Efficiency and productivity in Botswana's financial institutions

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Efficiency and Productivity in Botswana's Financial Institutions

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Certification

I, Boitumelo Dudu Moffat, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Economics, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

Boitumelo Dudu Moffat

04 March 2009

To my loving husband, parents, brothers and sisters

Table of Contents

List of Tables

List of Figures

Abbreviations

ABC	African Bank Corporation
ATM	Automated Teller Machine
BB	Bank of Baroda
BBS	Botswana Building Society
BCB	Botswana Cooperative Bank
BCCB	Bank for Credit and Commerce Botswana
BCCI	Bank for Credit and Commerce International
BDC	Botswana Development Corporation
BoB	Bank of Botswana
BPS	Botswana Postal Services
BSB	Botswana Savings Bank
BSE	Botswana Stock Exchange
CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
DHA	Disposable Hull Approach
DFA	Distribution Free Approach
DMU	Decision Making Unit
GDP	Gross Domestic Product
FDI	Foreign Domestic Investment
FNBB	First National Bank Botswana
NDB	National Development Bank
ROA	Return on Assets
ROE	Return on Equity
ROI	Return on Investment
SFA	Stochastic Frontier Analysis
SSA	Sub-Saharan Africa
TFA	Thick Frontier Analysis
TFP	Total Factor Productivity
VRS	Variable Returns to Scale

Abstract

The productivity and efficiency of the financial sector is pivotal to the attainment of economic growth and development in developed and developing economies alike, and is of particular interest in the wake of financial sector reform and restructuring. The financial system in Botswana has undergone major structural and institutional changes in recent years. Throughout the 1980s a series of financial reforms were introduced to boost the efficiency and productivity of financial institutions by enhancing the crucial role of market forces (BoB, 1999). New entrants to the system and new products such as Automated Teller Machines (ATM), credit and debit card services were permitted as a result. To date, no study has been carried out to assess the impact of these reforms on the efficiency of financial institutions in Botswana.

The main aim of this study is to conduct an empirical investigation of financial institutions in Botswana with a view to assessing their technical efficiency and productivity. By investigating technical efficiency and productivity among financial institutions in Botswana, this study addresses the following three questions: a) What is the mean efficiency score of financial institutions in Botswana? b) What is the total factor productivity change for Botswana's financial institutions? c) What are the major determinants of efficiency in the context of Botswana's financial institutions? Data envelopment analysis, which is a non-parametric approach, is employed in this study to analyse empirically the technical efficiency and productivity of financial institutions in Botswana. In order to assess the robustness and sensitivity of the results, three approaches namely, value-added approach, intermediation approach and operating approach are employed in defining the inputs and outputs of the institutions. The results suggest an asymmetry between institutions regarding their technical efficiency under

different approaches over the years. Similar to Dos and Ghosh (2006), the yearly technical efficiency estimates under the value-added approach are mostly higher than those of the other two approaches. This is because DEA is a flexible technique and produces efficiency scores that are different when alternative sets of inputs and outputs are employed.

Most of the inefficiency identified stem from the under utilisation of resources, as well as from the current scale of operation. This is consistent with other studies, for example, Rangan *et al*. (1988); Favero and Papi (1995); Taylor *et al*. (1997); Sathye (2001); Drake (2001) and Neal (2004). The overall average efficiency score under the three approaches during the sample period for Botswana's financial institutions is 0.62. This figure lies below other efficiency indices reported in other studies (for example see, Sathye (2003)), and this suggests that the banks in Botswana are performing relatively poorly.

In terms of productivity analysis, the results indicate that there has been a loss or little productivity growth at the frontier during the period in question, although there has been some improvement in the relative efficiency of most of the financial institutions in Botswana. The loss in total factor productivity has, therefore, been mostly due to technological regress. The empirical results demonstrate that foreign institutions are, overall, relatively more efficient than their public counterparts under the three approaches. It is unlikely that public institutions, by virtue of undertaking most of the government borrowing programs, can generate a significant fee-based income from this source.

The poor overall productivity performance of Botswana's financial sector is cause for concern, as it is likely to constrain the growth and development of the overall economy. As a consequence, the authorities will need to rethink their reform measures to date with the objective of stimulating more competition in the marketplace.

This thesis has made three significant contributions to the analysis efficiency in financial institutions. First, this is the first study to address the issue of efficiency and productivity in Botswana's financial institutions using DEA and Malmquist indices. Second, this study has employed a larger category of financial institutions than that of other studies. Finally, no previous study has assessed efficiency, productivity and their determinants in one study. This study, therefore, extends the existing literature by assessing the efficiency, productivity and the determinants as one study.

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Chapter One

Introduction

1.1 Background of the Study

Financial institutions play a fundamental role in the development of any economy (World Bank, 1989). The debate on finance and growth can be traced back to the days of Joseph Schumpeter in 1911 (Beck, Levine and Loayza, 1999). Schumpeter argued that financial institutions play a pivotal role in economic development because they determine which firms should use a society's scarce savings. According to his view, the financial system alters the path of economic progress by affecting the allocation of savings but not necessarily altering the savings rate. Thus, the Schumpeterian view of finance and development highlights the impact of institutions on productivity growth and technological change.

King and Levine (1993) asserted that the development of an efficient financial sector exerts a large impact on total factor productivity growth, which in turn accelerates the Gross Domestic Product (GDP). They attributed this to the high ability of efficient financial institutions to evaluate the risk and returns associated with various investments. Such institutions are able to allocate credit efficiently by identifying profitable investments that channel funds directly to them. This accelerates total factor productivity, which leads to higher long-term growth rates.

There are several theories that explain and justify the existence of financial institutions and their role in an economy (Beck, Levine and Loayza, 1999; King and Levine, 1993).

The fundamental point in the literature is that a well functioning financial system makes the overall economy more efficient in its usage of scarce resources. According to Fry (1988), financial institutions perform two basic economic functions. First, they create money and administer the payment system. Secondly, broadly speaking, they bring savers and borrowers together (act as intermediaries). More specifically, the World Bank (1989) stated that finance matters in an economy because it provides services such as: i) a payment mechanism, ii) savings mobilization, iii) credit allocation, and iv) limiting, pricing, pooling and trading the risk resulting from the process of saving mobilization and credit allocation. Basically, the contribution of finance in the development of an economy is that it can make the trade of goods and services and the process of borrowing and lending less expensive and more transparent if the institutions involved are efficient.

The magnitude of the financial sector's contribution to the overall efficiency of the economy is related to the degree of efficiency with which the financial system works. World Bank (1987) stated that an efficient use of resources is one of the cornerstones of a growing economy. The Neo-Classical Theory also views efficiency as being important in determining a private firm's competitive viability. At a more aggregate level technical efficiency is related to the problem of the optimal allocation of resources which is an important factor for the determination of an economy's growth. Therefore, the new-classical theory also concludes that if scarce resources are not allocated to their most productive ends, it is clear that an economy will grow at a slower rate than its potential capacity.

There are several implications arising from the inefficient functioning of financial institutions. First, if the firm is not efficient, the consequences are not only for the firm's profitability but also for its very survival in a competitive market. Inefficient firms are expected to be driven out of the market by more efficient ones and, in the long run, only efficient ones will remain. Thus, as far as the management of a firm is concerned, it is important to identify its relative level of efficiency with respect to other firms in the market and to the frontier of possibilities. At the social level, a sub-optimal allocation of resources generates 'dead weight' loss. This implies that society is consuming more resources than what is technically required to obtain the same level of outputs. In other words, more output can be produced with the same quantity of resources.

Secondly, from a policy perspective, inefficiency can result in the waste of scarce resources in the banking system itself and in the way such institutions allocate funds more generally within the economy. This implies the need for a strong monitoring role by financial institutions. The use of more efficient production processes could generate higher growth rates and induce overall gains in the productivity of these firms and the whole economy.

1.2 Statement of the Problem and its Significance

The problem of inefficiency in financial institutions is particularly significant in developing countries that are struggling to improve their economic status. In many cases, their domestic economies suffer from many problems, such as market imperfections, that make it possible for inefficient firms to survive. In order to address this problem, one should first assess the efficiency of firms. This will also indicate the

extent of the inefficiency and hence its determinants can also be corrected. This is especially important in the financial sector due to the crucial role it plays in facilitating transactions in the market and in improving the allocation of resources.

The financial system in Botswana has undergone major or significant structural and institutional changes in recent years. Throughout the 1980s, a series of financial reforms were introduced to boost the efficiency and productivity of financial institutions by enhancing the crucial role of market forces (BoB, 1999). New entrants to the system and new products such as Automated Teller Machines (ATM), credit and debit card services were permitted as a result.

Capital expenditure on equipment, however, may give a poor indication of whether the country has caught up with the new technology. Worthington (1999) argued that expenditure by the financial sector on items such as computer networks and ATMs may not adequately capture the actual change in functionality associated with a shift from labour intensive transaction services. This present study is concerned with an in-depth assessment of financial sector efficiency and productivity by means of employing a Malmquist Index. The context of this study is Botswana, where no study has so far assessed the efficiency and productivity of its financial institutions. This issue is of paramount importance for Botswana, where various economic reforms have been initiated with the aim of improving the efficiency and productivity of its financial institutions.

Financial institutions in Botswana, especially the commercial banks, have registered high profits during the past decade. These high profit levels have persisted in spite of

the entry of new banks, mostly foreign-owned institutions, and increased competition in the sector, which can be expected to eventually reduce these profits. Nevertheless, as Jefferis (2007) argued, persistently high profits suggest that competition in the financial sector remains inadequate. A key issue is whether financial institutions can be efficient and productive when there is limited competition in the sector. Ataullah and Le (2006), Chen *et al.* (2005) and Canhoto and Dermine (2003) found that competition is one of the most important factors enhancing firm efficiency and productivity.

With increased competition, some institutions may find that their competitive advantage lies in financing smaller firms. Sacerdoti (2005) thought that as large foreign banks enter the market they are expected to concentrate their lending to larger firms, which they may have a competitive advantage in financing. This may induce local firms, possibly with a better knowledge of local conditions, to expand the financing of smaller businesses and individuals.

Jefferis (2007) argued that, in the context of Botswana's financial sector, there is a greater focus on lending to households (rather than businesses), high bank charges, reliance on Bank of Botswana Certificates for assets and income, and on the extension of banking services to rural areas. Siphambe *et al.* (2005) stated that this lopsided approach can be attributed, to some extent, to the lack of innovation in Botswana's banking system. Avkiran (2000) found that technological innovation plays a principal role in shaping financial service delivery; in Australia, for example, alternative ways of customer access and product distribution enabled by technological innovation have lowered barriers to entry. Therefore, technological innovation can be regarded as a sign

of dynamic efficiency where financial institutions take advantage of new cost-effective technologies and pursue product and market development.

Efficiency has important ramifications not only for the institutions themselves but also for regulatory authorities and ultimately taxpayers (Berger *et al*. 1993). Information obtained from such studies can inform government policy by assessing the effects of various regulatory changes on efficiency. Management performance can be improved by identifying the best and worst practices associated with high and low efficiency, respectively. Generally speaking, areas of input overuse and/or output underproduction can be identified and this can enable management to take the necessary remedial action to improve the efficiency of their firms. Research issues can be addressed by describing the efficiency of an industry. If the institutions are efficient, then we expect improved profitability, reduced costs, greater amounts of funds intermediated and better price and service quality for consumers.

