and ease of technology transfer, managerial skills since foreign banks are generally multinational companies. The scale inefficiencies measures are 12%, 17% and 13% for foreign banks, local public and local private. For the banks to be full scale efficient, they are supposed to exhaust their 12%, 17% and 13% of under-utilized production scale. What explains this phenomenon? One reason may be that there has been an introduction of a new concept of banking in Kenya, and that is Islamic banking, offering different products and at lower rates. This is causing local banks to rethink what they are offering in terms of the products and interest charges they are giving. The Islamic banks follow the *Sharia* laws that do not believe in charging high interest rates, making the exploitation of scale economies difficult.

Table 5.8: Period average efficiency measures 1997-2006

	No. of banks	CRSTE	VRSTE	ScaleE
Foreign banks	9	0.640094	0.726756	0.880756
Local public banks	7	0.546712	0.653175	0.831031
Local private banks	24	0.49597	0.564617	0.878419

Table 5.9: Mann-Whitney test scores – Efficiency by ownership

Mann-Whitney test scores-Efficiency in intermediation			
	CRS	**VRS**	**SE**
Foreign Vs Local Public	182.5	525.5	261.5
	(-5.84**)	(-5.93**)	(-5.31**)
Foreign Vs Local Private	858	824	716
	(-1.59)	(-1.85)	(-2.62**)
Local Public vs Local Private	981.5	1204	821.5
	(-1.79)	(-0.6)	(-2.52**)

z scores are given in parentheses. ** indicates that test scores are significant under 5%level.

Foreign banks have been expanding their branch networks in the country as the local banks have been inefficient in service delivery. The way the Kenyan banks

operate is interesting in the sense that some foreign banks concentrate strategically in some certain highly profitable towns, and target a large number of corporate customer niches; large local banks have their branches spread in many regions in the country. Whereas some foreign banks refrain from retail banking to specialize in corporate products, large domestic banks are not discriminatory in terms of clientele composition. These strategic business modalities have a good deal to do with banks profitability and can have implications on measured efficiency.

The estimated technical efficiency and scale efficiency of local public banks, of which 4 are state-owned, are lower than the local private banks.

Mann-Whiney Test scores presented in Table 5.9 reveal that differences in estimated efficiency scores between foreign as compared to local public banks are statistically significant. On the other hand, estimated SE scores have shown significant differences in all cases. These findings suggest that recorded efficiency differences in different forms of ownership mainly resulted from issues related to the scale of operations.

5.4 Nature of RTS

Appendix 3 presents information on the RTS recorded by each bank in each year. CRS is considered as the most productive scale of operations (Avkiran, 2000). Further, evidence on RTS indicates some banks achieved CRS even though they were not technically efficient. Interestingly, only a few banks were in the IRS. As indicated in previous research, banks in IRS may enter into a market merger or other form of business collaboration with the major banks to expand their scale of operations (Avkiran, 2000). This study supports such strategic moves, since quite a number of small banks are in IRS. The two (CRS and VRS) efficiency measurements show that a large number of inefficient banks in Kenya were in the

DRS during the study period. Particularly during the latter part of the study, the number of banks in DRS has increased. Further, as identified in efficiency analyses, local-owned large banks were scale inefficient. The result on RTS confirms that the main cause of inefficiency of those banks were the excessive scale of operations. As suggested by Avkiran (2000), those banks that were in the DRS are required to downsize their scale of operations. The operations of such banks may be rationalized by reducing the number of bank branches and restructuring human resources.

5.5 Malmquist Indices of Efficiency Change

The investigation of productivity growth is achieved by applying a non-parametric method developed by Fare *et al* (1989), which computes total factor productivity (TFP) growth using a Malmquist index of productivity change. Within this framework, productivity growth may occur due to a combination of industry-wide technological change; that is, a shift in production surface, and a change in technical efficiency at the level of the operating unit, which is movement towards or away from the production surface. The Malmquist index can be decomposed to capture these two components; technological change and change in technical efficiency. Furthermore, the efficiency component can be decomposed into a pure technical and a scale efficiency change component.

Technical efficiency indicates the degree to which the operating unit produces the maximum feasible output for a given level of inputs, or uses the minimum amount of feasible inputs to produce a given level of output. Higher efficiency from one period to another does not necessarily suggest that the operating unit achieves higher productivity, since technology may have changed.

5.5.1 Productivity changes

Table 5.10 below gives the efficiency scores broken down into their respective components.

Table 5.10: Malmquist indices of efficiency changes

	Teffch	techch	PTech	sech	tfpch
Large banks	0.995	1.069	1	0.995	1.064
	0.997	1.066	1	0.997	1.063
	0.997	1.044	0.997	1.001	1.042
	0.992	0.995	0.993	0.999	0.987
	0.995	1.052	1	0.995	1.047
	0.992	0.995	0.993	0.999	0.987
Mean	**0.994667**	**1.036833**	**0.997167**	**0.997667**	**1.031667**
Medium banks	1.001	1.024	1.004	0.996	1.025
	0.996	0.965	0.998	0.998	0.962
	1.003	1.07	1.002	1.001	1.073
	0.99	1.076	0.99	1	1.065
	1.001	1.037	1	1.002	1.038
	1.001	1.014	1.002	1	1.016
Mean	**0.998667**	**1.031**	**0.999333**	**0.9995**	**1.029833**
Small banks	0.995	1.025	0.996	0.999	1.02
	1.01	0.995	1.01	1	1.004
	1	0.996	1.002	0.999	0.997
	1	1.018	1	1	1.018
	0.996	1.03	0.996	0.999	1.026
	1	1.047	1	1	1.047
	0.99	1.061	1	0.99	1.051
Mean	**0.999333**	**1.0245**	**1.001333**	**0.998**	**1.023833**
Non - bank Financial institutions	1.007	1.044	1.007	1	1.051
	0.997	1.06	1	0.997	1.057
	1.011	1.022	0.994	1.017	1.033
	0.998347	**1.031893**	**0.999273**	**0.999167**	**1.030333**

Broken down indices from Table 5.11

	Teffch	techch	PTech	sech	tfpch
Large Banks	-0.53	3.68	-0.28	-0.23	3.17
Medium Banks	-0.13	3.1	-0.07	-0.05	2.98
Small banks	-0.07	2.45	0.13	-0.2	2.38
NonBankfin	-0.17	3.19	-0.07	-0.08	3.03

Note indices computed from table 5.10 for a clear analysis.

Teffch is Technical efficiency change; **Tech** is technology change; **PTech** is pure technical efficiency change; **Sech** is scale efficiency change; and **Tfpch** is total factor productivity.

The results in table 5.11 indicate that total factor productivity increased by 3.2%, 2.9%, 2.3% and 3.0% for the large banks, medium banks, small banks and non-bank financial institutions, respectively. In each category of banks, the resultant increase in total factor productivity was a result of a positive technology change of 3.7%, 3.1%, 2.5% and 3.2%, respectively. However, the improvement in technology was reduced by inefficiencies in the banking sector (0.5%), (0.13%), (0.07%) and (0.2%), respectively, for each category of banks. The inefficiencies in the banking sector may further be decomposed to pure technical inefficiency and scale inefficiency changes. For instance, for the large banks, the 0.5% productivity change is decomposed to 0.28%for pure technical efficiency and 0.23% for scale efficiency. The same trend is observed in the medium, small and the three financial institutions analyzed.

It is expected that the banks with high efficiency scores should show some technology improvement, and this is the case. The performance of large banks shows increase in technological innovations by the largest percentage as followed by medium and then the small banks. Large banks are mainly foreign-owned and have resources to spend in new technology. Further, by virtue that they are foreign-owned, there is transfer of technology from the mother banks in Europe and America. The local banks falling under this category of large banks have also improved their technology.

In terms of pure technical and scale efficiency, the score is reversed as compared to the DEA results. However, this is offset by the varied technology change estimates, leading to estimates making the overall total factor productivity to be explained by technology change with the highest being for the largest banks. This is expected. Thus, the banks miss the frontier by (0.5), (0.13), (0.07) and (0.2) points for large, medium, small and financial institutions, respectively. These divergence proportions point out the rates by which they should have reduced

inputs use to produce the same level of outputs if they managed to operate on the full efficient frontier.

The results show small banks have to build capacity for technological innovations. They can invest in technology and improve on their efficiency to reach the full scale efficiency. Given the high cost that is associated with technology investment, they need to look for resources.

5.6 Summary of Findings

This chapter examines the trends in efficiency and productivity changes of the banking industry during the post-liberalization period. Efficiency scores and total factor productivity growth are estimated using the output-oriented DEA model. Three inputs and two outputs specifications are used to represent efficiency and productivity gains in the intermediation process. The analysis of mean estimated efficiency scores are presented in the chapter.

The DEA technique identifies benchmarking units for measuring relative efficiency of DMUs from the sample of DMUs under observation by piece-wise comparison of DMUs. Thus, estimated efficiency scores of a sample of DMUs are not appropriate to compare with the estimated efficiency scores from another sample of DMUs. Furthermore, issues related to model specification and input and output orientation used in assessment of efficiency may also reduce the comparability of estimated efficiency scores with other studies. Therefore, comparison of estimated efficiency scores of a sample with another may distort the reality. Thus, the comparison of estimated efficiency scores has to be limited to samples that have similar political, economic and social characteristics. In other words, it is important to consider the homogeneity of samples. Accordingly, the study has limited the comparison of estimated efficiency scores to banks in Kenya only.

The results suggest that the main source of inefficiency of banks in Kenya is as a result of technical inefficiency rather than scale inefficiency. However, from the Mann Whitney tests, scale inefficiency is found to be significantly contributing to overall inefficiencies, implying both technical and scale have contributed to inefficiencies in the banking sector. It is further observed that the inefficient use of labour and deposits, rather than underutilization of fixed assets in the intermediation process cause inefficiency in the banking sector. The banking industry is technology-based and the results suggest a situation where labourers in the banking sector are not fully utilized, and commercial banks keep excess liquidity than is necessary for efficient service provision. The under-utilization of workers and production input leads to low output per worker.

In terms of ownership and size, foreign banks are more efficient than local banks. And in the local category, local-private are more efficient than local-public. Medium-sized banks are more efficient than large and small banks. Large and small banks are found to suffer from diseconomies of scale. The estimated total factor productivity indicates a marked improvement in the productivity in banks, emanating from technological change. However, the improvements are reduced by inefficiencies in the banking sector emanating from purely technical changes and scale inefficiencies. Banks with better efficiency measures show greater technological improvements than the inefficient banks.

Overall, this chapter shows how the efficiency and productivity changes have evolved during the last 10 year (1997-2006) period. Furthermore, the recorded trends have shown that the changes in efficiency of banks may have been affected by some other factors with the financial reforms. The next chapter derives managerial inefficiency scores and investigates the factors affecting the managerial inefficiency of banks in Kenya.

CHAPTER SIX: ANALYSIS OF MANAGERIAL INEFFICIENCY

6.0 Introduction

This chapter investigates managerial inefficiency, which is referred to as X-inefficiency, in the post-liberalization period. Discussion in this chapter is based on Objective Two and Three. In order to attain X-inefficiency scores, a multi-product translog cost function is estimated. X-inefficiency scores are then predicted from the estimated translog cost function. Factors determining the X-inefficiency are then analyzed and a summary given at the end of the chapter.

One of the major concerns of the study is whether people in the banking sector really work as they should do. Multi-product translog cost function is used to estimate X-inefficiency in commercial banks. The primary purpose of estimating translog cost is not to establish the parametric relationships among its variables, but to get inputs with which to determine X-inefficiency. Overall X-inefficiency in commercial banks is assessed based on the consolidated commercial banks data and the analysis is extended to investigate the banks in various categories in terms of size. Using Limdep 8.0, the translog function is estimated.

As explained in the methodology, the stochastic frontier approach assumes the error terms follow the exponential or gamma distribution. We therefore use the maximum likelihood estimates which assume the disturbance term follows the exponential and gamma distribution. Further, this assumption is backed by the aggregation of data that involves different sizes of banks that is likely to have some noise. Other distributions, in particular the half normal and truncated half normal distribution was assumed and the results are not plausible as presented Appendix 5. The analysis is thus based on the estimates produced with assumptions of exponential distribution. In this section, the results of the translog function are presented for the three categories of banks and factors determining X-inefficiency are discussed.

6.1 Descriptive Statistics and X-inefficiency Scores

Given any data series, the first thing is to confirm the descriptive statistics of the data for all the dependent variables and independent variables for the multi-product translog model. It should not be obvious that the translog form of model is the most appropriate representation of the cost function in Kenya. Therefore, the reset test is done to ensure this is the correct representation of the cost function for the banking sector.

Table 6.1: Descriptive statistics for the translog data

	Summary				
	Skewness	**Kurtosis**	**Autocorrelation**	**Mean**	**Std deviation**
Ln (TC)= LnTotal Cost	0.5057	3.0872	0.955004	6.288655	1.22037427
Ln (Y1) =Ln Advances	0.6331	2.8645	0.898024	7.951631	1.28604716
Ln (Y2) =lnTotal earning assets	-0.0462	3.0651	0.8671163	6.642287	1.58828326
Ln (P1)=ln Price of funds	-0.0997	2.8502	0.7065882	1.725436	0.828934146
Ln (p2)=Ln Price of Labor	-0.1381	3.2568	0.7359082	1.317453	0.446702602
Ln P3=Ln Price of physical capital	-0.3301	4.8643	0.7516466	-1.12288	0.635873248
0.5*(lnY1*lnY1)	0.9636	3.3026	0.9093994	32.43911	10.7962827
0.5*(lnY2*lnY2)	0.6619	3.3092	0.8858984	23.31816	10.6470119
(lnY1*lnY2)	0.8199	3.4668	0.8999723	54.19876	20.3542623
0.5*(lnP1*lnP1)	1.0809	3.9754	0.6657799	1.831272	1.4718655
0.5*(lnP2*lnP2)	0.8527	3.2927	0.7348138	0.967363	0.593811767
0.5*(lnP3*lnP3)	2.9043	17.0555	0.6752803	0.832096	0.87358433
(lnP1*lnP2)	0.5598	3.2093	0.6541401	2.304022	1.45231197
(lnP1*lnP3)	-1.7685	10.1039	0.7385333	-2.01038	1.71698625
(lnP2*lnP3)	-0.5455	4.7867	0.7458126	-1.34623	0.847627713
(lnY1*lnP1)	0.0091	3.1282	0.7161155	13.48273	6.64438209
(lnY1*lnP2)	0.5743	3.9111	0.8007795	10.50336	4.09863531
(lnY1*lnP3)	-0.1948	5.6768	0.7095432	-8.53457	4.58358436
(lnY2*P1)	-0.3028	3.011	0.6894434	11.02351	5.26276597
(lnY2*P2)	0.764	4.4503	0.8061085	8.643358	3.56019029
(lnY2*P3)	-0.4394	5.3538	0.6968423	-7.08525	3.8701299

Source: Limdep ver 8.0 used to derive the descriptive statistics

Further, given that this is a panel dataset, a combination of cross section and time series data, we test for the presence of heteroskedasticity and autocorrelation,

which are problems of respective cross sectional and time data. Further, the normality nature of the data is sought for. The results are presented in the table 6.1.

Checking the Skewness and Kurtosis from Table 6.1 above shows that all the variables have a normal distribution, with the exception of two variables [0.5*(lnP3*lnP3)] and[(lnP1*lnP3)]. According to Hilderbrand (1986), the data above shows great skewness, with many values greater than 0.2. The Kurtosis shows a leptokurtic distribution, which implies it is less flat topped and with all values positive. In general, the data is fit for estimation. Autorcorrelation is absent as evidenced by the small coefficient values. An OLS regression is run so as to test for the presence of heteroskedasticity, and reset before the use of the data in estimating the translog function. The results of the Breusch-Pagan or Cook-Weisberg test for heteroskedasticity test are shown in Table 6.2 below. We fail to reject the null hypothesis that there is no heteroskedasticity. The reset test further confirms that the functional form is representative of the bank cost structure in Kenya. The deviations from the mean do not show a large variance.

Table 6.2 Breusch-Pagan / Cook-Weisberg test for heteroskedasticity and Reset test

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of TC dependent variable
chi2(1) = 3.50 **Prob > chi2 = 0.0613**

Ramsey RESET test using powers of the fitted values of TC
Ho: model has no omitted variables
F(3, 376) = 2.82 **Prob > F = 0.8121**

Source: Results from Stata ver 10

After the descriptive analysis of the data, we go ahead and estimate the translog cost function for a panel of 40 banks over 10 years. Limdep ver 8.0 is used. Maximum likelihood method of estimation is used to estimate the translog function, with an assumption of an exponential distribution of the error term. Limdep does the best in estimating the translog function for panel dataset compared to Stata 8 or 10. All packages are used and the best results are presented in Table 6.3 below.

From Table 6.3, estimates of the overall commercial banks stochastic frontier model and the significance of theta shows that banks experience some X-inefficiency during the period under study.