The assessment of the efficiency of Botswana's financial institutions is undertaken in this thesis by applying the non-parametric Data Envelopment Analysis (DEA) methodology. This technique distinguishes between three different types of efficiency namely, technical, pure technical and scale efficiencies, which other parametric methods fail to address. The DEA approach also provides an overall and objectively determined efficiency index that can be used in the ranking of Decision Making Units (DMUs)[1]. DEA also helps in identifying areas of input overuse and/or output underproduction. By comparing annual changes in the productivity of financial institutions, it is possible to identify discernable trends, if any, in the productivity of the financial sector as a whole.

[1] Charnes, Cooper and Rhodes (1978) used the term DMU because DEA can be used not only to measure efficiency of firms but also branches within a firm.

The sources of productivity growth, or decline, can be estimated by decomposing the Malmquist productivity indices into their constituent components, which indicate the extent to which the productivity change for each institution is due to a shift in the efficient frontier or to a process of moving closer to, or further away from, the efficient frontier. These components are often referred to as the 'frontier shift' and 'catch-up' elements of productivity change, respectively.

1.3 Objectives of the Study

The main objective of this study is to conduct an empirical investigation of financial institutions[2] in Botswana with a view to assessing their technical efficiency and productivity. By investigating technical efficiency and productivity among financial institutions in Botswana, this study aims to address the following three questions:

1) What is the mean efficiency score of financial institutions in Botswana?
2) What is the total factor productivity change for Botswana's financial institutions?
3) What are the major determinants of efficiency in the context of Botswana's financial institutions?

Research question 1

The first aspect of this study involves analysing the efficiency of financial institutions in order to calculate their efficiency scores. This will provide answers as to whether financial institutions in Botswana are efficient or not. Scale efficiency is also analysed in order to obtain the nature of returns for each financial institution.

[2] These comprise commercial banks, a savings bank, development banks, a merchant bank and a building society.

Research question 2

The second part of this study explores the nature of productivity changes by means of Malmquist indices. Using the Malmquist indices, three primary issues are addressed. The first is the measurement of productivity change over the period 2001/2002-2005/2006. The second is the decomposition of changes in productivity into the 'catching-up' effect and 'frontier-shift' effect. In turn, the catching-up effect is further decomposed to identify the main source of improvement (or *vis-à-vis*) through either enhancement in technical efficiency or increases in scale efficiency.

Research question 3

The third aspect of this study focuses on the major determinants of efficiency identified in this study. A univariate approach is employed to investigate the determinants of efficiency by cross-tabulating efficiency scores to factors such as size (in terms of assets), ownership status (public versus foreign), age (in terms of number of years of operation) and non-performing loans (as a percentage of total loans).

The research questions posed in this study have a major relevance to Botswana's financial institution policy issues because of their importance to the Botswana economy as a whole, and are more especially important given the substantial changes in financial institution regulations. For instance, if inefficient financial institutions have a tendency to remain inefficient, it would be of interest for policy makers to investigate how these institutions can remain economically viable and not be driven out of the finance market. Further, the policy makers and regulators would be concerned about whether inefficient institutions pose additional risks to the financial services sector as a whole. This is because a key role for the regulators of a country's financial institutions is to limit

systematic risk, that is, the risk that the problem of a few institutions could spread to many other banks that are otherwise liquid and solvent. This protects the money supply and the payment system from being severely disrupted. The research findings would also be of interest to the foreign investors studying the industry situation to undertake investments in the country.

1.4 Structure of the Study

This thesis is composed of eight chapters. After this introductory chapter, the remainder of this study is organized as follows: Chapter 2 presents an overview of Botswana's financial institutions including the history and development of these institutions. This chapter starts by providing an overview of financial institutions in Botswana and by reviewing Botswana's financial development. The performance of the private banking sector in Botswana and some of the government owned financial institutions is also reviewed. The chapter ends by reviewing other financial institutions in Botswana such as investment and merchant banks, private lending companies and insurance companies.

Chapter 3 describes the theoretical background of some efficiency concepts and measures that are applicable to financial institutions. The efficiency concepts include cost, revenue and profit efficiency. The parametric (the Stochastic Frontier Analysis (SFA), the Thick Frontier Approach (TFA) and the Distribution Free Approach (DFA)) and non-parametric (Data Envelopment Analysis (DEA)) measures of efficiency, which dominate the literature on financial institutions, are also discussed in this chapter. A brief literature review on the application of these approaches is also presented in this chapter.

Chapter 4 summarises the literature on efficiency of financial institutions in both developing and developed countries. This chapter mainly gives the practical implications of the theories reviewed in Chapter 3. The literature review summarises the most relevant and frequently cited findings that contribute to an understanding of this study. In particular, the literature is sought to review the utilisation of the DEA method specifically in regard to the evaluation of efficiency in the following order: 1) efficiency in financial institutions; 2) efficiency and productivity in financial institutions; 3) efficiency related to financial liberalization in the financial institutions; and 4) determinants of efficiency.

Chapter 5 discusses the methodology that is applied to extract and analyse the data. In particular, this chapter presents a framework of measuring efficiency by the use of DEA. The theoretical background of the Malmquist indices, and how to measure them, is also reviewed in this chapter. The sensitive issue of the specification of inputs and outputs employed in the evaluation of efficiency and productivity in financial institutions is also reviewed. The issue of the sample, data and its sources is also discussed. There is also a review of the determinants of efficiency based on developing and developed countries.

Chapter 6 reports the analysis of the results of the study. The results are analysed in a pattern that is consistent with the methodology described in Chapter 5. In particular, the results are classified into three main groups: first, the estimates of overall efficiency during the sample period under the three alternative approaches are described; second, changes in productivity over the 2001/2002-2005/2006 period are analysed; and third,

the univariate cross tabulation approach is employed to trace any discernable relationship of efficiency under different financial and prudential parameters.

Chapter 7 presents the policy implications of the study. Policy recommendations in accordance with this study are also highlighted in this chapter. The final chapter summarises the study and the main findings from previous chapters. Specific contributions made by this study and some limitations are outlined in this chapter. The chapter ends with some suggestions for future research.

Chapter Two
Financial Institutions in Botswana

2.1 Introduction

The purpose of this chapter is to present an overview of Botswana's financial institutions and the evolution of these institutions from the period prior to independence in 1966 to the present. Financial institutions in Botswana are mainly commercial banks, government-owned financial institutions, investment and merchant banks, private lending companies and insurance companies. All these institutions are different with respect to their activities but they play an important role in increasing the economic activity of the country. For a financial system to function well, both the banking and non-banking institutions should simultaneously build up and strengthen the financial system of the country and this can only happen if they are efficient, productive and transparent.

The importance of investigating the efficiency and productivity of Botswana's financial institutions could be justified by the fact that, in Botswana the non-bank institutions play a key role in complementing the facilities offered by commercial banks. Therefore, the existence of these institutions in tandem keeps the financial sector complete and enhances the overall growth of the economy. Similarly, in order to contextualise this study, it is important to review the background of these institutions.

Financial institutions in Botswana, especially the banking sector, have shown increased profitability over the years (Bank of Botswana, BoB, 2006). The banking system is profitable compared to those of other African countries and returns on assets and equity

are high by world standards. The banking sector in Botswana, as in many other countries, is one of the most heavily regulated sectors of economic activity. For firms to enter the market they have to satisfy the requirements[3] set out by the regulator regarding new entrants. There have been persistent concerns raised regarding the activities of the banking sector in Botswana and its wider economic role. Jefferis (2007) thinks that they arise from shortcomings such as a focus on lending to households rather than businesses, high bank charges, reliance on Bank of Botswana Certificates for assets and income, and the need to extend banking services more broadly throughout the country.

This chapter is organised as follows: Section 2.2 provides an overview of financial institutions in Botswana. Section 2.3 reviews Botswana's financial development. Section 2.4 presents the history and development of the banking sector in Botswana and Section 2.5 reviews the performance of some of the government-owned financial institutions. The penultimate section gives a review of other financial institutions in Botswana. Finally, Section 2.7 presents some concluding remarks.

2.2 Overview of Botswana's Financial Institutions

Financial institutions, especially the banking sector, exhibited high growth rates (based on assets owned and loans provided) over the decade 1995/96 to 2005/2006. They grew in real terms by 9.9 percent on average per annum while overall economic growth was only 6.8 percent a year over this period (BoB, 2006). The banking sector plays a crucial role in the Botswana Stock Exchange (BSE) where it dominates market capitalization, and has been recognised as a driving force in the growth of the BSE in recent years. This, in turn, reflected the high level of profitability and growth in sustained profits in

[3] To be discussed later in this chapter.

the sector. Commercial banks[4] continue to dominate the financial sector more broadly, in spite of the rapid growth of other segments of the financial sector, such as pension funds and insurance companies, over the past decade. Total bank assets and liabilities amounted to P18.8 billion (US$3.13 billion) at the end of 2006 (about 33 percent of GDP). In terms of liabilities, P13.8 billion represented customer deposits and in terms of assets, around P9 billion represented loans and advances.

Besides the commercial banks, there is one merchant bank and a number of government-owned financial institutions. These include the Botswana Savings Bank (BSB), which offers both deposit taking and lending products, the National Development Bank (NDB) and the Botswana Development Corporation (BDC). In addition, the Botswana Building Society (BBS) has a significant government shareholding, and offers both loans and deposits. The combined balance sheets of these institutions amounts to around one quarter of the combined balance sheets of the commercial banks (see Table 2.1).

Table 2.1: Financial Institutions' Balance Sheets (December, 2006)

Please see print copy for Table 2.1

[4] These include Barclays, Standard Chartered, First National Bank, Stanbic and Bank of Baroda. A sixth bank, Bank Gaborone started operating in mid 2006.

Jefferis (2007) claims that, by international standards, the level of concentration of the banking sector is high relative to the size of the economy particularly when compared to other middle-income countries. One of the controversial issues about the banking system in Botswana is its profitability, especially given concerns (discussed later) about the level of bank charges and access issues. Table 2.2 shows that Botswana banks are very profitable compared to the banks of other African countries where returns on assets and equity are high. This may be due to the high bank charges and access issues of the banking sector.

Table 2.2: Banking Profitability (various years)

Please see print copy for Table 2.2

High profit levels have persisted notwithstanding the entry of new banks, mostly foreign, and increased competition in the sector, which would be expected to bring profits down. Nevertheless, as Jefferis (2007) stated, persistent high profits suggest that competition in the financial sector is inadequate. One question to ask is whether these financial institutions can be efficient if there is inadequate competition in the sector? Competition has been found to be one of the contributing factors to improved efficiency according to research by, for example, Ataullah and Le (2006); Chen *et al*. (2005); and Canhoto and Dermine (2003). With increased competition, some institutions will find that their competitive advantage lies in financing smaller firms. Sacerdoti (2005) believes that as large foreign banks enter the market it is expected that they will concentrate their lending to larger firms, which may give foreign banks an advantage in

financing. As mentioned previously, this may induce local firms, possibly with a better knowledge of local conditions, to expand the financing of smaller entrepreneurs and individuals although the associated risk of such lending is likely to be higher.

There have been persistent concerns raised regarding the activities of the banking sector in Botswana and its wider economic role. As Jefferis (2007) stated these arise from shortcomings such as a focus on lending to households rather than to businesses, high bank charges, reliance on Bank of Botswana Certificates for assets and income, and the extension of banking services to only some areas of the country. Some analysts, for example, Siphambe *et al.* (2005), attribute this to the lack of innovation in the sector. Again, the question is whether financial institutions can be efficient if there is lack of innovation in the sector. As Avkiran (2000) stated, technological innovation plays a principal role in shaping financial service delivery. For example, the alternative ways of customer access and product distribution allowed by technological innovation have lowered barriers to entry and reduced margins. Therefore, technological innovation can be regarded as a sign of dynamic efficiency, where financial institutions take advantage of new cost-effective technologies and pursue product and market development.

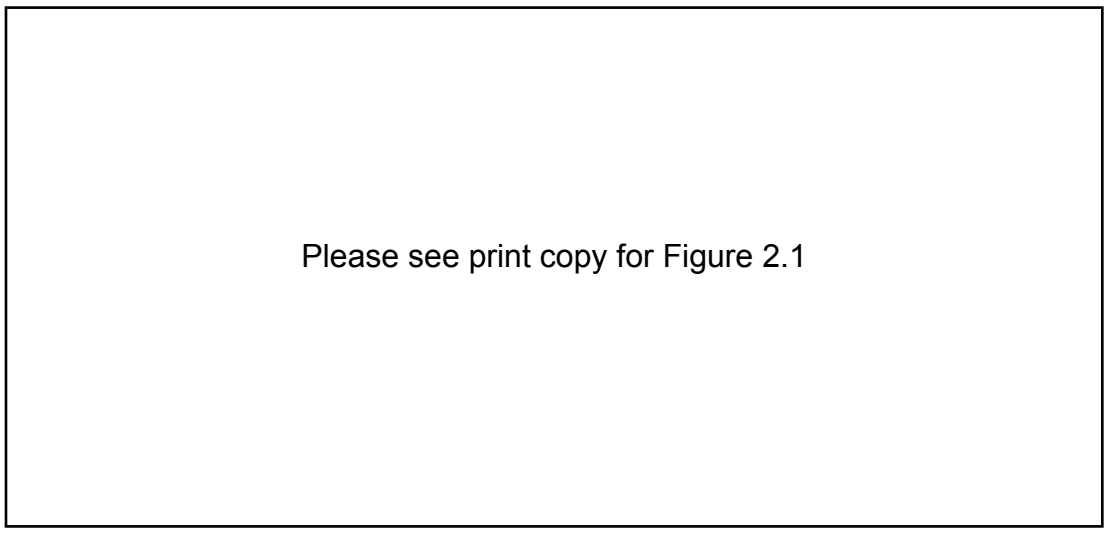
2.3 Botswana's Financial Development

One of the financial development indicators is the ratio of the broad money supply (denoted as M2) to GDP, and is also referred to as "financial depth". Botswana's financial depth stood at 31 percent with a per capita GDP of US$5600 (Bank of Botswana, BoB, 2006) in 2005. According to Sacerdoti (2005), this ratio is below the level that would be expected for a country at such an income level. A country with Botswana's level of GDP per capita (US$5600) is expected to have an M2/GDP ratio of

more than double the actual level of 31 percent as shown in Figure 2.1. This also implies that Botswana's banking sector is relatively small, and hence arguably underdeveloped compared to its income level.

The ratio of M2/GDP is strongly associated with the economic development of a country, and therefore, with per capita income. For most of the developing Sub-Saharan African (SSA) countries, the ratio of M2 to GDP in 2005 was in the range of 15 to 30 percent, with only South Africa, Mauritius and Seychelles recording higher ratios. This is not surprising since South Africa and Mauritius have a well developed financial infrastructure over and above relatively high per capita GDP rates.

Figure 2.1: Financial Depth and Per Capita GDP
(Selected Developing Countries, 2005)



Other financial development indicators include the level of bank deposits and private sector credit, both as a ratio of GDP. Table 2.3 reveals that Botswana's performance is only sightly below the average of aggregated middle-income countries as a group in Sub-Saharan Africa (excluding South Africa). In general, as can be seen, middle-income

countries in Sub-Saharan Africa (excluding South Africa) have far lower levels of financial development than those of other middle-income countries.

Table 2.3: Indicators of Financial Development by Income Group, 2000-2005

Please see print copy for Table 2.3

Another measure of financial development is the ratio of cash to deposits, which shows the relative importance of cash and the banking system in the economy. The higher this ratio is, the more dependent the economy is on cash and the less developed it is in terms of the complexity of its financial system. For Botswana the ratio is about four percent (BoB, 2006), which is relatively low, indicating that the banking system plays a generally more important role in transactions and as a store of value.

2.4 The Banking Sector

2.4.1 Market Structure

Botswana's banking sector currently consists of eight foreign majority-owned banks. Six of these are commercial banks, namely, Barclays Bank of Botswana, Standard Chartered Bank of Botswana, First National Bank of Botswana (FNBB), Bank of Baroda, Stanbic Bank and Bank Gaborone. The remaining two, African Banking Corporation Botswana and African Alliance, are an investment and merchant bank respectively. More than a decade ago, commercial banks accounted for an average of 89 percent of both deposits and loans of deposit taking institutions. Foreign equity for

commercial banks ranges between 70 and 100 percent. Stanbic Bank and Bank of Baroda are both 100 percent foreign owned. Barclays Bank and Standard Chartered Bank both have 75 percent foreign equity with First National Bank at 70 percent foreign equity. The top three banks, Barclays Bank, Standard Chartered and First National Bank, accounted for 82 percent of total bank deposits as shown in Table 2.4.

Table 2.4: Characteristics of the Six Largest Banks in the Market for Deposits (Figures as at 31st December 2006)

Please see print copy for Table 2.4

Barclays Bank, Standard Chartered and FNBB also accounted for 89 percent of total bank loans (see Table 2.5). This share is not surprising considering that, for example, until 2002, Stanbic Bank had concentrated on lending primarily to corporate clients, and the other banks entered the market only recently.

Table 2.5: Characteristics of the Six Largest Banks in the Market for Loans
Figures as at 31st December 2006

Please see print copy for Table 2.5

As noted before, banks in Botswana have recorded high profit growth. The return on equity ratio (ROE) has followed an upward trend since 1995. The ratio, however, dropped from 46.4 percent to 37.7 percent between 1999 and 2000, which was consistent with the decline in the ratio of broad money to non-mining GDP over the same period. The decline in the ROE ratio was also due to the large provisions made by some banks on non-performing assets and increased overhead costs (BoB, 2001). Despite the drop, profitability remained relatively high by international standards.

2.4.2 Regulation and Supervision

The banking sector in Botswana, as in many other countries, is one of the most heavily regulated sectors of economic activity. Supervisory and regulatory functions in the financial sector are split between the Ministry of Finance and Development Planning, the Botswana Stock Exchange and the Bank of Botswana (central bank). The Bank of Botswana, which was established in 1975, is responsible for the supervision of all

deposit-taking institutions. The Banking Supervision Department of the Bank of Botswana is responsible for the regulation of all banking operations. The reason for banking's prudential regulation is to minimise the risks of financial and macroeconomic crises stemming from the banking sector. Another reason is to protect depositors whose savings may be at risk in case of a banking crisis, and the third reason is to promote market efficiency.

The allocation of banking licenses is not restricted by policy, but rather on the basis of an individual institution having the required minimum capital and expertise to operate a financially sound institution. In addition, new entrants are obliged to present a detailed business plan and pass the 'fit and proper' test for their directors and senior managers: this ensures that institution management has no past criminal record amongst other things. The Bank of Botswana through the banking supervision department also ensures that the mechanisms for sustaining the soundness of licensed financial institutions are strengthened, and that the institutions are managed in a safe and prudent manner. In this regard, the bank enforces prudential standards with respect to capital adequacy, liquidity, loan classification, exposure limits and foreign exchange risk exposure.

The statutory capital adequacy requirement for commercial banks in Botswana is 15 percent of the bank's risk-weighted assets (BoB, 2006). If a bank falls below the 15 percent threshold it is not permitted to pay out dividends and the Bank of Botswana will initiate some discussions with the bank management. Overall, commercial banks are well capitalised and receive high marks for conformance with prudential standards (BoB, 2006). The loan classification requirement is up to 90 days, after which it is declared a non-performing loan.

The financial sector's liquidity ratios (i.e., ratio of assets against deposits) also remain well above the minimum statutory requirements (10 percent for commercial banks and 3 percent for credit institutions). In terms of the single exposure limits, no commercial bank may lend more than 30 percent of its audited unimpaired capital to an individual borrower. In addition to monitoring the commercial banks' compliance with reserve requirements, the Bank of Botswana ensures that commercial banks conduct their operations in a professional and transparent manner. To achieve this, the Bank of Botswana may, for the purpose of administration, call for any information regarding the bank's operations. The Bank of Botswana also provides a lender of last resort facility to the financial institutions under its supervision.

This regulatory structure, especially that of entry into the banking sector, has several consequences. First, the need to acquire a banking license to carry out banking business provides a barrier to entry to the market, and hence restricts the level of competition. For instance, non-bank companies cannot enter many areas of banking business. Second, any bank wishing to establish itself in Botswana and acquire a license essentially has to meet the same regulatory requirements as the existing full service banks, even if it wishes to undertake only a limited range of business. While some kind of regulation of entry into the banking sector is necessary, excessive regulation may unnecessarily inhibit new entry to the sector and innovation, thus contributing to reduced competition and possible stagnation.

2.4.3 Market Access

The issue of access is particularly relevant to the issue of entry. The regulatory authority in the banking sector highlights the absence of policy restrictions on the entry of

banking service providers. This applies to both foreign and domestic providers. However, for firms to enter the market they have to satisfy the requirements set out by the regulator regarding new entrants as discussed. The legal establishments may simply be due to market size and the fact that Botswana is not big enough to accommodate new full-service commercial banks. This regulatory structure, with its restrictions on new entry, leads to insufficient competition. There may be an argument for making the bank licensing regulations more flexible to accommodate the entry of different types of banks, not necessarily offering a full range of commercial banking services, so that competition can be stimulated. For example, non-banks such as retailers, cell-phone companies and insurers can be permitted to offer a limited range of banking services such as transaction facilities, small retail deposits and loans.

2.4.4 Investment, Prices and Performance Indicators

The stock of foreign direct investment (FDI) in the financial sector was over 650 million Pula[5] (equivalent to US$107 million) in 2006, representing over 6 percent of the total stock of foreign direct investment in that year. The financial sector is the third largest in the whole economy after mining and tourism in terms of its contribution to the stock of FDI, with its relative importance of over six percent in 2006.

The banking sector has maintained an impressive performance over the last decade, ranging from an expansion of infrastructure (mainly in terms of building more branches) to the introduction of new service facilities such as Automated Teller Machines, credit and debit cards. The use of performance indicators to measure solvency, liquidity, profitability and asset quality amongst others, has provided a means

[5] Pula is the local currency.

of assessing the performance of the sector over time. The net interest income, which is one of the main sources of income for financial institutions, has experienced an upward trend over-time. The ratio of non-performing loans to total bank assets, which is a major determinant of the quality of a bank's assets, declined from 3.3 percent in 1997 to 1.76 percent in 2006. This drop indicated an improvement in the quality of commercial banks' assets, as a ratio of 1 to 2 percent is generally regarded as normal (BoB, 2006).

The average monthly bank charges amount roughly to between P70 and P90 for a basic cheque account. A recent survey on the quality of banking services in Botswana revealed that commercial banks charge fees that are higher than those of other countries such as Mauritius and South Africa (BoB, 2001). The Bank of Botswana has no direct control on the setting of bank charges and other prices related to commercial banks' functions. However, as a consumer protection measure, the bank has enforced a policy that commits commercial banks to disclose their service charges and other fees to the public prior to their introduction.