Table 6.3: Multi-product translog cost function estimates

lnTC	Coefficient	standard error	t- value	p- value	Mean values
lnY1	0.786072	0.12129891	6.48	0	7.9516306
lnY2	-0.42585	0.11017541	-3.865	0.0001	6.6422868
lnP1	1.58E-03	0.19138419	0.008	0.9934	1.7254359
lnP2	1.014663	0.29532859	3.436	0.0006	1.3174527
lnP3	-0.15422	0.16995272	-0.907	0.3642	-1.1228839
0.5*(lnY1*lnY1)	3.00E-02	1.78E-02	1.685	0.092	32.439106
0.5*(lnY2*lnY2)	9.85E-02	9.56E-03	10.306	0	23.318156
(lnY1*lnY2)	-2.41E-02	1.03E-02	-2.353	0.0186	54.198759
0.5*(lnP1*lnP1)	0.2041	3.41E-02	5.991	0	1.8312716
0.5*(lnP2*lnP2)	0.232405	0.10561697	2.2	0.0278	0.96736293
0.5*(lnP3*lnP3)	-0.20933	3.46E-02	-6.055	0	0.83209612
(lnP1*lnP2)	-0.24703	4.33E-02	-5.705	0	2.3040223
(lnP1*lnP3)	-1.51E-03	3.54E-02	-0.043	0.966	-2.0103766
(lnP2*lnP3)	8.60E-02	5.90E-02	1.456	0.1453	-1.3462293
(lnY1*lnP1)	5.16E-02	2.08E-02	2.48	0.0131	13.482726
(lnY1*lnP2)	-0.17863	4.15E-02	-4.304	0	10.503356
(lnY1*lnP3)	8.85E-02	3.27E-02	2.703	0.0069	-8.5345745
(lnY2*P1)	-1.43E-02	1.93E-02	-0.741	0.4586	11.023513
(lnY2*P2)	0.111978	3.50E-02	3.2	0.0014	8.6433581
(lnY2*P3)	-8.97E-02	2.63E-02	-3.407	0.0007	-7.0852532
Variance parameters for compound error					
Theta	7.05186	0.52888892	13.333	0	
Sigmav	0.186383	8.94E-03	20.845	0	

Source: *Estimates derived from Limdep ver 8.0*

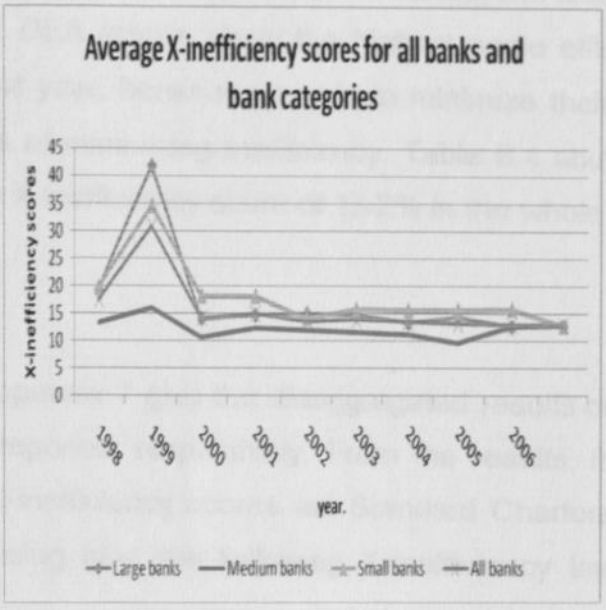
X-inefficiency indices are predicted from the estimates of the stochastic frontier model using the distribution of inefficiency term sigma conditional on theta as previously discussed under methodology. The purpose of estimating the multi-product translog cost function was to derive X-inefficiency prediction from the estimated model. Appendix 5 shows the estimates of X-inefficiency derived from the whole banking sector. The significance of the Theta and Sigma values of probability of {0.00000} implies that the banks definitely have or experience X-inefficiency. From the translog function, the X-inefficiencies scores are predicted and are as presented in Table 6.4 below.

Table 6.4 and Figure 6.1 give the results of the X-inefficiency scores for all the banks. The idea behind measuring X-inefficiency is to assess management's ability, effort and endeavour to achieve their organizational cost minimization goal. These variables are aligned to individuals' management capacity, which tend to change gradually. X-inefficiency for all the banks moved upwards from 1997 to 1998, moving from 17.5% to 30.9%. The resulting inefficiencies in the banking sector led to 5 banks failing during that period, as explained in Chapter 2. Since 1998, changes in X-inefficiencies have stagnated around 10-15%, showing existence of certain static management approaches that have caused some level of sustained inefficiency rates in the banking sector.

Table 6.4: X-Inefficiency scores (%)

AVGs	Large banks	Med banks	Small banks	All banks
1997	19.3	13.3	19.8	17.5
1998	41.9	16.1	34.7	30.9
1999	14.0	10.6	18.2	14.3
2000	14.7	12.4	18.1	15.1
2001	15.0	12.0	14.1	13.7
2002	14.6	11.6	15.8	14.0
2003	13.3	11.2	15.6	13.7
2004	14.2	9.6	15.7	13.2
2005	12.6	12.8	15.9	13.4
2006	12.8	13.2	12.7	12.9
Avg	**17.2**	**12.3**	**18.1**	**15.9**

Figure 6.1: Average X-inefficiency for all banks



During the period under review, the X-inefficiency scores average in all banks categories are all less than 50%. Most of the banks range below 20%, that is between 10% and 20% and the trend from 1999 to 2006 is a downward trend. For instance, the average score of all the banks in 1999 is at 15.9% level of X-inefficiency and reduces to 12.9% inefficiency level in 2006. A similar downward trend is observed in the large banks categories and the reverse however broken in 1998. The particular drivers of this inefficiency were mainly from some local-owned banks, which were financing elections in the year 1997, carried on to 1998. The same trend, however, does not repeat itself in 2002 when there was a change of government in Kenya after 24 years of President Moi's rule. Banking sector improves and shows less X-inefficiency in the subsequent years, though stabilizing at the range of 10-15%. The medium banks are able to reduce their X-inefficiency to a level below 10%.

The same classification in the previous DEA chapter has been followed here. Banks have been grouped into three categories: Large banks, medium banks and

small banks. It is important to note that the three categorizations under the DEA model show the same trends in X-inefficiency, reinforcing the findings of this study. For instance, in 2004, DEA results show the highest scale efficiency measures. This implies that in that year, banks were able to minimize their costs and attain some mileage in terms of minimizing inefficiency. Table 6.4 above attests to this, with the second lowest X-inefficiency score of 13.2% in the whole of banking sector being in 2004.

Tables 6.5, 6.6 and Appendix 7 give the disaggregated results of the banks in the large and medium categories, respectively. From the results, it is clear that the banks with the least X-inefficiency scores are Standard Chartered and NIC bank. Results from the translog give the following X-inefficiency levels for the large banks.

Table 6.5: Large banks X-inefficiency scores

YEAR	BBK	KCB	STD	COOP	CFC	CITI	CBA	NBK	NIC	STNBIC	I and M	DTRST*
1997	15.71	100	8.6	100	13.92	13.34	100	62.11	11.5	19.32	38.1	20.76
1998	14.36	12.17	7.66	18.29	10.62	16.92	20.58	56.89	11.68	10.53	28.41	23.86
1999	10.05	11.54	7.96	17.64	12.88	19.02	14.8	22.32	9.56	9.39	20.81	12.17
2000	20.63	12.58	4.74	15.17	21.89	16.47	19.05	5.95	13.22	11.76	17.02	17.67
2001	17.15	14.98	10.66	14.7	27.11	10.42	19.09	5.09	12.18	15.23	16.02	17.13
2002	13.11	16.99	11.65	13.42	20.05	12.38	19.43	7.18	11.6	24.04	14.1	11.81
2003	11.54	8.63	8.83	35.25	11.24	15.64	15.02	7.7	12.17	17.12	8.94	7.56
2004	14.51	9.38	8.07	17.55	11.93	30.19	18.25	8.12	13.77	18.6	8.26	12.13
2005	18.65	11.31	7.97	7.58	16.8	12.84	11.15	5.77	10.95	28.79	8.91	10.17
2006	9.68	13.98	7.09	7.48	18.02	15.42	17.99	4.93	15.31	27.49	7.8	8.31
AVG	**14.539**	**21.156**	**8.323**	**24.708**	**16.446**	**16.264**	**25.536**	**18.606**	**12.194**	**18.227**	**16.837**	**14.157**

Source: Results from Limdep 8.0. Appendix 8 gives the names of the banks in full.*

This implies that the two banks have been able to manage their costs in a manner that has been more efficient than the other banks. They have been able to maximize their output at minimum costs. The important thing to note is that Standard Chartered Bank is a foreign bank and NIC bank is a local bank. This means that in terms of ownership, there are some good locally managed banks, NIC Bank being one of them. Foreign banks are more efficient than local banks in DEA results, and this is true in the case of X-efficiency. It goes hand in hand that a bank experiencing technical efficiency will most likely be managed well with people with very high skills. Banks that seem to have high X-inefficiency are KCB, COOP, NBK and STNBIC Bank. Unfortunately, all these banks are locally-owned, with wide branch networks in the country. The fact that a particular bank has wide branch network increases chances of inefficiency. In economic theory, diseconomies of scale set in when a firm grows too big to the extent that managerial efficiency is compromised. Further, from DEA results, local banks are more inefficient compared to foreign-owned banks. Likewise, is the X-inefficiency results, high X-inefficiency scores reflect poor management.

Table 6.6: Medium banks X-inefficiency Scores.

	BOB	PRIME	FINA	IMPRL	HF	EABS	BOI	ABC	HABIBAG	KREP	GIRO
1997	6.91	14.03	10	10.74	22.29	21.22	8.5	10.94	16.53	14.4	10.66
1998	9.26	21.03	11.2	15.03	22.29	29.95	10.32	10.32	19.83	14.4	13.11
1999	6.15	13.06	9.02	9.46	13.99	15.58	5.86	8.53	10.9	14.4	9.76
2000	8.53	15.11	8.88	9.31	10.41	17.63	13.49	9.15	18.63	14.4	11.3
2001	10.53	13.09	9.3	10.46	8.93	10.69	13.62	10.06	24.49	9.55	11.06
2002	10.81	12.94	9.15	12.48	7.01	9.56	12.78	9.23	21.34	11.29	11.19
2003	21.97	10.13	8.3	14.05	6.3	10.82	12.48	7.61	12.89	10.23	8.45
2004	8.42	8.41	8.56	14.57	10.45	8.75	12.55	7.35	8.64	10.55	7.84
2005	7.67	10.12	16.74	27.57	12.2	8.79	9.95	10.06	11.73	16.85	8.92
2006	7.52	12.25	17.4	28.11	10.31	11.5	7.78	8.82	11.43	20.4	9.66
	9.777	**13.017**	**10.86**	**15.178**	**12.418**	**14.449**	**10.733**	**9.207**	**15.641**	**13.647**	**10.195**

Source: Results from Limdep 8.0. Appendix 8 gives the names of the banks in full*

For medium banks, the most X-efficient banks are BOB and ABC. The most X-inefficient banks include IMPRL, HABIBAG and EABS. In general, and from the above two tables, the banks X-inefficiency levels have been going down, implying they have been employing better and better people, more able to make good decisions. With a population where knowledge is being acquired at a very high rate, it is expected that those joining the workforce are better educated and skilled to make good managerial decisions that would lead to cost saving and maximization of profits.

Of the essence to note is that measures of inefficiency may also be shown by the level of non-performing loans that banks attract. This is one way of knowing how good the process of screening and how much the management takes time and effort in ensuring the loans they get are good quality. It is evident from the finding that banks that show least X-inefficiency indeed have the least ratios of non-performing loans to total loans, compared to those with high X-inefficiency scores. For instance, from Figure 6.2, we note that KCB, COOP and NBK have high X-inefficiency scores and also have high levels of non-performing loans.

Figure 6.2: Ratios of non-performing/total loans

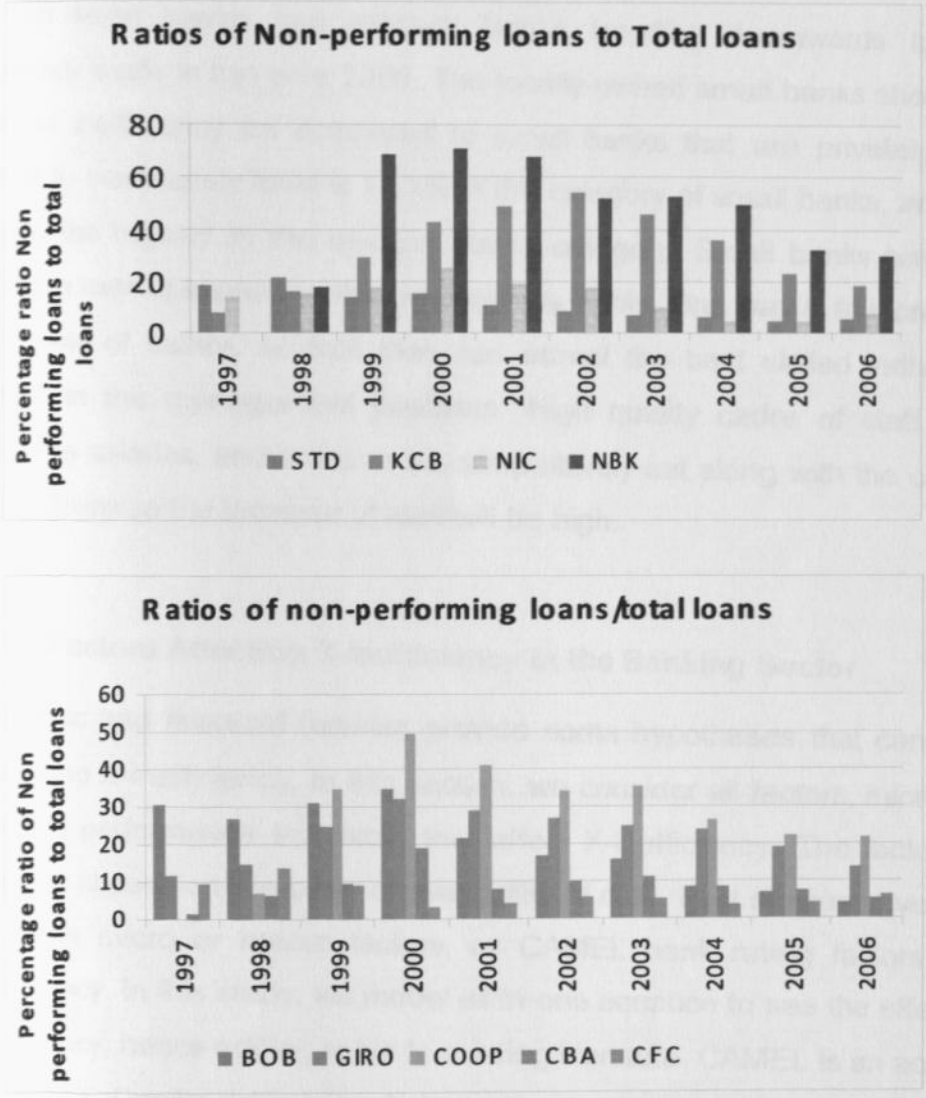


Figure 6.2 is a clear indication of this scenario, which links assets quality to managerial efficiency, with the exception of CBA, which seems to have very low ratios of non-performing loans but high X-inefficiency scores. Inefficiencies existing in banks in this case are explained by other factors other than loans. Other explanations would be high salary packages to the staff, which increase the overhead costs and in general the costs of running the banks. In the next section, we seek to find out the factors that determine or influence the level of X-inefficiency.

Appendix 7 presents results of the small banks. The general trend is the same as for the large banks and medium banks trending downwards towards more efficiency levels in the year 2006. The locally-owned small banks show the highest level of inefficiency as compared to small banks that are privately-owned. The lowest X- inefficiency level is 14.1% in the category of small banks, and this level is among the highest in the medium banks category. Small banks have some task ahead in term of improving their inefficiency levels. One way is to increase the level and scale of salary, so that they can attract the best skilled individuals in the market in the management positions. High quality cadre of staff require high attractive salaries, and it has to be competitively set along with the current market rate. Otherwise the turnover of staff will be high.

6.2 Factors Affecting X-inefficiency in the Banking Sector

Economic and financial theories provide some hypotheses that can be tested in explaining X-inefficiency. In this section, we consider all factors, micro, macro and financial performance indicators that affect X-inefficiency. The factors discussed here are chosen on the basis of availability of data. Past studies have mainly dwelt on either micro or macro factors, or CAMEL bank rating factors affecting X-inefficiency. In this study, we model all in one equation to see the effects on the X-inefficiency, hence adding value to existing literature. CAMEL is an acronym for the following C-Capital Adequacy, A-Asset Quality, M-Management, E-Earnings and L-Liquidity. The *apriori* expected outcome in the regression is also mentioned.

Capital Adequacy (CAP): This is one of the measures of bank performance regulated by the Central of Kenya. As noted by Berger and Mester (1997), high capital ratios force banks to keep high capital reserves at an opportunity cost, since such funds could earn higher returns if invested. The *apriori* expected sign for the capital measure is positive relationship with inefficiency. However, on the contrary, it may be argued that as the bank's capital ratio reaches the optimum level, the

bank's cost X-inefficiency will fall mainly because well capitalized banks may obtain external finance at lower costs than do poorly capitalized banks. Thus, at this point, we may say that the impact is indeterminate and may be positive or negative.

Asset Quality (A): This represents the bad loans' hypothesis. It is argued that inefficiencies most often arise from bad loans due to bad management decisions. Therefore, consistent with this hypothesis, it is expected that bad loan problems exacerbate X-inefficiency.

Bank Liquidity (LIQ): This is also one of the performance measures of the banking sector regulated by the Central Bank of Kenya. It is argued that when banks hold high liquidity, they do so at the opportunity cost of some investment options, which could generate high returns. Therefore, it is predicted that banks liquidity positively influences cost X-inefficient. Further, banks keep a lot of cash reserves in their tills and at the central bank in a credit needy economy such as Kenya's. The only explanation for this is the inefficiency in the intermediation process of the banking sector. Otherwise it is hard to explain why banks have excess liquidity whereas there is need for this money in the economy.

Bank Profit (PRT): This is part of the performance measures of the banking sector computed by the Central Bank of Kenya. This is predicted to lead to an increase in cost X-inefficiency. There is a positive relationship between profitability and market structure measures, such that highly profitable banks tend to consolidate their position in the market, even at the expense of cost efficiency.

Bank size: According to microeconomic theory on scale economies, bank size (beyond a certain point) is negatively related to efficiency because bigger banks, after crossing a certain threshold, may suffer from scale diseconomies due to the difficulties of managing a larger entity. However, since X-inefficiency is a

management quality (De Young, 1998) measure, it can be argued that large banks have the resources to attract high calibre personnel, who many deliver superior performance and lower X-inefficiencies. This notwithstanding, larger banks in a highly concentrated market may be able to influence prices, such that they appear to be more efficient (Mester, 1996). The expectation, therefore, is that the variable may have a positive or negative coefficient depending on what is strongly driving Kenyan banks.