The performance indicators detailed above give the relationship between two variables and are limited to specific information related to liquidity, profitability, asset quality and risk management. Also, each ratio yields a one-dimensional measure by examining one specific facet of organisational functions. Although ratios can be designed to support the objective of the analysis, ratio analysis is unable to differentiate exogenous or external factors from the analysis. Sathye (2001) argues that accounting ratios do not capture the long-term performance of firms and they aggregate many aspects of performance such as operations, marketing and financing. Capital expenditure on equipment may be falsely regarded as an indication of the technological catch-up. As

Worthington (1999) stated, this is because this indicator accounts for a sizeable expenditure in the financial sector on items such as computer networks and Automated Teller Machines. This may not adequately reflect the actual change in the functionality associated with the shift from labour intensive transaction services. Measuring and evaluating the operating efficiency of financial institutions requires analytic techniques that provide insights beyond those available from an accounting ratio analysis (Sherman and Gold, 1985). One of these is frontier analysis (discussed later) which this study adopts.

2.4.5 Policy Reforms in the Banking Sector

Until its independence in 1966 Botswana did not have a central bank nor did it issue its own currency. The country continued to be part of the South African monetary system, using South African coins and notes as local currency. However, the rapid development of the economy in the post independence period led to a reasonably rapid expansion of the financial sector. The creation of the central bank (i.e., Bank of Botswana) in 1975 and the introduction of the national currency (i.e., the Pula) in 1976 marked a cornerstone for a broader scope for financial development in Botswana.

Towards the late 1970s and for most of the 1980s, the central bank adopted a highly protective and regulatory stance towards the domestic banking system. The central bank considered that Botswana was already over banked and hence there was no need to grant further banking licenses (Harvey, 1996). This was one way to restrict competition in the industry, although a new form of license was issued in August 1982 to a third private commercial bank, the Bank for Credit and Commerce Botswana (BCCB). The

BCCB was a wholly owned subsidiary of the Luxembourg registered Bank for Credit and Commerce International (BCCI).

By the late 1980s, it was again recognized that the commercial banking sector faced several shortcomings and was in need of reform. The shortcomings reflected a high level of excess liquidity (BoB, Annual Report, 1999) due to rapidly growing foreign exchange reserves and the direct role of government in funding investments of the parastatals[6]. Distortions due to the controls imposed on interest rates and the lack of competition in the commercial banking system, which was dominated by only three banks, also led to several reforms. Interest rates had been negative in real terms and monetary policy tended to rely on direct controls. The result was that, while the banking sector was sound, it was not performing its intermediation role efficiently (BoB, Annual Report, 1999).

The Central Bank then abandoned its restrictive policy on bank licensing in 1987 and introduced a new market-oriented policy. This move was motivated by the view that it was not the proper business of the central bank to determine the extent of competition that should prevail in the banking sector. As a result, the restrictive policy on the awarding of commercial banking licenses was abandoned as an effort by the central bank to stimulate competition within the banking industry. Under the new arrangement, banking licenses would be issued to any banks, or group of investors, foreign or local as long as they met certain minimum requirements, including capital adequacy, proven managerial capabilities and willingness to provide further capital were the need arose.

[6] These include those institutions that are partly financed by government.

Against this historical background, it seems that the decision to liberalise the licensing procedure received a quick response from the market, although it is difficult to tell whether the entry by new banks was as a result of the change in policy or whether it was simply a fortunate coincidence. In December 1989, Zimbank (Botswana) Limited, a subsidiary of Zimbank Holdings (Zimbabwe) Limited, was granted a banking license under the then Financial Institutions Act (1975). It thus became the fourth commercial bank to enter the market and it commenced its operation in May 1990. The application lodged by Zimbank had posed a dilemma for the authorities as its majority was owned by the Zimbabwean Government. However, it was regarded as being efficiently managed in Zimbabwe on commercial criteria, and therefore the application was accepted.

First National Bank Botswana Ltd (FNBB), a wholly owned subsidiary of First National Bank of South Africa, was the next commercial bank to receive a license in 1990. It started its operations in September 1991. Two more commercial banks were licensed in 1991: Union Bank Botswana Ltd, which was a subsidiary of Standard Bank of South Africa, and ANZ Grindlays Botswana, a subsidiary of ANZ Grindlays of Australia. The two banks commenced work in 1992, thus bringing the total number of commercial banks in operation to six[7].

The main changes nonetheless occurred during the 1990s when the institutional structure of commercial banks underwent a significant change arising from mergers, closures, and acquisitions as well as the establishment of new institutions. ANZ Grindlays and Union Bank merged in 1992, the same year they both began operations,

[7] Earlier in 1991, FNBB had been forced by circumstances to acquire assets and liabilities of BCCB, which had to be closed following the collapse of the international mother body, BCCI (BoB, Annual Report, 2001).

with the approval of Bank of Botswana. They subsequently became Stanbic Bank Botswana Ltd, wholly owned by Standard Bank of South Africa. Harvey (1996) revealed that at the time of the merger, ANZ Grindlays Botswana had only one loan on its books and that it regretted its decision to set up its branch in Botswana. The merging of the two banks was followed by the decision of ANZ Grindlays Australia to sell all its African Subsidiaries to Standard Bank Investment Corporation (Stanbic) of South Africa. This subsequently reduced the number of commercial banks to five.

In 1994, FNBB had to take over Zimbank Botswana, as it was failing. During its four years of operation, it had never operated at a profit and had accumulated bad debts (Harvey, 1996). Other licensed banks were the Bank of Baroda, which started its operations in 2001, and the most recent one to be licensed in 2006, that is, Bank Gaborone.

2.5 Government-owned Financial Institutions

Financial institutions other than commercial banks have been researched less, especially in developing countries (Sufian, 2006). This is mainly due to the dominant role of commercial banks in the financial systems of these countries. For instance, in Botswana, the combined balance sheets of non-bank financial institutions amounted to around one quarter of the combined balance sheet of commercial banks (BoB, 2005). There are, however, two main reasons why these financial institutions do in fact subsist. One concerns economic development and the other relates to the financial stability of the whole economy. The diversity of specialised financial institutions varies in form, structure and sector of activity but they share the basic objective of providing services that have not been adequately provided by the banking industry. Such services include

lending to specific, mainly riskier sectors and providing, in some instances, equity finance and technical assistance as well as lending for agricultural purposes and small scale enterprises (World Bank, 1989). The financial institutions that have stipulated aims as above are often referred to as Development Financial Institutions. In Botswana, the institutions that fall into this category are the National Development Bank (NDB), Botswana Development Corporation (BDC) and the Botswana Building Society (BBS).

The National Development Bank was established in 1964 prior to the country's independence. The NDB's major function is to make available the type of finance that is unattractive to commercial banks, *inter alia*, agricultural finance, long term finance and finance for small scale enterprises. NDB is a government-owned establishment operating under the direct control of a board of directors, appointed by the Minister of Finance and Development Planning.

The NDB's operational performance since 1980 has been largely overshadowed by a drought, which has resulted in widespread arrears and default in its portfolio. World Bank (1989) reported that besides the drought there were other factors that affected the arrears, including a rapid and unmanaged portfolio growth; weak management and staff and the resulting poor quality of appraisals and supervision. The attitude of borrowing towards credit also played a part in the poor performance of the bank in the 1980s, which was, on the other hand, encouraged by the government through subsidized schemes and repeated drought relief programs.

The NDB's reliance on government for funding has in the past brought political and social pressures that were in conflict with its commercial objectives. These pressures

forced the bank to offer subsidized credit, ill-defined credit eligibility requirements and reduced incentives to supervise and collect debt adequately (World Bank, 1989). The National Development Bank was restructured in 1993 after years of poor performance. The restructuring included writing off bad debts, recapitalization through government equity injection, staff rationalization and the revision of lending policies (BoB, Annual Report, 1999).

The Botswana Development Corporation identifies investment opportunities in Botswana for exploitation by investors, and assists in developing and establishing viable businesses in the country. It is considered to be the most successful among the development finance institutions. According to World Bank (1989), BDC has achieved strong, sound policies and procedures, good management and a satisfactory staff development program over the years.

The Botswana Building Society originally grew out of the United Building Society of Johannesburg, which had established itself in Gaborone, the capital city of Botswana, in 1970. The BBS became a parastatal in 1977 and its primary objective has been to provide housing loans. It funds its activities through the sale of shares and acceptance of deposits, although the former source of funding is by far the most important.

The Botswana Savings Bank, being the only public deposit bank, was established in 1963 and referred to as the Post Office Savings Bank. At that time, it was administered under the Department of Posts and Telecommunications Services of South Africa and Bechuanaland, but later on, in the same year, it was handed over to the Bechuanaland Ministry of Works and Communications. In 1982, it was transferred to the Ministry of

Finance and was then renamed the Botswana Savings Bank (BSB). BSB has been the largest provider of banking services to the rural population, and its relationship with Botswana Postal Services offers great potential for extending its services.

Another institution, the Botswana Cooperative Bank (BCB) (formerly the Bechuanaland Cooperative Development Trust), had to be liquidated in 1995 after it became insolvent. The BCB was first established in 1962 with the sole aim of providing financial services to the various cooperative societies operating in Botswana. Its primary goal was to channel funds from excess cooperative societies to deficit societies thereby strengthening the entire cooperative movement. However, the BCB was not very successful in raising deposits from the cooperative movements, which were adversely hit by the effects of drought, managerial and financial problems (World Bank, 1989). Consequently, the institution was closed down in 1995.

2.6 Other Financial Institutions

2.6.1 Investment and Merchant Banks

Other institutions include finance companies consisting of investment and merchant banks. Investment banks receive their funding from banks and other wholesale money markets. They are involved in the finance of international trade, portfolio management, corporate finance, mergers, the provision of bridge financing and equity investment in commercial ventures. In Botswana, investment banks include Investec Bank, which is a subsidiary of Investec Group Limited. It opened its first office in Gaborone in September 1998 but was acquired by Stanbic Bank in 2004. The African Alliance, which opened its first office in Botswana in 2001, as a subsidiary of the Brait Group, under the international Financial Services Centre initiative is another investment bank.

Merchant banks, on the other hand arrange loans to companies, deal with international finance, buy and sell shares and manage initial public offerings. The only merchant bank in Botswana is the African Banking Corporation, a subsidiary of the African Banking Group Limited. It has its origins in Zimbabwe and it opened its first office in Botswana in 2000 under the International Finance Services Centre initiative.

2.6.2 Private Lending Companies

Private lending companies range from relatively large formal entities (Letshego, Penrich, First Funding), sometimes called "term lenders", to a large number of small, informal entities ("cash loans"). As they do not take deposits they are not subject to banking regulations, and accurate information from them is sparse; hence, they are not included in this particular study. There are also a large number of registered credit unions, burial societies, informal savings and loan groups (*metshelo*), and two microfinance operations (Women's Finance House and *Kgetse ya tsie*), which focus mainly on small-scale entrepreneurs.

Venture capital is another type of financial institution defined as independent and professionally managed entities that use pools of capital and that focus on equity-linked investments in privately-held high growth companies (Gompers and Lerner, 2001). Venture capital institutions in Botswana include Peo Holdings. It is a venture capital initiative established by De Beers Botswana and Debswana Diamond Company, which are its financers. It was set up in 1997 to improve the viability of small business enterprises. There is also the Venture Capital Fund, which was first established by the government of Botswana in 2003 to help existing citizen companies and foreign ventures in the local economy.