Market power (MKT). This variable represents the market power hypothesis. This can be measured using loans and deposits equally weighted or assets share. The market power hypothesis predicts that when banks have greater market power, they offer less favourable terms to their customers in order to recoup abnormal profits (Berger and Hanan, 1989). There is limited evidence that banks operating in more concentrated markets are less efficient, supporting the quiet life theory that inefficiency has been sustainable in banking because competition has not been robust (Berger and Hanan, 1997). The level of concentration is measured using the Herfindahl-Hirschman Index (HHI), which is computed by summing the squares of the market share of each firm in the industry within a specified market, thus:

$$HHI = \sum_{i=1}^{n} (sk)_i^2 \qquad [26]$$

where sk_i is the share (computed by using the percentage of turnover or assets, as appropriate) of firm i; n is the number of firms. The HHI scores range from 0 – for perfectly competitive industry to 10,000 (100^2) for a pure monopoly. The expected *apriori* sign for market share variable will be positively related to X-inefficiency. According to the interpretation of the United States Department of Justice and Federal Trade Commission, who developed the index, any score above 1800 represents a highly concentrated industry, which indicates the presence of oligopoly.

Multibank Holding Corporation (MBH): This represents the degree of foreign ownership of commercial banks in the local market. The banking sector has been undergoing reforms and privatization, though some banks still remain government-owned. Bank ownership matters when it comes to efficient operation of the bank. According to agency theory, there are potential conflicts between bank managers and other stakeholders. Government-owned banks, especially in Kenya, may be influenced by political allegiances, and therefore may tend to be inefficient. However, it is argued that with privatization and foreign bank ownership and penetration, there will be better corporate governance and, therefore, reduce X-inefficiency. Therefore, it is predicted that MBH is inversely related to X-inefficiency.

Financial Liberalization Factors (R): It is evident that the Kenyan economy has been undergoing financial reforms. Whereas this is a macro variable, it is necessary for us to include this variable in the estimation of the equation. The proxy to be used for financial liberalization will be the real loan rate. The idea is that financial repression is often indicated by negative real rates, such that an increase in r (real rate) represents financial liberalization as a remedial policy for financial repression. The *apriori* sign for this variable is indeterminate from past studies. For instance, Berger and Humphrey (1997) conclude that conventional wisdom, which holds that deregulation always improves efficiency and productivity, may be incorrect.

GDP

In this study, we capture the average income of bank customers measured by real per capita GDP. The variable represents general economic performance, or business cycle behaviour and, as such, the predicted impact on X-inefficiency is theoretically indeterminate.

We estimate Equation 27 in Chapter 4 (Methodology) using panel data regression. Before estimation of the equation, all the diagnostic checking of the data is done. This includes the standard descriptive statistics, correlation and stationarity. Table 6.7, 6.8 and 6.9 present the various diagnostics of the data.

Table 6.7: Descriptive statistics for the variables to be estimated

CAP	Skewness	-1.7206	Kurtosis	8.5304	Autocorrelation	0.8669
AQ	Skewness	-0.9916	Kurtosis	4.389	Autocorrelation	0.7614
LIQ	Skewness	-0.4315	Kurtosis	8.623	Autocorrelation	0.7057
PRT	Skewness	-0.3202	Kurtosis	2.8978	Autocorrelation	0.7322
BSZE	Skewness	0.6002	Kurtosis	2.8517	Autocorrelation	0.9348
MKT	Skewness	0.6144	Kurtosis	2.9189	Autocorrelation	0.9607
MBH	Skewness	-0.3844	Kurtosis	3.3961	Autocorrelation	0.7088
R	Skewness	-0.0227	Kurtosis	1.3859	Autocorrelation	0.955
GDP	Skewness	0.3976	Kurtosis	2.3525	Autocorrelation	0.0248

It is important for any researcher to check for skewness and kurtosis of the data to check out the distribution of the data, which should be normal, and also check out for outliers. In this case, Table 6.7 above shows that all the variables have a normal distribution, with the exception of CAP. The data above shows great skewness, with many values greater than 0.2. In general, the data is fit for estimation. Autorcorrelation is absent as evidenced by the small coefficient values.

A further analysis is done on the variables to check whether any two of the variables are correlated. Table 6.8 gives the correlation matrix. The finding is that most of the values are independent and lowly correlated, with the exception of size of the bank and market structure. The plausible explanation for this high correlation is that we estimate the bank size by using the asset base composition. Further, the market structure is arrived at by looking at the HHI and CR4 indices, which make use of assets. To correct for this, deposit or turnover may be used to compute the HHI and CR4. The same picture is portrayed of the market structure, so this does

not pose a problem. The market power variable was measured with both the loans and deposits weighted and assets share, and assets share gave a better result.

Table 6.8: Correlation matrix for estimation variables

	CAP	BSZE	AQ	PRT	MBH	LIQ	MKT	R	GDP
CAP	1	-0.56561	-0.13067	-0.09524	0.1146	0.67525	-0.58465	-0.02798	-0.0477
BSZE	-0.56561	1	-0.12346	0.62087	0.13436	-0.31481	0.98043	-0.20879	0.08703
AQ	-0.13067	-0.12346	1	-0.41777	-0.04875	-0.03861	-0.08368	-0.16815	-0.08358
PRT	-0.09524	0.62087	-0.41777	1	0.06758	-0.02323	0.5951	-0.16143	0.06604
MBH	0.1146	0.13436	-0.04875	0.06758	1	0.19135	0.0877	-0.27498	-0.01375
LIQ	0.67525	-0.31481	-0.03861	-0.02323	0.19135	1	-0.28013	0.21932	-0.06135
MKT	-0.58465	0.98043	-0.08368	0.5951	0.0877	-0.28013	1	-0.03819	0.00849
R	-0.02798	-0.20879	0.16815	-0.16143	-0.27498	0.21932	-0.03819	1	-0.15679
GDP	-0.0477	0.08703	-0.08358	0.06604	-0.01375	-0.06135	0.00849	-0.15679	1

As is usual with time series variables, we require an analysis of data properties, especially the strength of the memory process or the level of integration to purify the empirical analysis and to conform to theoretical postulates. We summarize unit root tests in Table 6.9. At log levels, the variables are all stationary, with market structure being weakly stationary. Eviews 6.0 is used to estimate the panel unit roots. The study makes use of Fisher-type tests using Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests (Maddala and Wu (1999) and Levin, Lin and Chu (2002) for the panel data. Common root Levin, Lin and Chu t* and PP confirm the ADF panel unit roots reported in table 6.9 below. Theoretically panel unit roots are simply multiple –series unit root tests that have been applied to panel data structures (where presence of cross-sections generates "multiple series" out of a single series). The observations are 400 with 9 cross sections units.The Levin, Lin

and Chu (2002) test assumes there is a common unit root process so that ρ_i is identical across cross sections.[24]

Table 6.9: Panel unit root tests ADF

	Lag 0	Lag 1
CAP	-3.626**	-3.370*
BSZE	-3.167*	-3.167*
AQ	-5.159**	-5.239**
PRT	-5.162**	-6.098**
LC	-4.283**	-5.516**
LIQ	-3.945**	-4.219**
MKT	-2.339	-2.318
R	-8.671**	-7.353**
GDPA	-10.52**	-12.53**

This can clearly be seen from the values of the variables, which is greater than the critical value at 1%, 5%** and 10%*, [25] except MKT. MKT is weakly stationary.

[24] Other methods and the formulations are in E-views 6.0 program guide book II

[25] Critical Values for unit root tests are: 1%t -3.49
5%t -2.89
10% -2.58

The hypothesized relationships are summarized below:

Variable	Proxy variable (Dependent variable) definition	Hypothesized relationship
CAP	Core capital / RWAS percentage	Positive/negative
AQ	NPLs/gross loans, percentage	Positive
LIQ	Liquid assets/total deposits, percentage	Positive
PRT	Profit before tax in Kenya shillings million in real terms.	Positive
SZE	Ratio of bank assets to total banking sector assets. Percentage	Positive/negative
MKT	Market concentration index, % measured by HHI	Positive
MBH	Ratio of foreign bank assets to total banking sector assets	negative
R	Real lending/deposit interest rate	Indeterminate
GDP	Economic growth, measured by real per capita GDP	Indeterminate
INEFF-1	Lagged inefficiency	Positive

These are then estimated using the panel regression and system GMM. Table 6.10 below presents the results.

For the panel model, Equation [25] in Chapter 4 of methodology is estimated. To choose between fixed effects model and random effects model, the Hausman specification test was performed. Under the test, the null hypothesis is that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator. In this case, we find a significant p-value, probability X^2 less than 0.05. Therefore, we use fixed effects for the panel estimation. The GMM is also estimated to check whether past inefficiencies have any impact on the present X-inefficiencies. We make use of GMM estimator proposed by Arellano and Bond (1991) which is an extension of

Anderson Hsiao (1982)'s instrumental variables estimator and is more efficient because it avails additional moments of restrictions. In this case, lagged values of the explanatory variables are not correlated with the first difference of error terms; the authors suggest that the lagged levels of independent and dependent variables can be used as potential instruments to estimate the first differenced equation. For GMM to be identified there must be at least as many instrumental variable as there are parameters to estimate. The instruments used are given in table 6.10 below. The Sargan test is used to test the validity of instruments used. A rejection of the test implies the instruments used are valid.

Table 6.10: Regression results

	Coefficient	t-statistic		GMM	t-value	Instruments
Constant	0.362	4.054		0.216	1.98	
CAP	0.018	2.164		0.1	1.876	CAP(-1)
AQ	0.523	6.651		0.14	2.16	AQ(-1)
LIQ	0.104	1.917		0.07	0.265	LIQ(-1)
PRT	0.116	3.98		0.2	1.96	PRT(-1)
SZE	-0.422	-9.66		-0.892	-1.75	SZE(-1)
MKT	0.089	1.644		0.68	0.591	
MBH	-0.345	-15.8		-0.33	-3.05	MBH(-1)
R	0.11	9.012		0.014	2.09	R(-1)
GDP	0.036	1.167		0.01	1.66	GDP(-1)
INEFF(-1)				0.19	1.86	INEFF(-2)
R-squared	0.789		Sargan test (P-value)	47.76	0.603	
Adjusted R-squared	0.736		AR (1) test value (p-Value)	-2.453	0.014*	
F-Statistic	36.786		AR (2) test (p-value)	-0.94	0.347	
Probability (F-statistic)	0					
DW Statistic	0.433					

An increase in the ratio of core capital to risk weighted assets leads to an increase in cost X-inefficiency. This suggests that it may be true that banks are maintaining

high capital ratios relative to an optimal level, thereby eroding banks cost efficiencies. Berger and Mester (1997) argue that banks do keep high capital reserves at an opportunity cost of earning returns from investment. Both models estimated show a positive relationship and are significant. This is particularly so for the large banks. Current capital requirement is also affected by past X-inefficiencies.

The asset quality variable that represents the bad loans hypothesis has a positive impact on cost X-inefficiency. This implies that when banks lend to the public and the loans go bad, accumulation of these bad loans increases the cost of running the bank. It is evident from the banking sector in Kenya that once a loan goes bad, it is very difficult to recover it. The court process is very slow and the whole process of debt collection is expensive. Problem loans, however, precede inefficiency when some weak management (and possibly some exogenous factors beyond the control of the bank management) have led to the deterioration of asset quality, high loan recovery costs, and consequently cost inefficiency. The coefficient is found to be positive and significant in the GMM and Panel. That is expected.

Liquidity is positively related to X-inefficiency, though statistically significant at 10%. This finding suggests that banks in Kenya increase their liquidity position; they do so at the opportunity cost of expanding their loan portfolios and thus suffer cost inefficiency. Banks should rethink their strategies and develop new ideas on how to use their money in most cost efficient and productive way.

Profitability too has a positive statistically significant impact on cost X-inefficiency. One plausible explanation for this is that if the banking sector in Kenya is not competitive, banks may manipulate the prices in their favour and increase their profitability without necessarily reducing costs. This usually happens in an oligopolistic market structure where top banks collude to gain certain profit

advantages. As discussed in Chapter 2, the market structure in the banking sector in Kenya is fairly concentrated.

Bank size matters when it comes to X-inefficiency. The theoretical prediction of this relationship is negative and in this study, it is found to be so. This implies that medium to larger banks tend to be closer to the efficient frontier than smaller banks. Further, they are more likely to achieve an optimal mix of inputs and outputs. The evidence is consistent with DeYoung (1998) that larger banks have the resources to attract high caliber personnel and thus attain lower X-inefficiencies. The DEA results in the previous chapter confirm the findings.

The results show that the market power hypothesis cannot be strongly supported. It is statistically significant at 10% level, which is acceptable on a one tailed test and at least indicates weak support of the hypothesis. Therefore, we can conclude that in the Kenyan banking sector, it is indeed true that banks with greater market power may offer less favorable terms to their customers in order to recoup abnormal profits. Big banks' interest rates are usually very high. The GMM coefficient for this variable is statistically insignificant, implying that past X-inefficiencies have to impact on the market structure.

The variable for multi-bank holding company shows a negative relationship with X-inefficiency at statistically significant t-statistic of 5% or higher. This has the implication that an increase in the degree of foreign bank ownership in Kenya has an effect, or is associated with a reduction of cost X-inefficiencies. This result suggests that where the corporate governance structure of banks in Kenya is such that there is substantial foreign ownership of banks, there is greater scrutiny of the management of the banks in order to mitigate agency-related problems and the pertinent agency costs, thus enhancing performance and reducing X-inefficiency.

The financial liberalization variable shows that the impact on X-inefficiency is positive and statistically significant. This implies that financial liberalization has increased cost X-inefficiency. This finding is consistent with other studies, which show that financial liberalization is associated with increased X-inefficiency in the banking sector and vulnerability to financial crises (see for example Maher et al, 1998 and Reinhart et al, 1998, Kirkpatrick et al 2008). There are various schools of thought where financial liberalization is meant to have created enormous improvements in the financial sector. The GDP variable is not significant.

What is evident is that past inefficiencies of the determinants affect current/present behaviour of bank variables as shown in the GMM estimate. The coefficient of GMM estimate are smaller than those of panel regression and fairly weakly significant. Past inefficiencies are carried on to the present period.

6.3 Summary of Findings

The objective of this chapter was to estimate the X-inefficiency and get the determinants of X-inefficiency of banks in Kenya. A translog cost function is estimated, from which the X-inefficiency scores are predicted. Factors assumed to be affecting X-inefficiency are then regressed using two models for comparison purposes and for getting the feedback mechanisms. A set of macroeconomic and microeconomic variables are used in the regression.

While all the models show a good fit of R^2, not all the variables are statistically significant, though they have the correct sign hypothesized in the study. The panel (fe) model gives the best estimates. The factors analyzed (MKT, AQ, CAP, SZE, LIQ, PRT, MBH, R, GDP) have been found to affect X-inefficiency as analyzed in the chapter. Other factors would have been considered given availability of data. Overall, these results suggest that these are the determinants of X-inefficiency in the banking sector in Kenya.

This chapter presented the findings of the translog cost function, predicted X-inefficiency in the models, and estimated regression results on factors affecting X-inefficiency in the banking sector in Kenya. It has highlighted the macroeconomic and microeconomic factors that have affected the technical efficiency of the banking industry. Having tackled the three objectives of the study, the next chapter concludes the findings of the study.

CHAPTER SEVEN: CONCLUSIONS AND RECOMMENDATIONS

7.0 Conclusions

This research examined efficiency and productivity gains in the banking industry in Kenya. It covered three research issues, namely, whether the banking sector in Kenya has experienced any efficiency and productivity gains in the post-liberalization period; whether there has been any managerial inefficiency; and the factors that determine the managerial inefficiencies (X-inefficiencies).

By addressing these three research issues, this study provides empirical evidence from the Kenyan banking industry to supplement the existing body of knowledge in efficiency and productivity as well as managerial efficiency. The study was presented in six main chapters, which followed the introductory Chapter One. Chapter Two presented the background to the banking sector, Chapter Three presented literature review on studies done in the banking sector in Kenya and other countries, and Chapter four gave the analytical framework and methodology used in the study whereas Chapters five and six gave the empirical evidence of the study. Specifically, Chapter Five dealt with Objective One while Chapter Six dealt with Objectives Two and Three. Chapter Seven concludes the study and gives insights to some policy implications.

This study was motivated by the fact that though the banking sector is the largest component of the financial system in Kenya, occupying more than 80% of financial sector assets, there is not much quantitative literature on the portfolio behaviour of this industry in the country to date. To investigate whether there were resource losses in commercial banks intermediation process, efficiency was measured using non-parametric Data Envelopment Analysis (DEA) to get respective banks' efficiency scores. In the second dimension of efficiency analysis, X-inefficiency in the banking industry was analyzed using multi-product translog cost function and then panel and GMM to analyze the factors that drive it. The data used in

estimation were from commercial banks' monthly returns accessed through Central Bank of Kenya and various Banking Surveys.

Section 7.1 summarizes the main conclusions about commercial banks efficiency status in the country. Section 7.2 summarizes X-inefficiency and its determinants. Section 7.3 presents policy implications and recommendations. Section 7.4 gives limitations of the study and areas for further research.

7.1 Commercial Banks Efficiency

In this study, efficiency is studied in three main contexts: investigation of technical and scale efficiency, and X-inefficiency analysis. A general observation on estimated commercial banks efficiency scores is that banks in Kenya performed fairly well during the period. The commercial banks' efficiency score was not less than 45% at any one point.

Overall, commercial banks were not fully technical and scale efficient during the study period. DEA estimates indicate that commercial banks had a chance to enjoy economies of scale almost throughout the period. Existing banks could expand and new ones could join the industry without compromising profitability. According to DEA efficiency scores, commercial banks operated on the decreasing part of their average cost curves and this gave them room to expand, with increasing returns to scale. With regards to technical efficiency, the estimates suggest that banks could produce the same amount of outputs with approximately 44% fewer resources under constant returns to scale and 35% fewer resources under variable returns to scale assumption than they actually employed.