2.6.3 Insurance Companies

Insurance companies hold privately-placed corporate bonds and commercial mortgages as assets and contracts with policyholders and obligations to future retirees as liabilities. This provides them with some idiosyncratic features that make them different from other financial institutions. Their assets and liabilities have special characteristics that are different from those of other financial institutions (Berger and Humphrey, 1997). Insurance companies include Botswana Eagle Insurance, Botswana Insurance, Botswana Insurance Fund Management, Botswana Export Credit Insurance, Metropolitan Life, Mutual and Federal, Regent Insurance Botswana, Botswana Insurance Holdings, Regent Life Botswana, Sesiro Insurance Company and General Insurance.

2.7 Summary

This chapter presented an overview of financial institutions in Botswana. Financial institutions in Botswana are mainly commercial banks, government-owned financial institutions, investment and merchant banks, private-lending companies and the insurance companies. At the top of the financial institutions there is the central bank, the Bank of Botswana. There are six commercial banks (Standard Chartered Bank, Barclays Bank, First National Bank, Stanbic Bank, Bank Gaborone and Bank of Baroda), which are currently in operation. Botswana Savings Bank is the only public deposit bank in Botswana.

Other financial institutions include a merchant bank (African Banking Corporation), an investment bank (African Alliance), several insurance companies and pension funds, leasing finance institutions, a building society (Botswana Building Society), a

development finance company (Botswana Development Corporation), a development bank (National Development Bank), a stock exchange (Botswana Stock Exchange), asset management companies and micro-lenders. Unfortunately, despite the past and expected changes, the study of efficiency in Botswana's financial institutions has not kept pace with the transformation in these institutions. Favero and Papi (1995) view efficiency as the strategic variable in tackling increasing competitive pressures and structural changes within these institutions.

Financial development, commonly measured as broad money as a ratio of GDP, has been considered to be below the level that would be expected for a country of Botswana's income level. This, therefore, implies that Botswana's financial sector is small and hence arguably underdeveloped compared to its income level. The banking sector plays a crucial role in the BSE where it dominates market capitalisation, and has been recognised as a driving force in the growth of the BSE in recent years. This in turn reflected a high level of profitability and sustained profits growth in the sector. The profits are high by African standards, where returns on assets and equity are also high.

High levels of growth and profitability in the financial sector, as noted earlier in this chapter, do not necessarily imply that the most efficient production process is being utilised. For example, Sherman and Gold (1985) in their study of bank branch efficiency found that one highly profitable branch was among the most inefficient ones. Also, while theory is based on the assumption of optimizing behaviour, not all microeconomic or macroeconomic units necessarily operate close to their efficiency levels. Jefferis (2007) states that high levels of profits nevertheless imply a lack of sufficient competition in the financial sector. Therefore, an argument for making the bank

licensing regulations more flexible to accommodate the entry of different types of banks, not necessarily offering a full range of commercial banking services, is in place.

The commercial banking sector in Botswana is clearly the case of an oligopoly, with only a few suppliers in the market. While this can be attributed to the small size of the market, this observation alone is enough to raise concerns that there may be a lack of vigorous competition in the market (BoB, Annual Report, 2003 and Jefferis, 2007). Government efforts to promote competition in the banking industry in the late 1980s did not bear much fruit, as new entrants in the market were quick to leave through closures, mergers and acquisitions. Lack of competition raises a question of whether these financial institutions are efficient. Competition has been found to be one of the contributing factors to improved efficiency [for example, Ataullah and Le (2006), Chen *et al*. (2005), Canhoto and Dermine (2003)]. With increased competition, some institutions will find that their competitive advantage lies in financing smaller firms. In particular, as large foreign banks enter the market, it is expected that they will concentrate their lending on larger firms, as foreign banks may have a competitive advantage enabling them to do this (Sacerdoti, 2005). This may induce local firms, possibly with a better knowledge of local conditions, to expand the financing of smaller entrepreneurs and individuals.

In sum, this chapter highlighted the fact that financial institutions in Botswana, especially the banking sector, have shown increased profitability over the years (BoB, 2006). The banking system is profitable even by African standards, where returns on assets and equity are already high by world standards. But as Jefferis (2007) considers that high levels of profits simply reflect a lack of sufficient competition in the financial

sector. Therefore, there might be inefficiency in these institutions due to the lack of competition in the sector. Also, the banking sector in Botswana, as in many other countries, is one of the most heavily regulated sectors of activity. For firms to enter the market, they have to satisfy the requirements set out by the regulator regarding new entrants. Such requirements hinder more competition. There have been persistent concerns raised regarding the activities of the banking sector and its wider economic role (Jefferis, 2007).

Chapter Three
Efficiency in Financial Institutions: Concepts and Measurement

3.1 Introduction

The purpose of this chapter is two fold. First, it provides a review of efficiency concepts which include, *inter alia*, cost, revenue and profit efficiency. Second, it reviews some methods that have been applied in measuring financial sector efficiency, focusing more on the parametric and non-parametric approaches. A further justification of the methods adopted in this study is provided in more detail in Chapter Five. It should be noted that there is no consensus on the preferred method for determining how efficiencies should be measured, since the use of each model in empirical studies depends on their objectives and the types of questions being investigated.

This chapter is structured as follows: Section 3.2 reviews the efficiency concepts followed by Section 3.3 which describes methods of measuring efficiency. The parametric and non-parametric approaches and a brief literature review on the application of these approaches are also presented in this section. Lastly, Section 3.4 summarises the chapter.

3.2 Efficiency Concepts

The first decision in any empirical analysis of efficiency is to choose which efficiency concept to adopt. This study mainly deals with technical efficiency, which is aimed at measuring the production unit's ability to obtain maximal outputs from a given set of

inputs, or utilizing minimal inputs for a permitted production of outputs. Stated otherwise, technical efficiency exists if no more of one output can be produced without a reduction in the production of some other output or an increase in at least one input (being on the production possibility curve). Technical efficiency can be decomposed into pure technical efficiency and scale efficiency components. On the one hand, pure technical efficiency measures how effective a unit is in allocating its resources in order to maximize its outputs at a given size, and scale efficiency illustrates how close the firm is to its most productive scale size.

Other concepts of efficiency include revenue, cost and profit efficiency. These concepts are based on an economic foundation for analysing efficiency due to their focus on economic optimisation in response to market prices. The following sub-sections discuss in turn the cost, revenue and profit efficiencies. It should be mentioned that these sub-sections highlight only a brief review of these concepts. For a detailed technical account of these concepts see, for example, Berger and Mester (1997) and Ferrier and Lovell (1990).

3.2.1 Cost Efficiency

The cost efficiency of any institution is measured by its performance relative to an estimated performance of the best firm characterised by minimum costs (Berger and Mester, 1997). Stated otherwise, cost efficiency gives a measure of how close a firm's costs are to those of the best practice firm in producing the same bundle of outputs under the same conditions. Normally, cost inefficiency arises due to technical inefficiency, which results in the use of an excess or sub-optimal mix of inputs and output quantities. Ikhide (2000) argues that costs are less vulnerable than revenues and

profits to extraordinary factors that can affect different firms or categories of firms disproportionately, such as variations in open-market interest rates. It is important to note that cost efficiency evaluates performance holding output quantities statistically fixed at their observed levels. This may not correspond to the optimal efficiency levels that involve a different scale and output mix. Adongo, Stork and Hasheela (2005) argue that a firm that is relatively cost efficient at its current output may or may not be cost efficient at its optimal output.

Cost efficiency may also be due to scale and scope efficiencies. Scale efficiency addresses the question as to whether the institution has the right size in terms of the relationship between an institution's per unit average production cost and the production volume. When an institution's per unit production cost declines as its output increases, the firm is said to enjoy economies of scale. Jensen and Meckling (1976) consider diseconomies of scale to exist when the per unit cost of production begins to rise beyond a certain level of production. This then means that the average cost curve is U-shaped, implying economies of scale at the early stages of output and diseconomies of scale at high levels of output.

The location of the optimum production scale relating to financial institutions has not been resolved in the literature. The consensus, however, is that the optimum scale may be much bigger than that suggested by earlier literature (Ikhide, 2000), due to the practice of the large scale branching of institutions; the rapid changes in information technology and, finally, financial innovation, which helps institutions to develop a number of alternative channels for the delivery of financial products.

Economies of scope address the question of whether a firm produces as efficiently as it possibly can, given its size. Technically, it assumes that a firm has a cost efficient frontier that depicts the lowest production cost for a given level of output, and attempts to measure the deviation from this frontier (Liebenstein, 1978). X-efficiency (or frontier efficiency) stems from technical efficiency, which measures the degree of waste and friction in the production process, and allocative efficiency, which measures whether the optimum levels of various inputs are being used.

3.2.2 Revenue Efficiency

As its name implies, the revenue efficiency approach measures the change in a firm's revenue adjusted for a random error, relative to the estimated revenue obtained from producing an output bundle as efficiently as the best-practice firm (Berger and Mester, 1997). This cannot be directly measured, but is inferred from the measurements of an output distance function that measures output efficiencies. Revenue efficiency occurs when firms charge higher prices for higher quality services, which results in higher revenues if the firms have sufficient market power to extract the resulting consumer surplus. Berger, Humphrey and Pulley (1996) found that revenue inefficiency can be primarily attributed to technical inefficiency rather than to allocative inefficiency. The main weakness of the revenue concept is that it does not take into account the increased costs of producing higher quality services, and thus, as DeYoung and Nolle (1996) argue, focuses only on one side of the overall financial picture of a firm.

3.2.3 Standard Profit Efficiency

This concept is based on changes in a firm's variable profits relative to the estimated profit needed to produce an optimal output bundle as efficiently as that of the best-practice firm (Berger and Mester, 1997). It reflects the goal of profit maximisation by incorporating both the cost and revenue functions that result from varying inputs as well as outputs. The standard profit measure is important where firms provide additional or higher quality services, which may increase revenues more than costs. Berger and Mester (1997) argue that examining efficiency from either the cost minimisation or revenue maximisation perspective in this case fails to capture the goal of firms to maximise profits by raising revenues as well as reducing costs.

Standard profit efficiency can also be described in terms of output and input components. Output (input) profit inefficiency includes output (input) technical inefficiency, which is the failure to produce as much output as planned. It also includes allocative inefficiency, which arises due to non-respondence to output (input) prices, including the cost and revenue effects of deviating from profit maximising the production target. It can also be described in terms of technical and allocative components. Technical profit inefficiency is defined as the loss of profits from a failure to meet the production plan as a result of the outputs being too low or the inputs being too high. Allocative inefficiency is defined as the loss of profits from making non-profit-maximising choices of outputs in the production plan.

3.2.4 Alternative Profit Efficiency

According to Berger and Mester (1997), this concept measures the change in a firm's variable profits relative to the estimated variable profit needed to produce an optimal

output bundle as efficiently as the best-practice firm. It attributes the changes in efficiency to best practices resulting from management efforts and environmental variables. The alternative profit efficiency function employs the same dependent variable as the standard profit function and the same exogenous variables as the cost function. Therefore, it differs from the standard profit function in that variable output quantities are used in lieu of variable output prices and it overcomes the shortfalls of the cost function by including profit as its dependent variable. Unlike the standard profit function specification, which assumes that firms do not have the capacity to fix output prices, the alternative profit specification assumes that firms have some power in determining output prices. Thus, the standard profit function is specified as a function of input and output prices, whereas the alternative profit function is specified as a function of input prices and output quantities.

Berger and Mester (1997) noted that the alternative profit specification is preferred over the standard profit specification for the financial sector when there are differences in the quality of banking services; markets are not perfectly competitive so that firms might have some market power in pricing their outputs; outputs are not completely variable so that firms cannot achieve every output scale and product mix; and output prices are not available. Despite the assumption that firms have some power in determining output prices, the alternative profit concept provides a way of analysing firm efficiency in developing countries where the assumption underlying the cost and standard profit efficiency measures may not hold.

3.3 Methods of Measuring Efficiency

Having described the types of efficiency, the next step is to determine how to measure them. There are different methods of measuring efficiency and they differ in terms of the measures they produce, the data they require and the assumptions they make regarding the structure of production technology (Coelli *et al*. 2005). The following sub-sections discuss some of these methods.

3.3.1 Traditional Methods and their Relevance to Financial Institutions

At a microeconomic level, efficiency is basically a simple concept in as much as it measures the extent to which resources like labour and raw materials are used efficiently to produce output. Traditional measures of financial sector efficiency are attractive because of their simplicity and ease of understanding. Some of the simple approaches to measuring efficiency are as follows.

(a) Firm Productivity per Employee Hour

Firm productivity per hour is estimated based on the productivity statistics on various sectors, collected by government agencies. This measure may not provide an accurate estimate of efficiency due to modern practices in financial institutions, which include trends towards the outsourcing of back-office operations to holding company affiliates and service bureaus. Adongo, Stork and Hasheela (2005) argue that failure to account for either the labour or capital used elsewhere in the holding company, but effectively working for the institution, could bias government productivity measures. This leads 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.

(b) 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. This measure, however does not tell us much about efficiency as it leaves out some inputs, such as interest expenditure and income in determining the level of efficiency.

(c) 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. This measure assumes that the size of the financial system is closely related to the quality of financial services. It can be argued that the level of a financial institution's credit may simply reflect the demand for the institution's services, which may have nothing to do with the sector's own efficiency.

(d) Interest Spreads and Margins

Ngugi (2004) views interest rate spreads as the most common macroeconomic measure of efficiency. It is a direct measure of a financial institution's mark-up over cost. The justification for using interest spreads to measure efficiency derives from the understanding that financial intermediation affects the net return on savings and gross return on investment (Adongo, Stork and Hasheela, 2005). Interest spreads can either be *ex ante* (calculated from contractual rates charged on loans and rates paid on deposits) or ex post (based on the differences between an institution's actual interest revenues and actual interest expenses). However, 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 draw downs from loans-loss provisions materialize in different time periods, this may lead to ex post spreads reflecting efficiency differences due to non-performing loans and monitoring costs associated with loan quality.

Net interest margins are also a common macroeconomic measure of efficiency. Adongo, Stork and Hasheela (2005) argue that net interest margins mirror the interest spreads. However, they can also reflect a variety of other factors such as taxation, deposit insurance regulation, overall financial structure and institutional indicators.

(e) Accounting Ratios/Ratio Analysis

A ratio analysis measures the relationship between two variables and is limited to specific information related to liquidity, profitability, asset quality and risk management. Some microeconomic studies, for example Ikhide (2000), use accounting ratios such as return on assets (ROA), return on investment (ROI) and return on equity (ROE) to represent efficiency. However, there are limitations in using these ratios. The ratio analysis assumes comparable units that imply constant returns to scale. Also, each ratio yields a one-dimensional measure by examining one specific facet of organisational functions. The ratio approach also offers no objective method of identifying efficient units from its inefficient peers. Although ratios can be designed to support the objective of the analysis, ratio analysis is unable to differentiate exogenous or external factors from the analysis.

Akhavein, Berger and Humphrey (1997) argue that accounting ratios are limited as measures of efficiency since they do not control for output mix or input prices. They also argue that these ratios do not allow the determination of whether X-efficiency or scale and scope efficiency are the sources of variation in bank performance. Sathye (2001) argues that accounting ratios do not capture the long-term performance of firms and they aggregate many aspects of performance, such as operations, marketing and financing. Sherman and Gold (1985) argue that measuring and evaluating the operating efficiency of banks requires analytic techniques that provide insights beyond those available from the accounting ratio analysis.

3.3.2 Efficiency Through the Use of a Production Function

Because the above simple methods have disadvantages in measuring and/or specifying inputs and outputs incorrectly, there are some alternative methods that follow the tenets of the microeconomic theory of production. Under these methods, the production possibility set consists of the feasible inputs and outputs that examine the efficiency of firms. The production function estimated is a technical expression that depicts output as a function of inputs. One of the widely used production functions is the Cobb-Douglas production function, which is commonly stated as follows:

$$Y_t = A_t K_t^{\alpha} L_t^{\beta}$$

Where Y, A, K, and L denote output, technology, capital and labour, respectively at time *t*. The coefficients α and β are often assumed to sum to one for constant returns to scale.

The Cobb-Douglas production approach was adopted by Haynes and Thompson (1999) in their study of mergers among UK building societies over the period 1981 to 1993.

They applied labour and fixed and liquid assets as inputs. Dummy variables were introduced to capture periods before and after the merger. The study found that productivity improved by approximately three percent in the first year after the merger and rose to five and a half percent five years later.

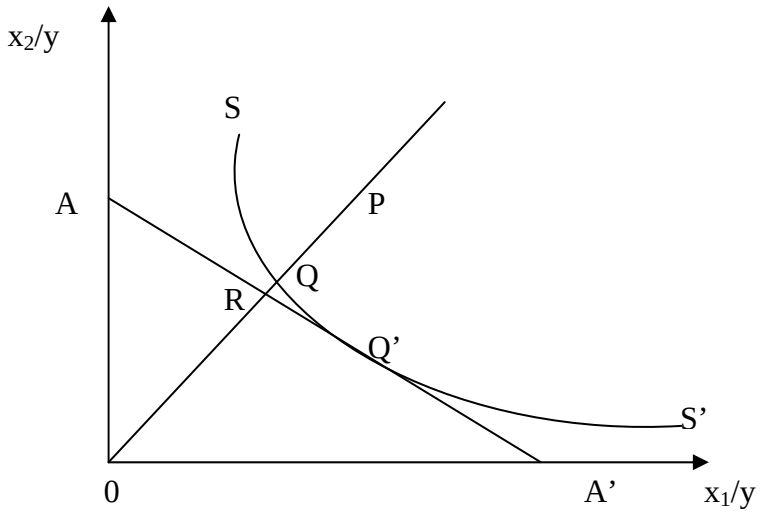
The problem with the use of a production function in efficiency analysis is that of how to specify the function. This is because the appropriate specification of the production function is unknown most of the time. Estimation of an inappropriate production function would invalidate the derived conclusions. Some analysts then addressed the problem by conducting a sensitivity analysis. They used differing forms of production function and argued that the results showed little difference from the ones they obtained before. Nevertheless, the problem of misspecification of the production frontier still remained.

3.3.3 Frontier Methods

One way to solve the problem of misspecification is to use another approach that specifies an efficiency frontier introduced by Farrell (1957). Here the general concept of efficiency refers to the difference between the observed and optimal values of inputs and input/output mixes (Boss and Kolari, 2003). The efficiency of a production unit is defined as the ratio of observed to optimal values of its outputs and inputs. The comparison can take the form of the ratio of observed to maximum potential output obtainable from the given input, or the ratio of minimum potential to observed input required to produce a given output.

In introducing this measure, Farrell (1957) defined technical efficiency as one minus the maximum equi-proportionate reduction in all inputs that still allows the continued production of given outputs. If prices are available, Lovell (1993) proved that a measure of economic efficiency (cost efficiency) can be provided by the ratio of minimum cost to observed cost given that the objective of the production unit is cost minimization. Thereafter, a measure of allocative efficiency can also be calculated by the ratio of economic efficiency to technical efficiency. This idea can be illustrated by simply assuming a firm uses two inputs, x_1 and x_2, to produce a single output y. The unit isoquant of the efficient firm is represented by the curve SS' in Figure 3.1, which shows combinations of inputs in producing a unit level of output under the assumption of constant returns to scale.

Figure 3.1: Illustration of Efficiency Measurement[8]



[8] This discussion is based on Coelli (1996).

In this figure, a point such as P represents the input of the two factors that a firm employs to produce a unit of output. The technical inefficiency of that firm could be represented by the distance QP, which is the amount by which all inputs could be proportionally reduced without a reduction in output. This is usually expressed in percentage terms by the ratio QP/0P, which represents the percentage by which all inputs could be reduced. The technical efficiency of a firm is most commonly measured by the ratio 0Q/0P, which is one minus QP/0P. It will take a value between zero and one, and hence provides an indicator of the degree of technical inefficiency of the firm. A value of one indicates the firm is fully technically efficient. For example, a firm at point Q is technically efficient because it lies on the efficient isoquant SS'.

If information on prices is available, then performance measures can be devised to incorporate such information. This will provide us with a measure of allocative efficiency. Allocative efficiency involves a selection of input mixes that produce a given level of output at minimum cost. In the figure above, relative input prices is represented by the isocost line AA', at which Q' instead of Q is the optimal point of production. The reason is that the cost of producing at point Q' is only 0R/0Q of those at Q. In other words, if the firm at point Q tries to have allocative efficiency such as that represented by Q', while keeping technical efficiency and factor price constant, the cost of production would be reduced by a factor of 0R/0Q. Therefore, if a firm is both technically and allocatively efficient then its costs would be a fraction (0R/0P) of what they in fact are. This is referred to as the overall efficiency or economic efficiency of the firm. Economic efficiency is given as the product of technical and allocative efficiency which, in this case, gives the overall cost of producing at Q' relative to producing at P. Formally,

Economic efficiency = 0R/0P = (0Q/0P) x (0R/0Q)

An extension to multiple inputs and outputs is easily achieved through the use of parametric or non-parametric approaches. Bauer *et al*. (1998) claim that these approaches differ in the assumptions made about the shape of the frontier, the treatment of a random error, and the distributions assumed for inefficiency and the random error. The parametric approaches impose more structure on the frontier compared to the non-parametric approaches. These methods also differ in terms of whether the underlying concept of efficiency is technological or economic. The parametric approaches were initially designed to measure economic efficiency, while the non-parametric approaches were initially designed to measure technical efficiency. Popular non-parametric techniques include Data Envelopment Analysis (DEA) and the Free Disposable Hull Analysis (DHA), but the most widely applied is the DEA. The non-parametric techniques generally do not take account of prices and, therefore, can account only for technical inefficiency in using too many inputs or producing too few outputs.

The parametric techniques consist of the Stochastic Frontier Approach (SFA), the Thick Frontier Approach (TFA) and the Distribution Free Approach (DFA). These three parametric approaches differ in the method adopted to distinguish between random errors and X-inefficiencies. In these methods a financial institution is labelled inefficient if its costs or profits are lower than those of the best practice institution after removing random errors.

The following sub-sections briefly review the frontier methods by focusing on the underlying concepts and assumptions, rather than the technical details of the estimation

procedures. This brief review of the methods provides justification for the adoption of non-parametric methods for this study, which is discussed in more detail in Chapter Five.

3.3.4 Parametric Techniques

(a) Stochastic Frontier Approach (SFA)

The SFA assumes that inefficiency follows an asymmetric half-normal distribution, while random fluctuations follow a symmetric normal distribution (Coelli *et al*. 2005). The efficiency results depend critically on the skewness of the data, and any inefficiency components that are more or less symmetrically distributed are measured as random errors. On the other hand, any random error components that are more or less asymmetrically distributed are measured as inefficiency. In particular, the distance between the observed value and the value on the frontier depends on two terms. One is a stochastic 'white noise' disturbance, which is designed to capture the elements of noise in the data and the other one is a non-normal asymmetric disturbance term, which is designed to capture inefficiency. The SFA results also depend on the arbitrary assumption that the X-efficiencies are orthogonal to the cost function exogenous variables, including those used to compute scale efficiency. This brief explanation makes it clear that this parametric approach has to specify a functional form and any misspecifications will lead to incorrect efficiencies.