In terms of ownership and size, foreign banks are more efficient than local banks. In the local banks category, local-private banks are more efficient than local-public banks. Medium-sized banks are more efficient than large and small banks. It is further observed from the summary of slacks that inefficient use of labour and deposits rather than under-utilization of fixed assets in the intermediation process is the cause of the inefficiency. The banking industry is technology-based and the results suggest a situation whereby workers in the banking sector are not fully utilized, and commercial banks keep excess liquidity than is necessary for efficient service provision. The under-utilization of workers and production input leads to low output per worker.

The results of DEA giving technical and scale efficiency are reinforced by the results of the managerial inefficiency. Banks that are more efficient technically and scale were found to have least managerial scores. For instance, foreign banks are more efficient than local banks in DEA results, and this is true in the case of X-inefficiency. It goes hand in hand that a bank experiencing technical efficiency is well managed by people with high skills. High X-inefficiency scores reflect poor management.

The estimated total factor productivity indicates an improvement in the productivity in banks, emanating from technological change. The improvement was mainly experienced in larger and medium banks than the smaller banks. However, the improvements are reduced by inefficiencies in the banking sector, emanating from purely technical changes and scale inefficiencies. Banks with the greatest efficiency measures showed greatest technological improvements. In general, one can conclude that:

- The efficiency scores in the intermediation process suggest that banks may gain efficiency improvements from reforms in the long-term.

- The local-owned commercial banks recorded lower average efficiency scores than the foreign-owned commercial banks, indicating that local public-owned commercial banks are the main contributor to low efficiency in Kenya.
- Medium size commercial banks show higher average technical and scale efficiency scores in the intermediation.
- Empirical investigation shows that commercial banks in Kenya gained some productivity improvements during the 10 year period covered by the study.

7.2 X-inefficiency

One of the major concerns of the study was whether people in the banking sector really work as they should do. Overall, inefficiency term of the stochastic multi-product translog cost function of commercial banks was significant, showing that banks experienced some X-inefficiency during the period. The Wald specification tests suggest that the stochastic frontier equation explains variations in X-inefficiency in Kenyan commercial banks. In spite of the fact that the overall X-inefficiency in commercial banks was at less than 60% during the period, there were no significant improvements over time. The three major categories investigated in the DEA model were also analyzed in the context of X-inefficiency.

Among the basic questions of this study was what drives inefficiency in commercial banks? Both micro and macro factors were used to determine variables affecting efficiency in the banking sector. The analysis of the determinants of X-inefficiency shows that there was a positive relationship with variables such as profitability, capital adequacy and liquidity, real interest rate, GDP, asset quality market structure, whereas variables such as size and multi-bank holding company were negatively related to X-inefficiency. GDP show weak significance in the models.

7.3 Policy Implications and Recommendations

Development in the financial services sector is considered a prime requirement for a country's economic development (McKinnon 1973; Shaw 1973). Thus, as part of the development strategy, the Government of Kenya commenced regulatory reforms to the financial services sector in 1987. The reforms aimed to enhance the capital accumulation process by improving efficiency and productivity of the financial services sector. Whereas the study did not seek to address the issue of the impact of the reforms on efficiency and productivity in the banking sector, it sought to address the issue of efficiency in the post-liberalization period.

Following from empirical evidence and major conclusions drawn from the analysis of bank efficiency and factors determining it, one can draw the following policy implications:

There is some inefficiency in the Kenyan banking sector and, therefore, the need for policies or reforms geared towards filling the gap remaining to attain 100% efficiency levels. Kenya is on the right path in terms of reforms it is pursuing, which are aimed at enhancing efficiency in the financial sector. Thus, much effort is required to see the implementation and fruition of the reforms. However, much effort should be put not to take reforms that would leave the banks exposed to financial crises.

From the study, it is found that commercial banks' average cost curve were on the rise. To circumvent this, policy ought to be directed towards enhancing competition in the existing banks. Central Bank of Kenya should be engaged in the formulation of sustained financial policies that encourage competition in the banking sector. A competition policy or strategy should be put in place to ensure fair competition, pricing and profitability. Foreign banks are more efficient than local banks. Kenya's next policy option is to encourage banks to venture out of Kenya and provide

services in other countries. That way, we will be investing elsewhere and getting returns from other countries. There exist a few large banks in Kenya that make very high profits and repatriate most of it to the mother bank's country abroad. The Foreign owned banks in particular are Citibank, Barclays and Standard Chartered are known to repatriate their profits.

Medium banks are more efficient as compared to large banks and small banks. The Kenyan budget 2007/2008 passed a motion for banks to increase their capital from the current Ksh 250 million to Ksh 1 billion by 2012. Some of the reasons for this motion were to increase the efficiency of the banks, adequately insulate banks in the event of failure and, in line with Kenya Vision 2030 enlarge banks' capacity to lend. In this study, this motion is supported as small banks are found to be least efficient. The small banks will now move to the category of medium, thus making a few more banks efficient. The other objectives will also be achieved because, as the banks capitalize, they can lend more and are insulated in the event of failure.

The main source of inefficiency is technical rather than scale inefficiency. One of the main sources of technical inefficiency is labour. This has the implication of some banks having human resources that are not fully utilized. For such banks, if too many workers are employed, they should expand banking activities in case other inputs (resources) are available. If the problem is shirking, banks should provide incentive to motivate staff to increase their productivity or performance. The other option is to retrench some workers if a bank has enough activities to do at its most optimal capacity.

In order to be able to exploit scale economies in the banking sector, banks should harness their under-utilized resources, including labour input and deposits that can be used in the production of new variety of products. That means that production of other non-traditional financial services in the banking industry should be encouraged. It is noted that banks crave for more investment in treasury bills

because they have not ventured deeply enough to diversity their investment opportunities. Product innovation has also an advantage of risk diversification and therefore reducing losses and adding to banks' revenue performance. Further, banks experiencing DRS should downsize, while those experiencing IRS should expand their branch networks.

Kenyan banks have been productive, with productivity emanating from technology change. Given that technology is the main driver to productivity in the banking sector, the Central Bank Supervision Department should design practicable regulation for technological standards requirement. If banks operate with poor technology, they halt their productivity growth and eventually slow down the intermediation process. Efficient ways of transactions and records keeping, the use of modern tools, including computers and automated systems are a prerequisite for efficient banking.

The improved autonomy given to boards of management under the commercialization process has led not only to improved efficiency, but also to reduction of the efficiency gap between state-owned banks and privately-owned banks. The analysis of efficiency scores of different forms of banks shows a stable trend in estimated efficiency. On the other hand, estimated MPIs show that Kenyan banks have focused on improving productivity in the intermediation process.

7.4 Limitations of the Study and Areas for Further Research

A number of factors have limited the empirical analysis of this study. Accordingly, all measures have been taken within the study to restrict any cause that may result in bias in the study due to the limitations explained below.

This study is based on secondary data, mainly collected from banks' monthly returns and annual returns. Therefore, the data may be subject to measurement

and allocation errors, which are common in traditional accounting reports. The study used non-parametric DEA to estimate productivity efficiency of banks in Kenya. Discriminatory power of DEA is mainly dependent on the sample size and the number of inputs and outputs considered in the efficiency assessment. The study makes use of two outputs and three inputs. If it were possible to use more inputs and outputs, it would have been better. However, data availability would not allow this.

It was difficult to get a sufficiently long series of banking data. The Central Bank of Kenya started receiving monthly returns from commercial banks in 1996, and later on in 2000 they changed the format and location of the database. Therefore, the only available data from Central Bank was from 2000. The data before 2000 was got from banking survey (Oloo, 2007). A longer reliable series would have enabled us compare results from pre-liberalization and post-liberalization periods. Lack of well organized data is a statistical problem for most developing countries. This limits good analytical studies to be carried out, thus making macroeconomic policy decision process fairly weak.

An area for further study is the challenge caused by adoption of new technology and innovations. This is a question that has not been resolved in this study. Bank supervisors at the Central Bank are challenged as they grapple with the issues of regulation and efficiency, as well as commercial banks performance. Another area of study may be the efficiency of Central Bank itself. Central Bank is a regulator of banks and microfinance institutions. Its efficiency may be analyzed along the lines of regulation efficacy or its effectiveness in implementation of monetary policy. The Central Bank has a role to play in promoting economic growth and, therefore, its exposition would be useful for performance assessment and subsequently for monetary policy improvements.

Efficiency, productivity, market structure and competition are some important aspects of banking operations in a country. This study covered only efficiency and productivity. Accordingly, this study suggests future research should concentrate on several other areas related to banks' efficiency and productivity, as well as address the related issue of competitive conditions in Kenya. This may be achieved using the same data set but by modifying the DEA and SFA models and introducing the Conjecture Variations (CV) approach or the Lerner index. Also, future work may undertake some refinements of the major methods used e.g bootstrapping methods in DEA applications; or even the exploration of non linearities in further investigations of the determinants of bank efficiency in Kenya (specifically the bank regulation variable).

Estimated efficiency scores using DEA for one country may not be compared with the estimated efficiency scores for another country. Further, the estimated scores may not reflect the true efficiency level of the DMUs under review. Thus, this study suggests that measuring efficiency and productivity change using cross-country data may lead to a better understanding of the performance of the banking industry in Kenya. Such a study may provide information about comparable efficiency scores for banks in Kenya with other banks in the region.

Some recent studies such as Drake *et al* (2006) suggest using a three-stage procedure for estimating efficiency scores. These studies suggest decomposing the impact of environment effect from estimated efficiency scores. However, this study has been based on the two-stage procedures for investigating factors influencing the technical efficiency. Thus, it is proposed to conduct future research be based on the three-stage procedure.

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APPENDICES

Appendix 1: Mergers and acquisitions in the banking sector, 1994-2006

Mergers and Acquisitions				
	Bank name	Merged with	To form	Date
1	East African Building Society	Akiba Bank Ltd	EABS Bank ltd	31.10.2005
2	ABN AMRO Bank	Citibank N.A	Citibank N.A	30.11.2005
3	Habib A.G. Zurich	Habib Africa Bank Ltd	Habib Bank A.G. Zurich	30.11.1999
4	TransnationalFinance Ltd	Transnational Bank Ltd	Transnational Bank Ltd	28.11.1994
5	Co-operative Merchant Bank Ltd	Co-operative Bank Ltd	Co-operative Bank of Kenya Ltd	28.05.2002
6	CBA Financial Services	Commercial Bank of Africa Ltd	Commercial Bank of Africa Ltd	26.01.1996
7	Giro Bank Ltd	Commerce Bank Ltd	Giro Commercial Bank Ltd	24.11.1998
8	Guardian Bank Ltd	First National Finance Bank Ltd	Guardian Bank Ltd	24.11.1998
9	National Bank of Kenya Ltd.	Kenya National Capital Corp.	National Bank of Kenya Ltd.	24.05.1999
10	Barclays Bank of Kenya Ltd	Barclays Merchant Finance Ltd	Barclays Bank of Kenya Ltd	22.11.1999
11	Kenya Commercial Bank	Kenya Commercial Finance Company	Kenya Commercial Bank Ltd	21.03.2001
12	Standard Chartered Bank (K) Ltd	Standard Chartered Financial Services	Standard Chartered Bank (K) Ltd	17.11.1999
13	National Industrial Credit Bank Ltd	African Mercantile Banking Corporation	NIC Bank Ltd	14.06.1997
14	Diamond Trust Bank (K) Ltd	Premier Savings and Finance Ltd	Diamond Trust Bank (K) Ltd	12.02.1999
15	Universal Bank Ltd	Paramount Bank Ltd	Paramount Universal Bank	11.01.2000
16	Bullion Bank Ltd	Southern Credit Banking Corporation Ltd	Southern Credit Banking Corporation Ltd	07.12.2001
17	Stanbic Bank (K) Ltd	Stanbic Finance (K) Ltd	Stanbic Bank Kenya Ltd	05.01.1996
18	Guilders Inter. Bank Ltd	Guardian Bank Ltd	Guardian Bank Ltd	03.12.1999
19	Ken Baroda Finance Ltd	Bank of Baroda (K) Ltd	Bank of Baroda (K) Ltd	02.12.1994
20	First American Bank Ltd	Commercial Bank of Africa Ltd	Commercial Bank of Africa Ltd	01.07.2005

Source: Bank Supervision Special Report, Central Bank of Kenya

	Conversions from	To	Date
1	National Industrial Credit Ltd	National Industrial Credit Bank Ltd	28.09.1995
2	Southern Credit Finance Ltd	Southern Credit Banking Corp. Ltd	26.09.1995
3	Victoria Finance Company Ltd	Victoria Commercial Bank Ltd	11.01.1996
4	Charterhouse Finance Ltd	Charterhouse Bank Ltd	01.01.1998

5	City Finance Ltd	City Finance Bank Ltd	23.03.1995
6	Consolidated Finance Ltd	African Banking Corp. Ltd	08.12.1994
7	Akiba Bank Ltd	EABS Bank Ltd	31.10.2005
8	Credit Finance Corporation Ltd	CFC Bank Ltd	29.03.1995
9	Credit Kenya Finance Ltd	Credit Bank Ltd	30.11.1994
10	Development Finance Co. Ltd	Development Bank of Kenya Ltd	20.09.1996
11	Diamond Trust Company Ltd	Diamond Trust Bank Ltd	15.11.1994
12	Equatorial Finance Co. Ltd	Equatorial Commercial Bank Ltd	23.06.1995
13	Equity Building Society	Equity Bank Ltd	28.12.2004
14	Family Finance Building Society	Family Bank Ltd	01.05.2007
15	Fidelity Finance Ltd	Fidelity Commercial Bank Ltd	07.03.1999
16	Finance Institution of Africa Ltd	FINA Bank Ltd	13.01.1995
17	Imperial Finance Co. Ltd	Imperial Bank Ltd	08.12.1994
18	Investments and Mortgages Ltd	Investment and Mortgages Bank Ltd	27.03.1996
19	K-Rep Ltd	K-Rep Bank Ltd	24.03.1999

Source: Bank Supervision Special Report, Central Bank of Kenya

Appendix 2: Chronological reforms in Kenya

Period	Financial Sector Developments
1966-1970	• **1969:** First time, the government introduced short-term debt instruments, treasury bills, which were meant to mobilize funds to finance short-term needs of the government. • Minimum liquid asset –deposit ratio was 12.5%. Commercial banks were supposed to maintain this ratio.
	• **1970:** Interest on special deposits account reduced from 3.5% to 3%. This was done to increase incentives for commercial banks to expand credit activities and reduce their reliance on interest earned
1971-1975	• **1971:** NBFIs were instructed to reduce their lending for financing imported consumer durables by specified amounts. • Further, the Government restricted credit by requiring commercial banks to deposit 5% of their deposit liabilities in cash (cash ratio) in addition to the liquidity ratio requirement put in place in 1969.
	• **1972:** Commercial banks were instructed by CBK to increase their lending to the private sector by a maximum of 12% for the year.
	• **1973:** The first oil shock due to the Arab-Israeli war • CBK restricted banks lending to foreign controlled companies to no more than 60% of their capital if at least 50% of the equity was owned by Kenyan nationals.

	• **1974:** The minimum liquidity requirements of 15%, which was earlier restricted to commercial banks, was extended to cover NBFIs. Interest on deposits, loans and rediscounting rates were revised upwards.
1976-77	• **1976:** Commercial banks were instructed to increase their outstanding credit to agriculture to 17% of their deposit liabilities by June 1976. • The minimum liquidity ratio of banks and NBFIs was raised from 15% to 18%. The maximum lending rate was raised to 10%.
	• **1977**: Growth in domestic credit was limited to 21%. • The restriction on local borrowing by foreign controlled companies imposed in 1973 was removed in order to encourage industrialization.
1978-84	• **1978:** The discounting rate was raised from 6% to 7.5%. • Following these measures, the banks' liquidity situation became tight, necessitating six months later a lowering of the liquidity ratio back to 15%. • The cash ratio of 4% was re-imposed on commercial banks. • **1982:** The maximum interest rate for bank loans was reduced from 16% to 15%. During the year, the government maintained a deflationary monetary policy in order to contain the high inflation recorded in 1982. • The government also restrained its expenditure, which reduced the need to borrow from the banking system and there was a general slow down in monetary expansion.
1985-92	• **1986:** The reforms, in the *Sessional Paper No.1 of 1986* include the following; • New government debt instruments, which introduced Treasury Bonds of one, two and five-year maturities intended mainly for monetary policy management. 6% cash ratio was re-imposed. • Lending rates for short-term securities, commercial banks' time deposit rates and maximum lending rate were adjusted upwards. This was partly a move to narrow the differential in interest rates between commercial banks and NBFIs and partly to widen the spread between minimum deposit rates and maximum lending rates, with a view to encouraging commercial banks to lend at longer terms. • **1989:** FSAP credit is approved. In the same year, credit becomes effective and shifts to indirect monetary tools initiated. • As a step towards harmonizing interest rates across the institutions, minimum saving deposit rate for commercial banks and NBFIs is raised by 0.5% and the maximum lending rate for loans and advances not exceeding three years rose to 15.5%. • The Banking Act of 1968 is revised to strengthen the CBK in its role. • **1990:** Interest rates were reviewed and adjusted upwards. • The requirement that ceilings on loan interest rate include all lending related charges and fees is removed and institutions can set their lending rates to reflect current market conditions. • CBK rates were raised by 2.9 percentage points, except for the discount rates for Treasury Bills, which increased by 1.9 percentage points. • Commercial banks interest rates on savings deposits, loans and advances (less than 3 years) were raised by 1.0 percentage points and 1.5 percentage points, respectively. • In November 1989, Tbill rate is fully liberalized. • **1991:** The growth rate in real GDP declined for the third consecutive year due to sluggish growth in aggregate domestic demand and foreign

	exchange shortage. • In July 1991, the government decontrolled interest rates, which was a big step towards full liberalization of the financial sector. • **1992** minimum capital asset ratio rose from 5.5% to 7.5%. • CBK • The CBK prepares prudential guidelines to encourage self regulation • Secondary market for foreign exchange certificates (forex-Cs) is established. • Re-introduction of cash ratio set at 6%. • Retention schemes are introduced allowing 100% retention of foreign exchange earnings from traditional exports
1993-2001	• **1993:** Monetary authorities pursued tight monetary policy with a view to reducing the growth rate of money and credit to rates sufficient to support economic growth at a modest increase in general price level. Use was made of direct and indirect instruments of monetary control. On the direct controls, CBK issued guidelines on the growth of Net Domestic Assets (NDA) of commercial banks with penalty placed on defaulters. The indirect instruments included the use of Open Market Operations in order to mop up excess liquidity in the wake of the 1992 general elections. • The rediscounting of government securities at the CBK was also restricted. • Cash ratio of commercial banks, which remained at 6% since 1986, was increased to 14%. • **1994:** The CBK streamlined the conditions and terms for re-discounting Treasury bills and overnight loans to commercial banks. Treasury bills that qualified for re-discounting were to have been held for not less than 75% of their life to maturity. • Overnight loans to commercial banks could only be secured through Treasury bills that had been held for at least 50% of their life. • Commercial bank cash ratio was raised to 20% in March 1994 and reduced to 18% in September the same year. • Liquidity ratio for commercial banks is maintained at 5% and NBFIs at 10%, all the prevailing commercial bank cash ratio requirement. • OMO sale of treasury bills is restricted to at least 0.5% below the weekly average tender rate. • **1995:** CBK broadened instruments of monetary policy and participants in the money market. Firms listed in the Nairobi Stock Exchange (NSE) were allowed to issue commercial paper. • Commercial banks are required to observe foreign exchange exposure limit of 20% of the paid up capital plus unimpaired reserves. • Newly converted NBFIs are required to observe half of the 18% mandatory cash ratio. • Foreigners permitted to invest in the local money market and participation in the OMO operations window was enlarged to include members of the general public. • The CBK started paying interest at 5% on all cash held by commercial banks and NBFIs at the Central Bank. • Revision of liquidity requirements fixes banks and NBFIs requirement at 25% and mortgage finance institutions at 20%. • Commercial banks allowed to exclude financial institutions deposits from cash ratio base • Commercial banks are henceforth required to submit monthly breakdown of government and parastatals deposits together with monthly statistic returns.