Mester (1996) applied this approach when measuring a sample of 214 banks in the US. He applied output levels, input prices, quality of output and the level of financial capital as explanatory variables in the cost function. It was concluded that banks were scale and scope efficient, but not X-efficient. Mester (1996) also argued that alternative distributions for inefficiency may be more appropriate than the half normal, and the

application of different distributions sometimes does in fact change the average efficiencies found for financial institutions. Therefore, he checked his results for robustness by changing the half normal distribution on the inefficiency factor to truncated normal and exponential distributions. The new models yielded results that were quite similar to the half-normal model. Hence, the efficiency results were robust to different distributional assumptions.

(b) Thick Frontier Approach (TFA)

TFA uses the same functional form for the frontier function as SFA but is based on a regression that is estimated using only the best performers in the dataset (Bauer *et al*, 1998). According to this approach, the deviations from predicted costs within the lowest average cost quartile of financial institutions represent random errors, while deviations in predicted costs between the highest and lowest quartiles represent inefficiency. TFA estimates separate cost functions for the lowest and highest average cost quartile. The residuals for both functions are assumed to represent only random errors, while the predicted difference between the two functions is assumed to represent X-efficiency differences (Berger and Humphrey, 1991).

The measured efficiency under the TFA is sensitive to the assumptions about which fluctuations are random and which represent efficiency differences. In most applications TFA gives an estimate of efficiency differences between the best and worst quartile to indicate the general level of overall efficiency, but it does not provide point estimates of efficiency for each firm. In this particular study, efficiency estimates for each firm are required in each time period so that efficiency differences between firms can be compared.

In their study, Berger and Humphrey (1991) applied the TFA to measure inefficiencies for all US banks in 1984. They estimated three models, namely, operating costs, interest costs and costs on purchased funds, for each quartile. They found that most of the differences between the lowest and highest quartiles were between 25 and 47 percentage points. Market factors explained only between 0 to 6 percentage points and the rest were due to the inefficiency factor. Furthermore, most inefficiencies were attributed to technical inefficiency rather than to allocative inefficiency.

(c) Distribution Free Approach (DFA)

The DFA, which was introduced by Berger (1993), specifies a functional form, as does SFA and TFA, but separates inefficiencies from random errors in a different way. It does not impose a specific shape on the distribution of efficiency (as does SFA) nor does it impose that deviations within one group of firms are all random errors and deviations between groups are all inefficiencies (as does TFA). Instead, DFA assumes that there is a core efficiency or average efficiency for each firm that is constant over time, while random errors tend to average out over time (Berger, 1993). DFA is similar to the Generalised Least Squares approach and, therefore, it requires panel data. A disadvantage of DFA is the requirement that efficiency be time invariant. This assumption becomes less tenable as the sample period increases (Kumbhakar and Lovell, 2000).

3.3.5 Non-Parametric Techniques

(a) Data Envelopment Analysis (DEA)

Data envelopment analysis has its origin in production theory as a means to evaluate production efficiency. It is a deterministic method for determining the relatively

efficient production frontier, based on the empirical data on the chosen mix of inputs and outputs of a number of entities called Decision Making Units (DMUs). From the set of available data, DEA identifies reference points (relatively efficient DMUs) that define the efficient frontier (as the best practice production technology). It then evaluates the inefficiency of other units, the interior points (relatively inefficient DMUs) that are below that frontier (Thanassoulis, 2001 and Emrouznejad, 1995-2001).

The main advantage of DEA is that, unlike regression analysis, it does not require an *a priori* assumption about the analytical form of the production function. Instead, it constructs the best practice production function solely on the basis of observed data and, therefore, the possibility of misspecification of the production technology is zero (Bauer *et al*. 1998). On the other hand the main disadvantage of DEA is that the frontier is sensitive to extreme observations and measurement errors (the basic assumption is that random errors do not exist and that all deviations from the frontier indicate inefficiency (Berger and Mester, 1997 and Bauer *et al*. 1998)).

3.3.6 Parametric versus Non-Parametric Approaches

The SFA, TFA, DFA and DEA are the four main efficiency frontiers that exist in the literature. As is evident from the previous discussion, there are many differences in terms of the underlying assumptions of each approach. The parametric approaches differ in the way they isolate inefficiencies from the random error while the non-parametric approach neglects the error term, and any existing error is accounted for as inefficiency. The difference in these approaches made some researchers curious to apply these different approaches to the same data set.

Ferrier and Lovell (1990) compared the SFA with DEA. Their sample consisted of 575 financial institutions that participated in the Federal Reserve System's Functional Cost Analysis program in 1984. They suggested that the two approaches were in agreement in some results and were in disagreement in others. Both approaches seemed to agree that big banks were enjoying lower costs because of scale economies. Big banks could increase efficiency by decreasing costs by 20-30 percent as reported by both approaches. Both approaches were in disagreement when identifying technical and allocative efficiencies. Ferrier and Lovell (1990) attributed this result to the different assumptions underlying these approaches.

Resti (1997) applied and compared the results from SFA and DEA. The approaches were tested on 270 Italian banks. He found a high correlation between the individual efficiencies measured by the SFA and the non-parametric approach. These high correlations reached 86.7 percent for the constant returns model and 70.8 percent for the variable returns model. He concluded that the parametric and non-parametric approaches did not differ dramatically when based on the same data and conceptual framework.

Hassan and Hunter (1996) applied the SFA and the TFA to Japanese-owned and US-owned multinational banks operating in the US over the period 1984-1989. They found that Japanese-owned banks were significantly less cost and profit efficient than were US-owned banks. The results suggested that most inefficiencies were operational in nature (overuse of labour and physical capital). The results also showed that the SFA average efficiency value was 0.81, which was much higher than the TFA average

efficiency value of 0.67, even though the same data set had been applied to both approaches.

In comparing the SFA and the DFA Berger and Mester (1997) applied both methods to US banks over the period 1990-1995. The results of their study suggested that efficiencies estimated by the SFA were reasonably consistent with those of the DFA. The average cost efficiency under SFA was higher but with less dispersion than that of the DFA. However, the average profit efficiency was somewhat lower with more dispersion under the SFA than under the DFA. Berger and Hannan (1998) showed results similar to those obtained by Berger and Mester (1997). They applied the SFA and the DFA using more than 5000 banks during the decade of the 1980s. They found the average efficiency of the SFA to be 0.92, slightly higher than the average efficiency of the DFA of 0.7.

As discussed earlier, there is no consensus on the best method or set of methods for measuring frontier efficiency. The choice of method may affect the policy conclusions that are drawn from the analysis. Resti (1997) asserts that policy makers and regulators should make their recommendations after applying at least two different approaches to the same data set. Even though the approaches are used on the same dataset, each approach can lead to different results, due to differences in underlying assumptions. Berger and Humphrey (1997) also argue that when methods are compared with one another using the same dataset, the ranking of individual banks often does not correspond well across methods. This study adopts the DEA approach to assess the technical efficiency situation of financial institutions in Botswana.

Why DEA?

The principal advantage of the DEA method is that, as a non-parametric technique, it permits analysis of small sample sizes, especially useful when the sample size is limited, as it is for Botswana's financial institutions. Other parametric methods require large sample sizes in order for there to be more degrees of freedom for valid results.

Compared to commonly used performance measurements, such as ratio and regression analysis, DEA focuses on the outliers; specifically, DEA identifies units that achieve the best results. Therefore, DEA allows for the examination of best performers and their best practices and gives the efficiency score for each firm. This is important for this particular study where financial institutions are aggregated (due to the small sample size), and hence it is important to know how each different form of financial institution performs. Regressions used in econometric efficiency analyses utilise a single optimization. Hence, the DEA solution is unique for each DMU under investigation, which allows a direct comparison to be made against a peer or a combination of peers. Finally, DEA uses data on various inputs and outputs (sources) and shows the magnitude of the inefficiency. A deficiency of the econometric approaches is their inability to identify sources and to estimate the inefficiency amounts associated with these sources.

Why Technical Efficiency?

The DEA approach was originally developed to measure technical efficiency in the public and not-for-profit sectors (Favero and Papi, 1995), as prices of inputs and outputs in these sectors were not available or reliable. The DEA model has been extended to cover profit making sectors, such as commercial banks, in order to analyse economic

efficiency. Under public ownership, profit maximisation or cost minimisation (thus fulfilling the condition of economic efficiency) may not be the main objective of an enterprise. On the other hand, profit maximisation is the ultimate objective of private enterprises, such as banks. As mentioned before, financial institutions in Botswana fall into two distinct classes, that is, private ownership and state (or public) ownership, and hence, the managers of these two distinct classes may follow different agendas and economic goals. Therefore, it seems reasonable to assess technical efficiency rather than economic efficiency by applying the DEA approach.

3.4 Summary

This chapter has discussed the theoretical basis of efficiency, in particular efficiency concepts, and methods to measure efficiency. To this end, some efficiency concepts in addition to technical efficiency have been discussed. It is evident from the literature that efficiency concepts, such as cost, revenue and profit efficiencies are due to technical efficiency. Cost inefficiency has been described as arising from technical inefficiency, which results in the use of an excess or sub-optimal mix of inputs and output quantities.

Empirical studies have found that revenue inefficiency can be primarily attributed to technical inefficiency rather than to allocative inefficiency (Berger, Humphrey and Pulley, 1996). Furthermore, standard profit efficiency can be described in terms of output and input components. Output (input) profit inefficiency includes output (input) technical inefficiency, which is the failure to produce as much output as planned. From this review, it can be implied that cost inefficiency, revenue inefficiency and profit inefficiency can be controlled if firms are technically efficient. While technical efficiency is merely one component of overall efficiency, an institution needs to be

technically efficient before it can be economically efficient. This forms the basis for this particular study, which is to assess the technical efficiency of firms rather than cost, revenue or profit efficiencies.

On the measurement of efficiency, the traditional methods can only be regarded as "alternative methods" of measuring efficiency, because of the disadvantages they have compared with other methods. The frontier methods, in particular the parametric SFA, DFA and TFA and the non-parametric DEA approaches are the most widely adopted. Even though these approaches can be applied to the same dataset, each approach will produce different results. This is due to the underlying assumptions of each approach. Parametric methods have the shortcoming of imposing a particular functional form that presupposes the shape of the frontier (Berger and Mester, 1997). If the functional form is misspecified, measured efficiencies may have some specification errors.

DEA is the only non-parametric approach that deals with measuring efficiency by the use of linear programming. The non-parametric approach imposes less structure on the frontier but has the shortcoming of not allowing for a random error owing to luck, data problems, or measurement errors. However, DEA works well with a small sample size and it imposes fewer constraints on the optimisation problem. DEA allows for the examination of best performers and their best practices and gives the efficiency score for each firm. This is important for this particular study where financial institutions are aggregated (due to the small sample size), and hence it is important to know how each different form of financial institution performs. Therefore, this study adopts the DEA method in assessing the efficiency of financial institutions in Botswana because of the

above extra advantages, facilitating fulfilment of the aims of this study. The DEA model is discussed in more detail in Chapter Five of this thesis.

Building on the understanding of different concepts and measurement of efficiency provided in this chapter, the following chapter is devoted to reviewing different empirical studies related to financial institutions on the application of the DEA approach.

Chapter Four

Empirical Literature Review on the Usage of DEA

4.1 Introduction

The previous chapter reviewed some theoretical aspects of efficiency, in particular efficiency concepts and their measurement. DEA was found to be a relevant measure of the concept of technical efficiency, which is the main focus of this study. The purpose of this chapter is to extend this literature review by citing empirical findings that will contribute to an understanding of this study.