- The CBK launches a new treasury bill that serves as a bill and a cheque and conforms to the magnetic ink character recognition (MICR)
- Cash ratio requirement remains at 18%.

- **1996:** To encourage independent decision on quotation when purchasing treasury bills the CBK starts displaying OMO rate on the Reuter screen.

- *Repurchase Agreements (REPOs)* were introduced as an alternative instrument in the money market, especially by the CBK to alter the reserve levels.

- 60 and 270 days Treasury Bills were discontinued while the 30, 90 and 180 days Treasury bills were replaced with 28, 91 and 182 days Treasury bills.

- Conditions for CBK lending to commercial banks were relaxed in 1996. Treasury bills were accepted as collateral for either borrowing or discounting regardless for their time maturity.

- *Lombard borrowing Facility* for commercial banks was introduced. This facility allowed banks to borrow up to 5% of their paid up capital, interest was set at 4% above the Treasury bill rate.
- Repos extended to all banks after the pilot of selected banks in 23rd September 1996.

- **1997:** Donor funds of Enhanced Structural Adjustment Facility (ESAF) fund from the IMF stopped.

- In April 1997, the Central Bank of Kenya (Amendment) Act 1996 became law. The amendment granted more autonomy to the bank and essentially to ensure that the task of managing money supply in the economy was separated from that of spending. In accordance with Section 4B of the Act, CBK is required to issue monetary policy statements containing policies and means of which the bank intends to achieve the policy targets, reasons for adopting such monetary policies.
- The Central Bank of Kenya (Amendment) Act 1996 also limits government borrowing from CBK.
- Liquidity ratio reduced from 25% to 20%.
- Bank introduced a two way REPO with commercial banks to smoothen liquidity management, thus limiting the need for frequent resort to inter-bank borrowing.

- **1998:** All banking licenses are to expire by 31st December. The license to cover both the head office and branches banks, NBFIs, building societies and microfinance companies to streamline licensing procedures.
- The banking sector experienced turbulence as some banks developed liquidity problems due to mismanagement. The Banking Act was amended to deal with the problem of non-performing loans.
- Five commercial banks are placed under CBK's statutory management.
- Two commercial banks merge.
- The government initiated a systematic withdrawal of Bearer Certificates of Deposits (CDs) as deposit and borrowing instruments. This instrument was prone to misuse, as it was one of the causes of the turbulence in the banking sector.
- Cash ratio is lowered gradually to 12% from 15%.

- **1999:** Gazette notice is issued following the 1998 CBK Amendment Act giving the Ministry of Finance powers to prescribe monetary penalties. Policies employed to manage liquidity in the banking sector included restraint in monetary policy in a three-pronged approach.
- Loans to directors are fully approved by the board of directors on the same terms as the ordinary borrowers fully secured by tangible assets and

reported to CBK within 7days of approval, lending is only concessionary for house loans and cars.

- Three out of the five banks under statutory management are successfully restructured and one is re-opened.
- CBK organizes a seminar for bank directors with the objective of enhancing corporate governance
- Banks adopt the International Accounting Standards (IAS) by implementing IAS 30
- The Banking Act is amended, where capital and capital requirements are adopted in line with the Basle Capital Accord and international supervisory practices on measurement of capital adequacy. Guidelines and regulations were also revised and issued.
- Cash ratio is reduced to 12% from 15% in June 1998, to 14% in July 1998 and 13% in September 1999 with effect from 31st December.
- Minimum capital is increased for the banks and NBFIs to Ksh 200 million and Ksh 150 million, respectively, and expected to increase to Ksh 500 million and Ksh 375 million by 2002, aimed at strengthening the capital base.
- Bearer certificates of deposit observed to be volatile and being abused as avenues for money laundering and other malpractices are phased out by 31st December 1999.
- During the 1998/1999 banks and NBFIs are encouraged to use the VSAT services to improve efficiency in communication.

- **2000:** Another bank placed under CBK's statutory management is re-opened.
- One more of the banks under statutory management is re-opened. Two institutions continue to remain under statutory management.
- The Deposit Protection Fund Board (DPFB) places one bank institution under liquidation.
- Two NBFIs merge with their parent banks and one converts into a commercial bank. The number of NBFIs subsequently reduces to ten.
- The DPFB places Reliance Bank and Fortune Finance that were under statutory management under liquidation.
- Tight monetary policy was pursued using OMO in Treasury bills, discount and overnight lending by CBK as a lender of last resort.
- The statutory cash ratio was reduced from 12% to 10% in October 2000 to encourage commercial banks to lower interest rates especially on loans.
- Minimum core capital for banks and mortgage finance companies are increased from Ksh 200 million to Ksh 500 million while that of non-bank financial institutions are raised from Ksh 150 million to Ksh 375 million.The increments will be instituted gradually up to 2005.
- Foreign exchange exposure is set at 20% of core capital of institutions. Moreover, the forex exposure is redefined to take into account off-balance sheet items denominated in foreign currency.

2001:

- The CBK maintained tight monetary policy for the fifth year using OMO including REPOs, reserve ratio, discount facilities.
- The Central Bank of Kenya (Amendment Act), 2000 popularly referred to as the "Donde Bill" was passed in July and subsequently assented in August 2001.
- The effects of withholding donor funds in early 2001, was felt during the year as this created a big financing gap, which was financed though domestic credit. This affected demand for private sector credit that fell by 5.9%.
- The Banking Act is amended to allow sharing of information among banking institutions and also with CBK. The Act paves way for diversification of

	lending and security requirements by mortgage finance companies. Building societies are required to be members of the DPFB in order to protect small depositors. • The Building Societies Act is amended to harmonize it with the Banking Act, with the objective of creating a level playing field for banks and building societies.
2002-2006	• **2002:** Liquidity levels still above the minimum 20% standing at 46%. • It was proposed that the Banking Act Section 3 (1) of the Banking Act be amended to allow investment banks licensed by the Capital Market Authority (CMA) to use the term "bank". • **2003:** • Financial Sector Assessment programme carried out by IMF and World Bank in Kenya. • The cash ratio for commercial banks was reduced to 6% from 12%. Liquidity ratio increased to 49%. • **2004:** Liquidity ratio reduced from 49% to 42%. • CBK started Risk based supervision to the commercial banks with a view to proactively detect threats to financial stability. • The committee issued the Basel II Capital Adequacy Accord, which in addition to credit and market risk also incorporates the operational risk that banks face. The accord whose overarching objective is to foster global financial system stability is effective from the beginning of 2007 in G10 countries. • **2005:** Proceeds of Crime and Money Laundering Prevention Bill was approved for publication by the Cabinet in January 2005, presented in Parliament in February 2006 and May 2007 and is awaiting further deliberations by parliament. • CBK issued revised prudential guidelines to the banking sector November 2005 to be effective 1st January 2006. • December 2005 all Forex Bureaus are instructed to cease dealing in telegraphic transfers and third party cheques with immediate effect. • The CBK formulated risk management guidelines to guide banks on the minimum requirements for risk management frameworks. • **2006:** The Microfinance Bill is published by Attorney General in July 2006 and subsequently tabled in Parliament. The Act was assented to by the President in December 2006. • The Finance Act was enacted in December 2006 • The president assented to the Banking (Amendment) Act 2006 effectively enacting it into law. Among the amendments included the introduction of the "In Duplum" Rule. • A draft SACCO Bill was formulated and was approved by Cabinet in December 2006. The SACCO Bill proposes the establishment of the SACCO Societies Regulatory Authority, whose mandate will be to register, license, regulate and supervise SACCO societies. • It is a requirement that shareholders with more than 5% shareholding in an institution should not participate in its management or serve as an Executive Director. • **2007:** Operational supervisory powers of licensing, revocation of licenses, opening and closing of places of business and statutory management ceded from the Minister of Finance to the Central Bank of Kenya in May 2007.

Sources: *Monthly Economic Reviews, Quarterly statistical bulletin and annual Reports various issues, Central Bank of Kenya*
Kenya Monetary Policy Statements (Bi-annual), Various issues
Economic Survey and Annual budget speech various issues, Government of Kenya

Appendix 3: Summary of efficiency scores

Bank	Year		CRSTE	VRSTE	Scale	RTS
Habib Bank	1997	1	0.638	0.744	0.857	irs
	1998	2	0.65	0.727	0.894	irs
	1999	3	0.72	0.78	0.922	irs
	2000	4	0.743	0.84	0.884	irs
	2001	5	0.667	0.718	0.929	irs
	2002	1	0.878	0.921	0.953	irs
	2003	2	1	1	1	-
	2004	3	0.932	0.942	0.989	irs
	2005	4	0.932	0.951	0.98	irs
	2006	5	0.805	0.82	0.982	irs
Housing Finance	1997	6	0.386	0.509	0.758	drs
	1998	7	0.386	0.509	0.758	drs
	1999	8	0.454	0.595	0.763	drs
	2000	9	0.577	0.693	0.832	drs
	2001	10	0.763	0.832	0.916	drs
	2002	6	0.863	0.941	0.917	irs
	2003	7	0.842	0.864	0.975	irs
	2004	8	0.731	0.737	0.992	drs
	2005	9	0.151	0.168	0.898	drs
	2006	10	0.592	0.592	0.999	-
Diamond Trust Bank	1997	11	0.401	0.426	0.941	drs
	1998	12	0.3	0.311	0.965	drs
	1999	13	0.395	0.396	0.999	-
	2000	14	0.497	0.498	0.997	irs
	2001	15	0.34	0.344	0.988	drs
	2002	11	0.592	0.633	0.936	drs
	2003	12	0.693	0.715	0.969	drs
	2004	13	0.56	0.571	0.981	drs
	2005	14	0.655	0.661	0.991	drs
	2006	15	0.711	0.79	0.899	drs
Development Bank Kenya	1997	16	0.5	0.778	0.642	drs
	1998	17	0.419	0.452	0.927	drs
	1999	18	0.486	0.494	0.984	irs
	2000	19	0.543	0.697	0.78	drs
	2001	20	0.715	0.884	0.809	drs
	2002	16	0.581	0.692	0.839	drs
	2003	17	1	1	1	-
	2004	18	0.723	0.73	0.991	drs
	2005	19	0.641	0.653	0.981	drs
	2006	20	0.597	0.606	0.985	drs
Credit Bank	1997	21	0.688	0.769	0.894	irs
	1998	22	0.443	0.529	0.837	irs
	1999	23	0.397	0.444	0.893	irs
	2000	24	0.359	0.401	0.895	irs
	2001	25	0.476	0.502	0.947	irs
	2002	21	0.804	0.964	0.833	irs
	2003	22	0.708	0.788	0.898	irs
	2004	23	0.65	0.725	0.896	irs
	2005	24	0.601	0.684	0.879	irs
	2006	25	0.603	0.654	0.923	irs
Cooperative Bank	1997	26	0.172	0.424	0.406	drs
	1998	27	0.322	0.522	0.616	drs

	1999	28	0.363	0.517	0.702	drs
	2000	29	0.528	0.833	0.634	drs
	2001	30	0.503	0.738	0.682	drs
	2002	26	0.694	0.724	0.96	drs
	2003	27	0.647	0.669	0.967	irs
	2004	28	0.651	0.677	0.961	drs
	2005	29	0.849	0.929	0.914	drs
	2006	30	0.827	0.96	0.862	drs
Consolidated Bank	1997	31	0.424	0.471	0.901	drs
	1998	32	1	1	1	-
	1999	33	0.657	0.701	0.938	drs
	2000	34	0.343	0.358	0.957	drs
	2001	35	0.255	0.263	0.967	irs
	2002	31	0.367	0.404	0.908	irs
	2003	32	0.38	0.413	0.921	irs
	2004	33	0.375	0.429	0.875	irs
	2005	34	0.667	0.719	0.928	irs
	2006	35	0.562	0.592	0.95	irs
CBA	1997	36	0.468	0.486	0.963	drs
	1998	37	0.413	0.425	0.971	drs
	1999	38	0.39	0.4	0.974	drs
	2000	39	0.374	0.383	0.977	drs
	2001	40	0.456	0.46	0.991	drs
	2002	36	0.534	0.592	0.901	drs
	2003	37	0.772	0.889	0.868	drs
	2004	38	0.63	0.684	0.921	drs
	2005	39	0.713	0.785	0.908	drs
	2006	40	0.49	0.6	0.816	drs
Citibank NA	1997	41	0.386	0.413	0.934	drs
	1998	42	0.348	0.364	0.956	drs
	1999	43	0.283	0.309	0.916	drs
	2000	44	0.418	0.552	0.758	drs
	2001	45	0.515	0.808	0.637	drs
	2002	41	0.555	0.707	0.784	drs
	2003	42	0.595	0.736	0.807	drs
	2004	43	0.453	0.549	0.825	drs
	2005	44	0.576	0.77	0.747	drs
	2006	45	0.546	0.729	0.749	drs
Chase Bank	1997	46	0.401	0.636	0.63	drs
	1998	47	0.151	1	0.151	irs
	1999	48	0.172	1	0.172	irs
	2000	49	0.306	0.319	0.959	irs
	2001	50	0.187	0.199	0.941	irs
	2002	46	0.6	0.761	0.789	irs
	2003	47	0.698	0.738	0.945	irs
	2004	48	0.591	0.611	0.966	irs
	2005	49	0.565	0.581	0.971	irs
	2006	50	0.453	0.478	0.948	irs
CFC	1997	51	0.299	0.327	0.914	irs
	1998	52	0.41	0.415	0.988	drs
	1999	53	0.456	0.496	0.921	drs
	2000	54	0.421	0.462	0.911	drs
	2001	55	0.253	0.382	0.664	drs
	2002	51	0.515	0.591	0.872	drs
	2003	52	0.661	0.722	0.915	drs
	2004	53	0.95	1	0.95	drs

	2005	54	0.806	0.945	0.853	drs
	2006	55	0.787	0.989	0.796	drs
Barclays Bank	1997	56	0.234	0.365	0.642	drs
	1998	57	0.419	0.665	0.629	drs
	1999	58	0.369	0.648	0.568	drs
	2000	59	0.392	0.765	0.512	drs
	2001	60	0.321	0.824	0.389	drs
	2002	56	0.585	0.841	0.695	drs
	2003	57	0.655	0.978	0.67	drs
	2004	58	0.735	1	0.735	drs
	2005	59	0.601	0.958	0.627	drs
	2006	60	0.639	1	0.639	drs
Bank of India	1997	61	0.349	0.948	0.368	drs
	1998	62	0.604	0.623	0.97	irs
	1999	63	0.556	0.602	0.922	irs
	2000	64	0.586	0.619	0.946	irs
	2001	65	0.616	0.705	0.874	irs
	2002	61	0.949	0.965	0.984	drs
	2003	62	1	1	1	-
	2004	63	0.978	0.987	0.99	drs
	2005	64	1	1	1	-
	2006	65	1	1	1	-
City Finance Bank	1997	66	0.636	0.693	0.917	irs
	1998	67	1	1	1	-
	1999	68	1	1	1	-
	2000	69	1	1	1	-
	2001	70	1	1	1	-
	2002	66	1	1	1	-
	2003	67	0.709	1	0.709	irs
	2004	68	0.681	0.96	0.709	irs
	2005	69	0.713	1	0.713	irs
	2006	70	0.558	1	0.558	irs
Habib AG Zurich	1997	71	0.776	0.896	0.865	irs
	1998	72	0.979	1	0.979	irs
	1999	73	0.762	0.823	0.927	irs
	2000	74	0.606	0.661	0.917	irs
	2001	75	0.626	0.696	0.9	irs
	2002	71	0.738	0.817	0.903	irs
	2003	72	1	1	1	-
	2004	73	0.779	0.801	0.972	irs
	2005	74	0.864	0.869	0.994	drs
	2006	75	0.831	0.844	0.985	drs
Transnational Bank	1997	76	0.558	0.616	0.906	irs
	1998	77	0.163	0.167	0.976	irs
	1999	78	0.178	0.18	0.989	irs
	2000	79	0.275	0.287	0.959	irs
	2001	80	0.158	0.168	0.939	irs
	2002	76	0.393	0.403	0.976	irs
	2003	77	0.341	0.342	0.995	drs
	2004	78	0.322	0.325	0.991	drs
	2005	79	0.449	0.459	0.977	drs
	2006	80	0.382	0.389	0.982	drs
Victoria commercial banks	1997	81	0.213	0.221	0.962	drs
	1998	82	0.52	0.525	0.991	irs
	1999	83	0.467	0.478	0.976	irs

	2000	84	0.509	0.511	0.995	irs
	2001	85	0.462	0.545	0.849	drs
	2002	81	0.654	0.747	0.876	irs
	2003	82	0.587	0.642	0.914	irs
	2004	83	0.614	0.655	0.938	irs
	2005	84	0.536	0.556	0.963	irs
	2006	85	0.593	0.609	0.973	irs
Standard hartered bank	1997	86	0.442	0.488	0.906	drs
	1998	87	0.644	0.759	0.849	drs
	1999	88	0.554	0.659	0.84	drs
	2000	89	0.444	0.575	0.772	drs
	2001	90	1	1	1	-
	2002	86	0.822	0.989	0.831	drs
	2003	87	0.846	1	0.846	drs
	2004	88	0.782	0.932	0.838	drs
	2005	89	0.65	0.875	0.743	drs
	2006	90	0.715	0.983	0.727	drs
KCB	1997	91	0.62	0.677	0.915	drs
	1998	92	0.299	0.741	0.403	drs
	1999	93	0.368	1	0.368	drs
	2000	94	0.425	1	0.425	drs
	2001	95	0.411	0.96	0.428	drs
	2002	91	0.603	0.739	0.816	drs
	2003	92	0.715	0.873	0.819	drs
	2004	93	0.622	0.833	0.747	drs
	2005	94	0.576	0.811	0.71	drs
	2006	95	0.527	0.787	0.67	drs
K-Rep	1997	96	0.365	0.818	0.446	drs
	1998	97	0.485	0.552	0.878	drs
	1999	98	0.485	0.552	0.878	drs
	2000	99	0.485	0.552	0.878	drs
	2001	100	0.485	0.552	0.878	drs
	2002	96	0.447	0.515	0.869	irs
	2003	97	0.513	0.552	0.93	irs
	2004	98	0.506	0.536	0.944	irs
	2005	99	0.503	0.532	0.946	irs
	2006	100	0.491	0.511	0.961	irs
Middle East Bank	1997	101	0.356	0.373	0.956	drs
	1998	102	0.324	0.328	0.988	drs
	1999	103	0.309	0.33	0.939	drs
	2000	104	0.29	0.291	0.996	irs
	2001	105	0.345	0.442	0.78	drs
	2002	101	0.531	0.539	0.985	irs
	2003	102	0.498	0.5	0.998	irs
	2004	103	0.425	0.426	0.997	irs
	2005	104	0.462	0.463	0.998	irs
	2006	105	0.531	0.533	0.996	drs
NIC	1997	106	0.322	0.4	0.805	drs
	1998	107	0.384	0.505	0.761	drs
	1999	108	0.387	0.5	0.773	drs
	2000	109	0.337	0.435	0.776	drs
	2001	110	0.409	0.5	0.817	drs
	2002	106	0.687	0.733	0.938	drs
	2003	107	0.672	0.693	0.97	drs
	2004	108	0.708	0.751	0.942	drs
	2005	109	0.719	0.769	0.934	drs

	2006	110	0.565	0.586	0.964	drs
Oriental Commercial Bank	1997	111	0.441	0.513	0.859	drs
	1998	112	0.395	0.412	0.959	drs
	1999	113	0.551	0.578	0.954	drs
	2000	114	0.368	0.38	0.968	drs
	2001	115	0.923	0.94	0.982	drs
	2002	111	1	1	1	-
	2003	112	0.925	0.93	0.994	drs
	2004	113	0.701	1	0.701	irs
	2005	114	0.74	0.747	0.991	drs
	2006	115	0.475	0.479	0.992	drs
Stanbic	1997	116	1	1	1	-
	1998	117	0.344	0.353	0.972	drs
	1999	118	0.431	0.448	0.961	drs
	2000	119	0.474	0.5	0.947	drs
	2001	120	0.421	0.43	0.979	drs
	2002	116	0.553	0.556	0.995	drs
	2003	117	0.565	0.589	0.959	drs
	2004	118	0.461	0.463	0.995	drs
	2005	119	0.459	0.472	0.973	drs
	2006	120	0.531	0.575	0.924	drs
Southern Credit Bank	1997	121	0.465	0.479	0.971	drs
	1998	122	0.371	0.401	0.926	irs
	1999	123	0.408	0.447	0.912	irs
	2000	124	0.285	0.295	0.966	irs
	2001	125	0.375	0.514	0.729	irs
	2002	121	0.425	0.529	0.803	irs
	2003	122	0.507	0.58	0.874	irs
	2004	123	0.514	0.57	0.902	irs
	2005	124	0.498	0.548	0.91	irs
	2006	125	0.531	0.596	0.891	irs
Prime Bank	1997	126	0.178	0.198	0.896	drs
	1998	127	0.306	0.353	0.865	irs
	1999	128	0.319	0.33	0.967	irs
	2000	129	0.281	0.288	0.977	irs
	2001	130	0.3	0.306	0.98	irs
	2002	126	0.496	0.549	0.904	irs
	2003	127	0.684	0.751	0.911	irs
	2004	128	0.626	0.648	0.966	irs
	2005	129	0.599	0.648	0.925	irs
	2006	130	0.586	0.606	0.967	drs
Prime Capital and Credit Bank	1997	131	0.373	0.377	0.989	drs
	1998	132	0.377	0.382	0.986	drs
	1999	133	0.377	0.382	0.986	drs
	2000	134	0.399	0.427	0.935	drs
	2001	135	0.537	0.675	0.795	drs
	2002	131	1	1	1	-
	2003	132	1	1	1	-
	2004	133	1	1	1	-
	2005	134	0.971	0.984	0.987	drs
	2006	135	1	1	1	-
Paramount Universal Bank	1997	136	0.37	0.491	0.754	drs
	1998	137	0.704	1	0.704	irs
	1999	138	1	1	1	-

	2000	139	0.429	0.66	0.65	irs
	2001	140	0.407	0.408	0.998	irs
	2002	136	0.406	0.72	0.564	irs
	2003	137	0.461	0.791	0.583	irs
	2004	138	0.434	0.637	0.682	irs
	2005	139	0.795	1	0.795	irs
	2006	140	0.656	0.735	0.892	irs
landM Bank	1997	141	0.281	0.293	0.958	irs
	1998	142	0.316	0.395	0.802	drs
	1999	143	0.362	0.453	0.8	drs
	2000	144	0.333	0.392	0.851	drs
	2001	145	0.385	0.527	0.731	drs
	2002	141	0.611	0.652	0.936	drs
	2003	142	0.73	0.803	0.909	drs
	2004	143	0.747	0.792	0.944	drs
	2005	144	0.729	0.766	0.951	drs
	2006	145	0.796	0.88	0.905	drs
Imperial Bank	1997	146	0.397	0.559	0.71	drs
	1998	147	0.514	0.537	0.957	irs
	1999	148	0.455	0.47	0.966	irs
	2000	149	0.412	0.421	0.979	irs
	2001	150	0.416	0.422	0.986	irs
	2002	146	0.519	0.548	0.947	irs
	2003	147	0.489	0.501	0.976	irs
	2004	148	0.5	0.502	0.997	irs
	2005	149	0.384	0.388	0.987	irs
	2006	150	0.391	0.391	1	-
National Bank	1997	151	0.389	0.395	0.987	irs
	1998	152	0.373	0.613	0.609	drs
	1999	153	0.368	0.781	0.471	drs
	2000	154	0.657	0.884	0.743	drs
	2001	155	0.856	1	0.856	drs
	2002	151	0.953	0.957	0.995	irs
	2003	152	0.911	0.911	1	-
	2004	153	0.821	0.826	0.994	drs
	2005	154	1	1	1	-
	2006	155	1	1	1	-
ABC	1997	156	0.867	1	0.867	drs
	1998	157	0.495	0.502	0.986	irs
	1999	158	0.465	0.485	0.958	irs
	2000	159	0.468	0.479	0.977	irs
	2001	160	0.508	0.525	0.968	irs
	2002	156	0.601	0.745	0.806	irs
	2003	157	0.727	0.799	0.911	irs
	2004	158	0.657	0.684	0.961	irs
	2005	159	0.546	0.609	0.897	irs
	2006	160	0.603	0.607	0.994	irs
Bank of Baroda	1997	161	0.488	0.506	0.965	irs
	1998	162	0.732	0.82	0.894	irs
	1999	163	0.684	0.73	0.937	irs
	2000	164	0.647	0.683	0.947	irs
	2001	165	0.619	0.657	0.942	irs
	2002	161	1	1	1	-
	2003	162	0.835	0.97	0.861	drs
	2004	163	0.933	0.972	0.96	drs
	2005	164	0.889	0.919	0.967	drs

	2006	165	1	1	1	-
Fidelity Commercial Bank	1997	166	0.663	0.689	0.962	irs
	1998	167	0.425	1	0.425	irs
	1999	168	0.347	0.588	0.59	irs
	2000	169	0.337	0.425	0.792	irs
	2001	170	0.331	0.356	0.929	irs
	2002	166	0.518	1	0.518	irs
	2003	167	0.56	1	0.56	irs
	2004	168	0.547	1	0.547	irs
	2005	169	0.454	0.894	0.508	irs
	2006	170	0.47	0.987	0.476	irs
Equatorial Commercial Bank	1997	171	0.325	0.356	0.912	irs
	1998	172	0.568	0.614	0.925	irs
	1999	173	0.452	0.474	0.953	drs
	2000	174	0.407	0.425	0.958	irs
	2001	175	0.505	0.543	0.93	drs
	2002	171	0.663	0.774	0.857	irs
	2003	172	0.603	0.704	0.857	irs
	2004	173	0.644	0.706	0.912	irs
	2005	174	0.546	0.585	0.932	irs
	2006	175	0.564	0.578	0.977	irs
EABS Bank	1997	176	0.501	0.513	0.978	drs
	1998	177	0.26	0.267	0.974	irs
	1999	178	0.272	0.278	0.98	irs
	2000	179	0.239	0.242	0.984	irs
	2001	180	0.256	0.296	0.864	drs
	2002	176	0.673	0.697	0.966	irs
	2003	177	0.588	0.599	0.982	irs
	2004	178	0.61	0.646	0.945	irs
	2005	179	0.776	0.849	0.914	drs
	2006	180	0.652	0.708	0.922	drs
Dubai Bank	1997	181	0.376	0.444	0.846	drs
	1998	182	0.156	0.174	0.896	irs
	1999	183	0.182	0.308	0.591	irs
	2000	184	0.182	0.308	0.591	irs
	2001	185	0.182	0.308	0.591	irs
	2002	181	0.427	1	0.427	irs
	2003	182	0.424	0.649	0.654	irs
	2004	183	0.413	0.601	0.688	irs
	2005	184	0.595	0.736	0.809	irs
	2006	185	0.534	0.664	0.804	irs
Fina Bank	1997	186	0.096	0.109	0.877	irs
	1998	187	0.723	0.743	0.972	irs
	1999	188	0.693	0.712	0.974	irs
	2000	189	0.605	0.613	0.986	irs
	2001	190	0.65	0.666	0.976	irs
	2003	187	0.803	0.866	0.928	irs
	2004	188	0.802	0.808	0.992	irs
	2005	189	0.495	0.503	0.984	irs
	2006	190	0.468	0.473	0.989	irs
Giro Bank	1997	191	0.569	0.58	0.98	irs
	1998	192	0.492	0.499	0.986	irs
	1999	193	0.543	0.549	0.988	irs
	2000	194	0.514	0.521	0.988	irs

	2001	195	0.482	0.487	0.989	irs
	2002	191	0.502	0.775	0.647	irs
	2003	192	0.568	0.796	0.714	irs
	2004	193	0.607	0.836	0.726	irs
	2005	194	0.595	0.824	0.722	irs
	2006	195	0.556	0.691	0.804	irs
Guardian Bank	1997	196	0.464	0.467	0.994	irs
	1998	197	0.825	0.846	0.975	irs
	1999	198	1	1	1	-
	2000	199	0.536	0.538	0.997	irs
	2001	200	0.495	0.514	0.963	drs
	2002	196	0.592	0.617	0.96	irs
	2003	197	0.662	0.682	0.969	irs
	2004	198	0.676	0.69	0.98	irs
	2005	199	0.719	0.722	0.996	irs
	2006	200	0.714	0.715	0.998	irs
		mean	0.561458647	0.650090226	0.876406015	

Source: DEAP 2.1

Appendix 4: Summary of input slacks

Input Slacks 2002-2006			
	1	2	3
1	0	3.516	0
2	0	0	0
3	0	8.477	0
4	0	28.925	0
5	0	49.35	0
6	608.48	53.767	0
7	752.804	0	0
8	0	0	933.546
9	0	0.212	1.925
10	0	0	0
11	0	0	190.322
12	0	0	132.652
13	990.055	0	0
14	2869.963	0	0
15	2960.137	0	1042.275
16	0	23.338	222.246
17	0	0	0
18	0	0	136.739
19	0	0	240.094
20	0	0	224.913
21	0	18.482	0
22	0	4.311	0
23	0	0	0
24	0	0	0
25	0	9.064	0
26	3361.999	440.234	0
27	9667.969	669.377	0

28	11048.45	350.43	0
29	10645.9	521.877	0
30	11689.56	1030.126	0
31	0	50.976	0
32	0	93.996	0
33	0	94.33	0
34	0	156.78	0
35	0	123.436	0
36	0	0	0
37	0	0	0
38	1457.848	0	0
39	6934.557	0	0
40	5736.863	0	0
41	0	0	850.002
42	0	0	1373.157
43	938.783	0	929.597
44	0	0	2453.899
45	0	0	3015.884
46	0	0	0
47	0	0	0
48	0	0	0
49	0	0	0
50	0	0	0
51	0	213.129	624.604
52	0	0	378.378
53	0	0	0
54	0	1033.048	1118.84
55	0	1809.382	2161.128
56	1095.011	1922.796	0
57	2383.161	800.372	0
58	0	0	0
59	0	0	473.484
60	0	0	0
61	0	62.641	0
62	0	0	0
63	0	0	62.723
64	0	0	0
65	0	0	0
66	0	0	0
67	0	0	0
68	0	0	12.667
69	0	0	0
70	0	0	0
71	182.443	0	0
72	0	0	0
73	215.886	0	0
74	0	0	0
75	0	0	0
76	0	5.459	0

77	0	0	88.869
78	0	0	118.548
79	0	3.597	160.043
80	0	2.884	184.347
81	50.105	0	0
82	552.841	0	0
83	725.933	0	0
84	880.33	0	0
85	847.573	0	0
86	3961.418	238.823	0
87	0	0	0
88	6827.652	155.227	0
89	0	0	1648.836
90	0	0	1448.894
91	9478.325	1947.818	0
92	6911.027	1848.924	0
93	0	1673.28	524.982
94	0	1966.615	868.571
95	261.09	1895.467	0
96	0	34.271	0
97	0	31.318	0
98	0	70.36	0
99	0	125.34	0
100	0	182.665	0
101	0	0	0
102	0	0	0
103	0	0	0
104	0	0	0
105	0	0	94.965
106	0	0	1307.224
107	0	0	1259.863
108	2811.528	0	698.187
109	4649.391	0	804.42
110	4868.093	0	596.002
111	0	0	0
112	0	0	73.966
113	0	0	0
114	0	0	132.929
115	0	0	159.5
116	733.231	0	0
117	166.385	0	0
118	0	0	231.088
119	1735.469	0	0
120	7505.933	0	810.164
121	0	16.219	0
122	0	10.983	0
123	0	12.397	0
124	0	7.392	0
125	0	17.811	0

126	0	0	0
127	281.962	0	0
128	0	0	0
129	871.685	0	0
130	1074.468	0	0
131	0	0	0
132	0	0	0
133	0	0	0
134	69.963	0	0
135	0	0	0
136	0	5.105	0
137	0	2.827	0
138	0	0	0
139	0	0	0
140	0	0	0
141	908.387	0	0
142	407.831	0	411.961
143	2241.708	0	451.018
144	3997.058	0	371.796
145	5636.507	0	1059.745
146	0	0	0
147	0	0	0
148	0	0	0
149	0	3.993	0
150	0	0	0
151	5413.784	137.323	0
152	3242.637	143.997	0
153	3316.584	62.004	0
154	0	0	0
155	0	0	0
156	54.454	0	0
157	0	0	0
158	0	17.926	0
159	237.244	0	0
160	0	61.367	0
161	0	0	0
162	0	0	1846.731
163	0	0	0
164	0	0	0
165	0	0	0
166	0	0	0
167	0	0	0
168	0	0	0
169	30.465	20.542	0
170	429.303	28.625	0
171	0	0	0
172	169.848	0	0
173	0	0	0
174	0	0	0

175	133.278	0	0
176	0	0	0
177	0	0	0
178	0	0	0
179	1585.812	0	0
180	637.782	0	0
181	0	0	0
182	0	9.176	0
183	0	10.657	0
184	0	0	0
185	0	0	0
186	932.039	0	0
187	606.873	0	0
188	875.496	0	0
189	0	0	0
190	0	0	0
191	1103.267	23.995	0
192	905.241	0.629	0
193	1215.11	0	0
194	1195.375	9.215	0
195	809.49	0	0
196	0	0	0
197	0	0	0
198	0	0	0
199	0	0	0
200	0	0	0
mean	824.449	101.783	159.659

Source: DEAP 2.1

Appendix 5: Summary of X-inefficiency Scores

Bank	Year	Half normal distribution	Truncated normal	Gamma	Exponential
BBK	1997	0.1914	0.5106	0.1622	0.1571
KCB	1997	1.4689	1.5836	1.1154	1.1001
STD	1997	0.0281	0.2733	0.0795	0.086
COOP	1997	1.8037	1.4366	0.9249	0.9543
CFC	1997	0.5719	0.4644	0.1714	0.1392
CITI	1997	0.4726	0.4468	0.1412	0.1334
CBA	1997	1.5524	1.4482	0.9809	0.9653
NBK	1997	1.6961	1.1025	0.5534	0.6211
NIC	1997	0.5103	0.3876	0.1092	0.115
STNBIC	1997	0.9361	0.5922	0.2092	0.1932
IandM	1997	1.2884	0.8561	0.4419	0.381
DTRST	1997	1.0968	0.6196	0.2066	0.2076
BOB	1997	0.2955	0.3028	0.0676	0.0926
PRIME	1997	1.1998	0.6247	0.2002	0.2103
FINA	1997	0.5952	0.3774	0.1021	0.112

IMPRL	1997	0.8927	0.4952	0.1527	0.1503
HF	1997	1.1736	0.6461	0.1834	0.2229
EABS	1997	1.1268	0.7587	0.3362	0.2995
BOI	1997	0.3646	0.3443	0.0942	0.1032
ABC	1997	0.5808	0.3457	0.0899	0.1032
HABAG	1997	0.5171	0.6003	0.1918	0.1983
KREP	1997	0.7899	0.4775	0.126	0.144
GIRO	1997	0.9075	0.4419	0.124	0.1311
GURD	1997	0.6698	0.3234	0.0823	0.098
SCRD	1997	1.1013	0.4882	0.1275	0.1471
VIC	1997	0.9905	0.5339	0.1646	0.1662
CHASE	1997	0.9374	0.4641	0.1375	0.1382
EQUAT	1997	0.7774	0.4687	0.1558	0.141
PCPTL	1997	1.0485	0.5644	0.1966	0.1801
CONSO	1997	0.8181	0.5763	0.2356	0.1856
MEB	1997	1.0425	0.7646	0.3332	0.3048
DEVT	1997	1.1597	0.6553	0.3383	0.2279
HABIB	1997	0.4417	0.3821	0.0997	0.1135
CRDIT	1997	0.1587	0.1092	0.0402	0.0484
TRANS	1997	1.2402	0.6687	0.2681	0.2362
FIDLTY	1997	0.6885	0.2685	0.0672	0.0845
PARM	1997	0.4604	0.2851	0.0768	0.0892
ORNT	1997	0.992	0.5638	0.1644	0.1788
DUBAI	1997	1.0317	0.3112	0.0866	0.0955
CITFIN	1997	0.7342	0.2019	0.053	0.0703
BBK	1998	0.1528	0.4754	0.1655	0.1436
KCB	1998	0.0859	0.4094	0.0967	0.1217
STD	1998	0.0178	0.2316	0.0621	0.0766
COOP	1998	0.7063	0.5708	0.1798	0.1829
CFC	1998	0.4616	0.356	0.1361	0.1062
CITI	1998	0.591	0.54	0.1624	0.1692
CBA	1998	0.6446	0.6151	0.2235	0.2058
NBK	1998	1.6109	1.0508	0.4716	0.5689
NIC	1998	0.5176	0.3939	0.1215	0.1168
STNBIC	1998	0.7006	0.353	0.0791	0.1053
IandM	1998	1.1679	0.7374	0.2939	0.2841
DTRST	1998	0.9242	0.6717	0.2769	0.2386
BOB	1998	0.1858	0.1987	0.0583	0.0691
PRIME	1998	1.07	0.4685	0.143	0.1403
FINA	1998	0.5463	0.3321	0.0921	0.1
IMPRL	1998	0.7701	0.361	0.0928	0.1074
HF	1998	1.1736	0.6461	0.1937	0.2229
EABS	1998	1.0183	0.6271	0.189	0.2122
BOI	1998	0.2954	0.2693	0.0666	0.085
ABC	1998	0.6017	0.3689	0.0918	0.1094
HABAG	1998	0.4728	0.5307	0.1603	0.1653
KREP	1998	0.7899	0.4775	0.1149	0.144
GIRO	1998	0.8278	0.359	0.1027	0.1066

GURD	1998	0.3282	0.1202	0.0376	0.0513
SCRD	1998	0.986	0.353	0.0944	0.105
VIC	1998	0.8798	0.4762	0.1188	0.1435
CHASE	1998	0.8107	0.278	0.0682	0.0865
EQUAT	1998	0.7408	0.4278	0.1375	0.1272
PCPTL	1998	1.0485	0.5644	0.227	0.1801
CONSO	1998	0.0051	0.0391	0.0145	0.0256
MEB	1998	1.0383	0.7598	0.3277	0.301
DEVT	1998	0.9006	0.424	0.1381	0.1256
HABIB	1998	0.4313	0.3903	0.0824	0.1159
CRDIT	1998	0.5786	0.4103	0.1388	0.1217
TRANS	1998	1.1721	0.5856	0.2133	0.1897
FIDLTY	1998	0.824	0.3009	0.056	0.0918
PARM	1998	0.4604	0.2851	0.0727	0.0892
ORNT	1998	0.7258	0.2929	0.067	0.0902
DUBAI	1998	1.0073	0.2849	0.0647	0.0892
CITFIN	1998	0.7342	0.2019	0.0511	0.0703
BBK	1999	0.0542	0.3327	0.0836	0.1005
KCB	1999	0.1062	0.3874	0.0992	0.1154
STD	1999	0.0284	0.245	0.0557	0.0796
COOP	1999	0.6857	0.557	0.1666	0.1764
CFC	1999	0.5647	0.4329	0.1444	0.1288
CITI	1999	0.7423	0.585	0.1713	0.1902
CBA	1999	0.5608	0.4881	0.14	0.148
NBK	1999	1.6115	0.646	0.2398	0.2232
NIC	1999	0.4537	0.3132	0.0823	0.0956
STNBIC	1999	0.7203	0.3071	0.0711	0.0939
landM	1999	1.0825	0.6184	0.1988	0.2081
DTRST	1999	0.4984	0.4099	0.12	0.1217
BOB	1999	0.1574	0.1644	0.0382	0.0615
PRIME	1999	1.07	0.439	0.1151	0.1306
FINA	1999	0.5346	0.2915	0.0752	0.0902
IMPRL	1999	0.7442	0.3101	0.0835	0.0946
HF	1999	0.8871	0.4665	0.1199	0.1399
EABS	1999	0.9257	0.5083	0.1392	0.1558
BOI	1999	0.0977	0.1511	0.0445	0.0586
ABC	1999	0.5525	0.2709	0.0782	0.0853
HABAG	1999	0.44	0.3655	0.0818	0.109
KREP	1999	0.7899	0.4775	0.1229	0.144
GIRO	1999	0.8322	0.3232	0.0762	0.0976
GURD	1999	0.6618	0.2245	0.0603	0.0749
SCRD	1999	1.014	0.3636	0.105	0.108
VIC	1999	0.6856	0.3412	0.0943	0.1025
CHASE	1999	1.4034	0.5413	0.2037	0.1701
EQUAT	1999	0.9156	0.5732	0.204	0.1844
PCPTL	1999	0.984	0.4412	0.1354	0.1318
CONSO	1999	0.037	0.067	0.029	0.0363
MEB	1999	0.8411	0.5125	0.1392	0.1578

DEVT	1999	0.775	0.3434	0.0854	0.1028
HABIB	1999	0.3335	0.2677	0.0663	0.0847
CRDIT	1999	0.4775	0.2717	0.0704	0.0856
TRANS	1999	0.7907	0.2303	0.0657	0.076
FIDLTY	1999	0.4527	0.191	0.0627	0.0675
PARM	1999	0.2506	0.1324	0.0441	0.0542
ORNT	1999	0.9188	0.439	0.1205	0.1305
DUBAI	1999	1.0073	0.2849	0.0628	0.0892
CITFIN	1999	0.7342	0.2019	0.0575	0.0703
BBK	2000	0.4201	0.6155	0.1486	0.2063
KCB	2000	0.1873	0.4233	0.0925	0.1258
STD	2000	0.0034	0.1049	0.0307	0.0474
COOP	2000	0.6881	0.4999	0.1198	0.1517
CFC	2000	0.8513	0.6389	0.2155	0.2189
CITI	2000	0.6641	0.5301	0.1523	0.1647
CBA	2000	0.6585	0.5857	0.1744	0.1905
NBK	2000	1.3163	0.1528	0.0401	0.0595
NIC	2000	0.6237	0.4428	0.1236	0.1322
STNBIC	2000	0.6071	0.397	0.104	0.1176
IandM	2000	0.9811	0.542	0.199	0.1702
DTRST	2000	0.618	0.5562	0.1909	0.1767
BOB	2000	0.3121	0.2708	0.0679	0.0853
PRIME	2000	1.0971	0.4967	0.1541	0.1511
FINA	2000	0.4742	0.2857	0.0831	0.0888
IMPRL	2000	0.7077	0.3039	0.0877	0.0931
HF	2000	0.6389	0.3493	0.0875	0.1041
EABS	2000	1.0628	0.5556	0.1688	0.1763
BOI	2000	0.4536	0.451	0.1021	0.1349
ABC	2000	0.5991	0.2973	0.0799	0.0915
HABAG	2000	0.6156	0.5768	0.1751	0.1863
KREP	2000	0.7899	0.4775	0.1305	0.144
GIRO	2000	0.9871	0.3818	0.1028	0.113
GURD	2000	0.7362	0.2483	0.0696	0.0803
SCRD	2000	0.4373	0.1219	0.0463	0.0514
VIC	2000	0.8004	0.3444	0.0959	0.1034
CHASE	2000	1.1481	0.5855	0.2118	0.1907
EQUAT	2000	0.5713	0.2698	0.0684	0.0853
PCPTL	2000	0.9799	0.3447	0.1014	0.1035
CONSO	2000	0.8467	0.4094	0.0826	0.1216
MEB	2000	0.8951	0.566	0.1978	0.1814
DEVT	2000	0.0139	0.0506	0.026	0.0304
HABIB	2000	0.4816	0.4371	0.1098	0.1301
CRDIT	2000	0.508	0.2751	0.0757	0.0864
TRANS	2000	1.6122	0.4963	0.1504	0.1509
FIDLTY	2000	0.821	0.2664	0.0582	0.0843
PARM	2000	0.6782	0.2184	0.0543	0.0737
ORNT	2000	0.9813	0.2723	0.0941	0.084
DUBAI	2000	1.0073	0.2849	0.068	0.0892

CITFIN	2000	0.7342	0.2019	0.0514	0.0703
BBK	2001	0.3135	0.5451	0.1221	0.1715
KCB	2001	0.2786	0.4923	0.1274	0.1498
STD	2001	0.0294	0.3568	0.098	0.1066
COOP	2001	0.7892	0.4878	0.1487	0.147
CFC	2001	0.9192	0.7202	0.3191	0.2711
CITI	2001	0.2355	0.3481	0.0899	0.1042
CBA	2001	0.5732	0.5865	0.195	0.1909
NBK	2001	0.0761	0.1185	0.0321	0.0509
NIC	2001	0.5267	0.4098	0.1024	0.1218
STNBIC	2001	0.7439	0.501	0.1331	0.1523
IandM	2001	0.8374	0.5188	0.1681	0.1602
DTRST	2001	0.7268	0.5445	0.1599	0.1713
BOB	2001	0.3782	0.3524	0.0784	0.1053
PRIME	2001	0.8154	0.4396	0.1242	0.1309
FINA	2001	0.5785	0.3033	0.0768	0.093
IMPRL	2001	0.765	0.3497	0.1005	0.1046
HF	2001	0.6593	0.2898	0.0787	0.0893
EABS	2001	0.8581	0.3576	0.093	0.1069
BOI	2001	0.4855	0.4544	0.1086	0.1362
ABC	2001	0.5466	0.3342	0.0886	0.1006
HABAG	2001	0.7381	0.6799	0.2174	0.2449
KREP	2001	0.7483	0.3138	0.0726	0.0955
GIRO	2001	1.0873	0.3731	0.1063	0.1106
GURD	2001	0.8252	0.3457	0.0836	0.1036
SCRD	2001	1.3795	0.8357	0.4033	0.3637
VIC	2001	0.6512	0.2886	0.0785	0.0896
CHASE	2001	0.8222	0.3901	0.112	0.116
EQUAT	2001	0.5504	0.3411	0.0844	0.1026
PCPTL	2001	1.2118	0.5784	0.2286	0.1876
CONSO	2001	1.0144	0.7094	0.2434	0.2634
MEB	2001	0.9376	0.613	0.2228	0.2052
DEVT	2001	0.0879	0.0983	0.0373	0.0456
HABIB	2001	0.4211	0.4395	0.098	0.131
CRDIT	2001	0.4385	0.3006	0.07	0.0923
TRANS	2001	1.0036	0.5165	0.1372	0.1588
FIDLTY	2001	0.6827	0.2555	0.0726	0.0819
PARM	2001	0.8413	0.3682	0.0879	0.1096
ORNT	2001	0.8598	0.1738	0.0574	0.0627
DUBAI	2001	1.3761	0.644	0.2302	0.2219
CITFIN	2001	0.7664	0.1747	0.0479	0.0643
BBK	2002	0.1709	0.44	0.102	0.1311
KCB	2002	0.466	0.5426	0.1529	0.1699
STD	2002	0.0537	0.393	0.0939	0.1165
COOP	2002	0.6256	0.451	0.1213	0.1342
CFC	2002	0.7746	0.6056	0.1865	0.2005
CITI	2002	0.3357	0.4172	0.1028	0.1238
CBA	2002	0.6385	0.5935	0.1927	0.1943

NBK	2002	0.3979	0.2107	0.0541	0.0718
NIC	2002	0.4922	0.3902	0.1022	0.116
STNBIC	2002	0.9559	0.6758	0.2277	0.2404
IandM	2002	0.7275	0.4685	0.1167	0.141
DTRST	2002	0.5723	0.3976	0.1111	0.1181
BOB	2002	0.3413	0.3628	0.0923	0.1081
PRIME	2002	0.8387	0.435	0.1168	0.1294
FINA	2002	0.4847	0.2969	0.0764	0.0915
IMPRL	2002	0.8541	0.4208	0.1008	0.1248
HF	2002	0.4986	0.2033	0.0617	0.0701
EABS	2002	0.8775	0.3138	0.0784	0.0956
BOI	2002	0.3937	0.4284	0.1149	0.1278
ABC	2002	0.5718	0.3005	0.0868	0.0923
HABAG	2002	0.6635	0.6278	0.1989	0.2134
KREP	2002	0.9127	0.3801	0.0878	0.1129
GIRO	2002	1.059	0.3775	0.1066	0.1119
GURD	2002	0.6013	0.296	0.0792	0.0914
SCRD	2002	0.9738	0.4307	0.1136	0.1279
VIC	2002	0.613	0.3381	0.0796	0.1019
CHASE	2002	0.6786	0.2736	0.0721	0.0862
EQUAT	2002	0.5823	0.3342	0.0866	0.1009
PCPTL	2002	0.5328	0.2921	0.0973	0.0905
CONSO	2002	1.3615	0.7894	0.3245	0.3222
MEB	2002	0.8218	0.5735	0.1752	0.185
DEVT	2002	0.4902	0.2257	0.0791	0.0752
HABIB	2002	0.451	0.4134	0.096	0.123
CRDIT	2002	0.3859	0.2668	0.0643	0.0846
TRANS	2002	0.8942	0.4578	0.0889	0.1371
FIDLTY	2002	0.743	0.2782	0.0648	0.0871
PARM	2002	1.2791	0.4082	0.1109	0.1212
ORNT	2002	0.5256	0.19	0.0525	0.0674
DUBAI	2002	1.2825	0.4486	0.1216	0.134
CITFIN	2002	0.6105	0.1683	0.0421	0.0628
BBK	2003	0.08	0.3898	0.0791	0.1154
KCB	2003	0.0525	0.275	0.0686	0.0863
STD	2003	0.0183	0.284	0.0709	0.0883
COOP	2003	1.5914	0.8256	0.4809	0.3525
CFC	2003	0.3929	0.3788	0.091	0.1124
CITI	2003	0.4112	0.5099	0.121	0.1564
CBA	2003	0.439	0.4944	0.1355	0.1502
NBK	2003	0.4773	0.234	0.0693	0.077
NIC	2003	0.5918	0.4095	0.0954	0.1217
STNBIC	2003	0.8436	0.5471	0.1907	0.1712
IandM	2003	0.3155	0.2881	0.0645	0.0894
DTRST	2003	0.3597	0.2272	0.0592	0.0756
BOB	2003	0.5857	0.6388	0.2281	0.2197
PRIME	2003	0.5185	0.3364	0.0965	0.1013
FINA	2003	0.3879	0.26	0.0711	0.083

IMPRL	2003	0.8547	0.4678	0.1317	0.1405
HF	2003	0.3716	0.1708	0.0565	0.063
EABS	2003	0.8245	0.3628	0.0792	0.1082
BOI	2003	0.4135	0.4185	0.1251	0.1248
ABC	2003	0.4166	0.2299	0.0618	0.0761
HABAG	2003	0.418	0.4322	0.1023	0.1289
KREP	2003	0.7966	0.3406	0.0958	0.1023
GIRO	2003	0.7852	0.2672	0.0679	0.0845
GURD	2003	0.5351	0.235	0.0716	0.0774
SCRD	2003	0.7316	0.3396	0.0944	0.1019
VIC	2003	0.8909	0.3864	0.1119	0.115
CHASE	2003	0.6324	0.2645	0.0694	0.0842
EQUAT	2003	0.7318	0.3085	0.0863	0.0944
PCPTL	2003	0.5197	0.3308	0.1086	0.1
CONSO	2003	2.058	0.7398	0.426	0.2848
MEB	2003	0.933	0.5426	0.1573	0.1706
DEVT	2003	0.2809	0.205	0.0654	0.0708
HABIB	2003	0.3674	0.3376	0.0811	0.1017
CRDIT	2003	0.4234	0.2414	0.0601	0.0789
TRANS	2003	1.1589	0.6364	0.2021	0.2179
FIDLTY	2003	0.6669	0.2179	0.0676	0.0736
PARM	2003	1.0529	0.3107	0.0825	0.0949
ORNT	2003	1.0834	0.2207	0.0609	0.0744
DUBAI	2003	1.2515	0.4117	0.1182	0.1226
CITFIN	2003	1.0071	0.3748	0.0935	0.1121
BBK	2004	0.2175	0.483	0.1418	0.1451
KCB	2004	0.1052	0.3072	0.077	0.0938
STD	2004	0.0305	0.2514	0.0664	0.0807
COOP	2004	0.8187	0.5562	0.2266	0.1755
CFC	2004	0.2987	0.4033	0.0969	0.1193
CITI	2004	0.9094	0.762	0.3509	0.3019
CBA	2004	0.6623	0.5711	0.1966	0.1825
NBK	2004	0.5052	0.2527	0.0722	0.0812
NIC	2004	0.74	0.4595	0.1387	0.1377
STNBIC	2004	1.0827	0.5777	0.2128	0.186
landM	2004	0.3484	0.2588	0.0618	0.0826
DTRST	2004	0.7975	0.4089	0.1106	0.1213
BOB	2004	0.2624	0.2652	0.0669	0.0842
PRIME	2004	0.4967	0.2653	0.0748	0.0841
FINA	2004	0.4118	0.2718	0.078	0.0856
IMPRL	2004	0.8967	0.4821	0.1346	0.1457
HF	2004	0.6017	0.3482	0.0906	0.1045
EABS	2004	0.7042	0.2795	0.0631	0.0875
BOI	2004	0.4562	0.4212	0.1359	0.1255
ABC	2004	0.4605	0.2182	0.0669	0.0735
HABAG	2004	0.4504	0.2757	0.0786	0.0864
KREP	2004	0.8608	0.3534	0.0969	0.1055
GIRO	2004	0.7641	0.2402	0.0568	0.0784

GURD	2004	0.559	0.2196	0.0749	0.074
SCRD	2004	0.7297	0.3413	0.0737	0.1023
VIC	2004	0.9754	0.3836	0.126	0.1142
CHASE	2004	0.7127	0.2837	0.0643	0.0885
EQUAT	2004	0.5986	0.2173	0.0619	0.0735
PCPTL	2004	0.4762	0.2782	0.0832	0.0873
CONSO	2004	1.3135	0.664	0.2473	0.2322
MEB	2004	1.1779	0.6271	0.2773	0.213
DEVT	2004	0.6578	0.3909	0.1173	0.1163
HABIB	2004	0.1904	0.1719	0.0388	0.0634
CRDIT	2004	0.4608	0.2104	0.049	0.072
TRANS	2004	1.1967	0.6812	0.2262	0.2455
FIDLTY	2004	0.7326	0.1906	0.0493	0.0676
PARM	2004	1.1528	0.3473	0.0934	0.1042
ORNT	2004	1.1054	0.2104	0.0687	0.072
DUBAI	2004	1.2331	0.3182	0.092	0.0968
CITFIN	2004	1.3183	0.5302	0.159	0.1663
BBK	2005	0.332	0.5789	0.15	0.1865
KCB	2005	0.1453	0.3812	0.0926	0.1131
STD	2005	0.0125	0.2456	0.0581	0.0797
COOP	2005	0.0923	0.2286	0.0702	0.0758
CFC	2005	0.349	0.538	0.159	0.168
CITI	2005	0.2933	0.4317	0.1037	0.1284
CBA	2005	0.3718	0.3759	0.0893	0.1115
NBK	2005	0.1866	0.1468	0.0376	0.0577
NIC	2005	0.5113	0.368	0.0927	0.1095
STNBIC	2005	1.2455	0.7438	0.3987	0.2879
IandM	2005	0.3763	0.2868	0.0802	0.0891
DTRST	2005	0.5573	0.3388	0.0743	0.1017
BOB	2005	0.1898	0.232	0.0708	0.0767
PRIME	2005	0.6133	0.3366	0.0933	0.1012
FINA	2005	0.841	0.537	0.1496	0.1674
IMPRL	2005	1.1255	0.7269	0.2995	0.2757
HF	2005	2.4	2.5883	2.0458	2.1114
EABS	2005	0.4622	0.2815	0.0795	0.0879
BOI	2005	0.3339	0.3289	0.0886	0.0995
ABC	2005	0.6972	0.3346	0.0994	0.1006
HABAG	2005	0.462	0.3945	0.1115	0.1173
KREP	2005	1.0765	0.54	0.1634	0.1685
GIRO	2005	0.8255	0.2884	0.0915	0.0892
GURD	2005	0.6076	0.2502	0.0785	0.0808
SCRD	2005	0.7782	0.3927	0.1036	0.1163
VIC	2005	1.2015	0.585	0.2385	0.1905
CHASE	2005	0.7242	0.2929	0.0701	0.0907
EQUAT	2005	0.7148	0.3317	0.0959	0.1002
PCPTL	2005	0.5541	0.3375	0.1014	0.1016
CONSO	2005	0.6065	0.1844	0.0513	0.0659
MEB	2005	1.0311	0.6031	0.1994	0.1999

DEVT	2005	0.9174	0.6795	0.301	0.2434
HABIB	2005	0.2516	0.2466	0.0547	0.08
CRDIT	2005	0.5618	0.2281	0.0551	0.0758
TRANS	2005	0.9442	0.4653	0.1146	0.14
FIDLTY	2005	0.864	0.299	0.0679	0.0918
PARM	2005	0.8793	0.1476	0.0418	0.0579
ORNT	2005	1.5318	0.5003	0.1389	0.1543
DUBAI	2005	1.3472	0.3325	0.1239	0.1005
CITFIN	2005	1.2031	0.4432	0.1338	0.1329
BBK	2006	0.0151	0.3195	0.0739	0.0968
KCB	2006	0.2206	0.466	0.1058	0.1398
STD	2006	0.0074	0.2062	0.0504	0.0709
COOP	2006	0.0364	0.2242	0.0638	0.0748
CFC	2006	0.3481	0.5647	0.1926	0.1802
CITI	2006	0.357	0.5043	0.1233	0.1542
CBA	2006	0.5885	0.5645	0.1618	0.1799
NBK	2006	0.0172	0.1121	0.0342	0.0493
NIC	2006	0.6936	0.5014	0.1404	0.1531
STNBIC	2006	1.0224	0.7265	0.3793	0.2749
IandM	2006	0.1997	0.2381	0.057	0.078
DTRST	2006	0.2496	0.2608	0.0673	0.0831
BOB	2006	0.1118	0.2253	0.0522	0.0752
PRIME	2006	0.6486	0.4126	0.1045	0.1225
FINA	2006	0.8806	0.5517	0.1795	0.174
IMPRL	2006	1.0941	0.7341	0.2891	0.2811
HF	2006	0.7245	0.3435	0.0828	0.1031
EABS	2006	0.6248	0.3873	0.0976	0.115
BOI	2006	0.1871	0.2366	0.0588	0.0778
ABC	2006	0.5335	0.2836	0.0698	0.0882
HABAG	2006	0.4613	0.3841	0.0831	0.1143
KREP	2006	1.2089	0.6136	0.1871	0.204
GIRO	2006	0.7393	0.3185	0.085	0.0966
GURD	2006	0.488	0.2313	0.054	0.0766
SCRD	2006	0.7371	0.3588	0.0989	0.1068
VIC	2006	1.1007	0.5206	0.1636	0.1611
CHASE	2006	0.7537	0.3426	0.0971	0.1027
EQUAT	2006	1.3767	0.527	0.1814	0.164
PCPTL	2006	0.7802	0.54	0.1867	0.1689
CONSO	2006	0.6982	0.2488	0.0719	0.0801
MEB	2006	0.9425	0.4746	0.122	0.1434
DEVT	2006	0.7817	0.4315	0.1246	0.1287
HABIB	2006	0.2795	0.2446	0.0551	0.0795
CRDIT	2006	0.5674	0.2627	0.0771	0.0836
TRANS	2006	1.1628	0.6397	0.2067	0.2201
FIDLTY	2006	0.8509	0.3027	0.0765	0.0926
PARM	2006	1.4972	0.3821	0.1537	0.114
ORNT	2006	1.3223	0.6269	0.2131	0.2134
DUBAI	2006	1.3214	0.3363	0.1223	0.1015

CITFIN	2006	1.1039	0.4288	0.1176	0.1282

Source: Limdep ver 8.0

Appendix 6: Summary of studies done

Authors	Policy issue discussed	Approach	Inputs	Outputs
Elyasiani and Mehdian (1990a)	Technological change	Intermediation	Deposits (saving and time), labour, capital	Real estate loans, commercial and industrial loans, other loans and investment
Berg *et al.*(1993)	Cross country comparison	Alternative approach	Labour and capital	Total loans, total deposits and number of branches
Barr, Seiford and Siems (1994)	Bank failure	Production approach	Full-time equivalent employees, salary, premises and fixed assets, other non-interest expenses, total interest expenses and purchase funds	Core deposits, earning assets, and total interest income
Favero and Papi (1995)	Scale efficiency and influence of input-output specifications	Assets	Labour (number of employees), capital (book value of fixed assets and premises), loanable funds, and net funds from other banks [and financial capital]	Loans to other banks and non-financial institutions, investment and security and non-interest income
Elyasiani and Mehdian (1995)	Deregulation	Intermediation	Time and savings deposits, demand deposits, capital and labour	Investment real estate loans, commercial and industrial loans, and other loans
Berger A. N. and De Young (1997)	Problem loans and cost efficiency	Intermediation approach	Operating expenses	Commercial loans, real estate loans, transaction deposits and fee-based income
Noulas (1997)	Productivity growth	Intermediation	Physical capital, labour and deposits	Liquid assets, loans and advances, and investments
Bauer *et al.*(1998)	Methodological/ policy issues	Production	Labour, physical capital, small denomination time and savings deposits, and purchased funds	Demand deposits, real estate loans, commercial and industry loans and instalments loans
Golany and Storbeck(1998)	Performance evaluations	Production approach	Teller hours, operating expenses, market size, economic status of the area, competitive activity	Loan (direct, indirect, commercial and equity), deposits (checking, savings and deposit certificates), average number of accounts per customer, customer satisfaction
Barr *et al.* (1999)	Efficiency performance/ Methodological	Integrated	Salary expenses, premises and fixed assets, other non-interest expenses, interest expenses	Earning assets, interest income and non-interest income
Fried, Lovell and	Bank mergers	Alternative	All operating	Nos. deposit,

Yaisawarng (1999)			expenses	deposit interest rates , nos. loan, loan interest rate transaction volume and service variety
Avkiran (1999)	Bank mergers and deregulation	Intermediation	Staff number, deposits, interest expenses and non-interest expenses	Net loans, net interest income and non-interest income
Alam (2001)	Branching restrictions	Intermediation (different combination of input-output has been used)	Physical capital, labour, purchased funds, demand deposits, other deposits, core deposits, and loanable funds (Dollar value)	Securities, real estate loans, commercial and industrial loans, installments loans, total loans (Dollar value)
Noulas (1997)	Deregulation	User cost	Interest expenses and non-interest expense	Interest revenue and non-interest revenue
Sathye (2001)	Productive efficiency gained on reforms	Intermediation	Net worth, borrowing, operating expenses, number of employees, number of banks	Deposits, net profits, advances, non-interest income interest spread
Casu and Girardone (2002)	Performance comparison	Intermediation	Labour costs, deposits and physical capital	Total loans and other earning assets
Cinca, Molinero and Garcia (2002)	Review on input-output specifications	Alternative (different combinations)	Number of employees, fixed assets and deposits	Operating income, deposits and loans
Leong and Dollery (2002)	Methodology	Intermediation	Deposits and fixed assets	Loans and risk weighted assets
Leong Dollery and Coelli (2002)	Methodology	Model A Model B Model C	Interest expenses and operating expenses Deposits and fixed assets Deposits and fixed assets	Interest income and other income loans Risk weighted assets
Pastor (2002)	Cross country variations	Value added	Personnel expenses, and nonpersonnel operating costs (with environmental and risk variables)	Loan, deposits, other earning assets
Casu and Molyneux (2003)	Cross country	Intermediation	Total cost and total customer and short-term deposits	Total loans and other earnings assets
Isik and Hassan (2003a)	Deregulation	Intermediation	Labour, loanable funds, and capital	Short-term loans, long-term loans, other earnings assets and risk adjusted off-balance sheet activities
Isik (2003)	Deregulation	Intermediate Value-added approach	Labour (number of full time employees), capital (book value of fixed assets), banking funds. Labour, capital and funds	Short-term loans, long-term loans, other earnings assets Short-term loans, long-term loans, other earnings assets and risk adjusted off-balance sheet activities
Tortosa-Ausina	Non-traditional	Intermediation approach	Labour, funding	Loans and other

(2003)	activity and bank efficiency	(1) Restricted (2) Unrestricted	and physical capital Same as above	earnings Loans, other earnings, and non traditional activity
Drake and Hall (2003)	Mergers, problem loans	Intermediation approach	General and administrative expenses fixed assets, retail and wholesale deposits and problem loans	Total loan and bills discounted, liquid assets and other investment and other income
Maghyereh (2004)	Productivity improvements	Intermediation	Labour, capital and deposits	Loans and liquid assets, investments other income
Sufian F (2007)	Relative efficiency between the domestic and foreign banks in Malaysia	Intermediation	Total deposits, labour and fixed assets	Total loans, income
Jamal *et al* (2008)	Relative efficiency in Jordian banks	Intermediation	Total assets, Net operating expenses, No. of employees	Net operating income, Demand deposits, Net direct credits
Hamin *et al* (2008)	Technical efficiency of Islamic banks and Islamic windows	Intermediation	Total deposits, total overhead expenses	Total earning assets.

Appendix 7: Small banks X-inefficiency scores

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	AVG
GURD	69.8	5.13	7.49	8.03	10.36	9.14	7.74	7.4	8.08	7.66	14.083
SCRD	74.71	10.5	10.8	5.14	36.37	12.79	10.19	10.23	11.63	10.68	19.304
VIC	76.62	14.4	10.25	10.34	8.96	10.19	11.5	11.42	19.05	16.11	18.879
CHASE	73.82	8.65	17.01	19.07	11.6	8.62	8.42	8.85	9.07	10.27	17.538
EQUAT	74.1	12.7	18.44	8.53	10.26	10.09	9.44	7.35	10.02	16.4	17.735
PCPTL	78.01	18	13.18	10.35	18.76	9.05	10	8.73	10.16	16.89	19.314
CONSO	78.56	2.56	3.63	12.16	26.34	32.22	28.48	23.22	6.59	8.01	22.177
MEB	90.48	30.1	15.78	18.14	20.52	18.5	17.06	21.3	19.99	14.34	26.621
DEVT	82.79	12.6	10.28	3.04	4.56	7.52	7.08	11.63	24.34	12.87	17.667
HABIB	71.35	11.6	8.47	13.01	13.1	12.3	10.17	6.34	8	7.95	16.228
CRDT	64.84	12.2	8.56	8.64	9.23	8.46	7.89	7.2	7.58	8.36	14.293
TRANS	83.62	19	7.6	15.09	15.88	13.71	21.79	24.55	14	22.01	23.722
FIDLTY	68.45	9.18	6.75	8.43	8.19	8.71	7.36	6.76	9.18	9.26	14.227
PARM	68.92	8.92	5.42	7.37	10.96	12.12	9.49	10.42	5.79	11.4	15.081
ORNT	77.88	9.02	13.05	8.4	6.27	6.74	7.44	7.2	15.43	21.34	17.277
DUBAI	69.55	8.92	8.92	8.92	22.19	13.4	12.26	9.68	10.05	10.15	17.404
CITIFIN	67.03	7.03	7.03	7.03	6.43	6.28	11.21	16.63	13.29	12.82	15.478

Source: Limdep ver 8.0

Appendix 8: Names of the bank

	Acronym	Full names
1	BBk	BARCLAYS BANK
2	KCB	KENYA COMMERCIAL BANK
3	STD	STANDARD CHARTERED BANK

4	COOP	COOPERATIVE BANK
5	CFC	CREDIT FINANCE BANK
6	CITI	CITIBANK NA
7	CBA	COMMERCIAL BANK OF AFRICA
8	NBK	NATIONAL BANK OF KENYA
9	NIC	NIC BANK
10	STNBC	STANBIC BANK
11	I&M	INVESTMENT AND MORTGAGE
12	DTRST	DIAMOND TRUST BANK
13	BOB	BANK OF BARODA
14	PRIME	PRIME BANK
15	FINA	FINA BANK
16	IMPRL	IMPERIAL BANK
17	HF	HOUSING FINANCE
18	EABS	EAST AFRICA BUILDING SOCIETY
19	BOI	BANK OF INDIA
20	ABC	AFRICA BANKING CORPORATION
21	HABAG	HABIB AG BANK
22	KREP	K-REP BANK
23	GIRO	GIRO BAK
24	GURD	GURDIAN BANK
25	SCRD	SOUTHERN CREDIT BANK
26	VIC	VICTORIA BANK
27	CHASE	CHASE BANK
28	EQUAT	EQUATORIAL BANK
29	PcPtl	PRIME CAPITAL AND CREDIT BANK
30	CONSO	CONSOLIDATED BANK
31	MEB	MIDDLE EAST BANK
32	DEVT	DEVELOPMENT BANK
33	HABIB	HABIB BANK
34	CRDIT	CREDIT BANK
35	TRANS	TRANSNATONAL BANK
36	FIDLTY	FIDELITY BANK
37	PARM	PARAMOUNT UNIVERSAL BANK
38	ORIENT	ORIENTAL BANK
39	DUBAI	DUBAI BANK
40	CITYFINANCE	CITY FINANCE BANK