As discussed in the previous chapter, technical efficiency estimates an efficient frontier and measures the average differences between observed financial institutions and those on the frontier. Since information on the technology of financial institutions is not available, studies that are reviewed hereunder rely on accounting measures of costs, outputs, inputs, revenues and profits to measure the efficiency of the institutions.

This review of the empirical literature is discussed under seven main sections. Section 4.2 provides an overview of financial sector efficiency studies. Section 4.3 reviews the efficiency of financial institutions based on cross-country studies and individual country studies. Section 4.4 reviews the efficiency and productivity of financial institutions followed by Section 4.5, which reviews studies dealing with financial liberalisation in relation to financial institutions' efficiency. Section 4.6 presents the determinants of financial sector efficiency as found in the literature. Lastly, Section 4.7 summarises the chapter.

4.2 Overview of Financial Sector Efficiency Studies

The efficiency of financial institutions has been researched more in developed countries than in developing countries. Berger and Humphrey (1997) presented an extensive international literature survey on the efficiency of financial institutions by examining 130 studies performed with different efficiency techniques, including DEA, in 21 countries. Table 4.1 summarises the mean efficiency estimates by region for the 130 studies according to Berger and Humphrey (1997). Seventy five percent of the studies focused on US financial institutions while another twenty percent examined financial institutions in other developed countries including Norway, Spain and the UK. Only five percent of the studies were performed in developing countries, in particular, India, Mexico and Tunisia.

Table 4.1: Survey of Financial Institutions' Efficiency Studies

Please see print copy for Table 4.1

The main findings of the efficiency studies of financial institutions were rearranged into three broad categories, based upon whether a study's primary contribution was to inform government policy, to address general research issues or to improve managerial performance. Most studies found that inefficiencies were quite substantial, in the order of 20 percent or more of the total financial industry.

As noted above, only a few financial sector efficiency studies have focused on developing economies. The relatively scant literature on financial institution efficiency

in these economies focuses mainly on the efficiency differentials among institutions with different ownership status and asset size. This is due to the fact that these institutions are still in their infancy, and markets are usually characterised by high state ownership and rapid entry by foreign banks. The policy issues in these studies address questions regarding the privatisation of state-owned institutions, elimination of restrictions for domestic and foreign institutions' entry and operations, and the existence of scale economies associated with mergers and acquisitions.

The following literature review summarises the most relevant and frequently cited findings that contribute to an understanding of this study. In this research, information is sought to review the utilisation of the DEA method, specifically in the evaluation of efficiency, and proceeds in the following order:

1. Efficiency in financial institutions.
2. Efficiency and productivity in financial institutions.
3. Efficiency related to financial liberalisation in the financial institutions.
4. Determinants of efficiency.

4.3 Efficiency in Financial Institutions

In the past few years, DEA has been frequently applied to financial institution studies. In the extensive DEA literature, Emrouznejad *et al.* (2008) listed more than 4000 research articles published in journals or book chapters that are written by 2500 distinct authors. The first application, by Sherman and Gold (1985) analysed efficiencies of different branches of a single bank. The study analysed the overall efficiency of 14 branches of a US savings bank and DEA results showed that six branches were operating inefficiently compared to the others.

A shift from the unit of assessment from branches to consolidated financial institutions was addressed by Rangan *et al*. (1988). They applied a DEA approach to a larger sample of 215 US banks and split inefficiency into that stemming from pure technical inefficiency and scale inefficiency. They adopted the intermediation approach and employed three inputs (labour, capital and purchased funds) and five outputs (three types of loans and two types of deposits). Their results indicated that banks could have produced the same level of output with only 70 percent of the inputs actually employed. Scale inefficiencies of the banks were relatively small, suggesting that the sources of inefficiency were pure technical rather than scale efficiency.

Thereafter, a number of efficiency studies were conducted and these have established different findings. These studies employed inputs and outputs in accordance with the production, intermediation and asset approaches[9]. Favero and Papi (1995) applied the non-parametric DEA on a cross section of 174 Italian banks in 1991 in measuring the technical and scale efficiencies of these banks. In implementing both the intermediation and the asset approaches, the traditional specification of inputs was modified to allow for an explicit role of financial capital. In addition, regression analysis was employed on a bank specific measure of inefficiency to investigate the determinants of bank efficiency. According to the empirical results, efficiency was best explained by productivity specialisation and bank size and, to a lesser extent, by location.

Taylor *et al*. (1997) applied DEA to panel data from 1989 to 1991 for 13 Mexican commercial banks, and found that an average bank had an efficiency score of 0.72. The

[9] Discussed in Chapter Five.

results indicated that banks could increase their efficiency relative to that of their competitors by shifting their input mix over time. Accounting profit ratios resulting from income and expense management were considered to be independent from DEA efficiency. They also found that, while there was a weak positive relationship between profitability and efficiency, DEA efficient banks were not necessarily the most profitable. Return on Assets (ROA) and Return on Equity (ROE) were only weakly correlated with technical efficiency. This conclusion was, however, based on a comparison of two different methods of measuring efficiency. As highlighted in the previous chapter, traditional methods such as ROA and ROE do not control for output mix and hence give a one dimensional and incomplete picture of the process (see also Akhavein, Berger and Humphrey, 1997; Debasish, 2006).

In an evaluation of the relative productive efficiency and performance of US commercial banks from 1984 to 1998, Barr *et al*. (1999) employed a constrained-multiplier, input-oriented data envelopment analysis. The study found a strong relationship between efficiency and inputs (salary expense, premises and fixed assets, other non-interest expense, interest expense and purchased funds) and outputs (earning assets, interest income and non-interest income). A close relationship was found to exist between efficiency and the soundness of banks as determined by bank examiner ratings. This study, however, was able to incorporate a wide number of inputs and outputs in the model due to the large number of observations. However, this particular study has a limitation of small sample size, and hence cannot employ a large number of inputs and outputs.

In an interesting study on efficiency, productivity and technological change in the Portuguese banking sector, Mendes and Rebelo (1999) found that annual efficiency did not increase over time. The results suggested that Portugal was facing a state of over-banking and over-branching. The size of the market, the existing number of institutions and branches and the increased competition suggested that Portuguese banks were not fully able to absorb the probable benefits of the large sums invested. This is, however, in contrast to other empirical studies that provide support for a positive relationship between efficiency and competition (for example, Canhoto and Dermine, 2003). Mendes and Rebelo (1999) also failed to check if there were any productivity gains over time even if efficiency did not improve. This is because lower efficiency from one period to another does not necessarily suggest that the institution achieves lower productivity since the technology may not have changed.

In Southern Africa, Ikhide (2000) examined the existence of scale and scope economies in the cost efficiency of Namibian banks, with the aim of establishing whether the Namibian economy was over-banked. The study also incorporated an analysis of the efficiency of banks in Botswana and South Africa for comparison with the Namibian banks. Using data for a three year period, 1996-1998, it was established that Namibian banks had significantly large unexploited scale economies, and hence were under-banked. He also found that banks in Botswana and Namibia had an increasing share of profits coming from non-interest income. The study, however, incorporated data from only three commercial banks in Botswana. A study to consider the efficiency of all banking institutions in Botswana, therefore, is necessary to give a broader idea of their efficiency. Berger and Humphrey (1997); Figueira *et al*. (2006), for example, argued that cross country findings cannot be relied upon, as different countries face different

regulations and economic environments. It is, therefore, plausible and desirable to conduct an exclusive study on Botswana to assess the efficiency of its financial institutions.

Thanassoulis (2001) argues that the use of the constant returns to scale assumption alone is not always appropriate in real life contexts. One implication of the CRS assumption is that firm size does not matter for efficiency and productivity. The assumption that small firms generate as much output per unit of input as do large firms is unrealistic in sectors such as financial institutions. The CRS model is only appropriate for measuring technical efficiency among firms that are operating at their optimal scale. Factors that may cause institutions not to operate at an optimal scale include imperfect competition, leverage concerns and certain prudential requirements.

The fact that institutions face non-constant returns to scale has been documented empirically by, *inter alia*, McAllister and McManus (1993), Wheelock and Wilson (1999), Katib and Mathews (2000). The latter applied DEA in their study of Malaysian banks from 1989 to 1995. Their results showed that average technical efficiency ranged from 68 percent to 80 percent, and that most commercial banks did not operate at constant returns to scale. They also concluded that most technical inefficiency was attributed to scale inefficiency. Hence, investigations on the efficiency of financial institutions should allow, at least in principle, for the existence of variable returns to scale. This particular study adopts the Variable Returns to Scale (VRS) assumption in order to assess institution size and returns to scale.

Sathye (2001) empirically investigated X-efficiency in Australian banks by applying the DEA method to arrive at efficiency scores. Banks in the sample were found to have low levels of overall efficiency compared to European and US banks. The results indicated that, as a source of overall inefficiency, the technical component was more important than the allocative component. He attributed the inefficiency in Australian banks to the wasting of inputs, that is, technical inefficiency rather than to their choice of incorrect input combinations, that is, allocative inefficiency. The study, therefore, highlighted the advantage of the DEA approach by indicating the source of inefficiency that would help banks with strategic planning. Sathye (2001) also found that domestic banks were more efficient than foreign-owned banks. For the case of Botswana foreign owned banks are expected to be more efficient than their domestic counterparts, because they bring in better technology that helps to improve efficiency.

Drake (2001) sampled nine UK banks to assess their technical and scale efficiency and productivity gains. He used two models, one with three inputs and three outputs and the other one with four inputs and two outputs. The study presented evidence that increasing returns to scale were apparent for smaller banks while larger banks exhibited decreasing returns to scale. Drake (2001) also found that very large banks were more efficient than smaller banks. Malmquist productivity indices suggested that UK banks had positive productivity growth over the period. For most banks, the productivity growth was the net result of a mixture of a positive frontier shift and negative catch-up.

Neal (2004) also investigated the efficiency and productivity change in Australian banking between 1995 and 1999. He found that banks exhibited a higher level of allocative efficiency than technical efficiency. This was inconsistent with Sathye

(2001), who attributed the inefficiency in Australian banks as being due to wastage of inputs (technical inefficiency) rather than to choice of the incorrect input combinations (allocative inefficiency). This difference was, however, due to the fact that the assumption of variable returns to scale adopted by Neal (2004) raised technical efficiency scores. Neal (2004) also found that large national banks were on the best practice frontier for most years in the sample. The Malmquist indices of productivity change showed a significant improvement in the efficiency of the banking sector. Whilst the Drake (2001) and Neal (2004) studies are similar in scope to the present one, they failed to investigate the determinants of inefficiency in banking institutions. This particular study extends the analysis by checking the determinants of efficiency in financial institutions.

Das and Ghosh (2006) investigated the performance of the Indian commercial banking sector during the post reform period. Three different approaches specifically, the intermediation approach, the value-added approach and the operation approach were employed to identify how efficiency scores vary with changes in inputs and outputs. The analysis linked the variation in calculated efficiencies to a set of variables, such as bank size, ownership, capital adequacy ratio, non-performing loans and management quality. The findings suggested that medium-sized public sector banks perform reasonably well and are more likely to operate at higher levels of technical efficiency. A close relationship was observed between efficiency and soundness as determined by a bank's capital adequacy ratio. The empirical results also showed that technically more efficient banks were those that had, on average, fewer non-performing loans. A multivariate analysis based on the Tobit model reinforced the findings.

By applying the DEA method, Sufian (2006) investigated the efficiency of Malaysian Non-Bank Financial Institutions during the period 2000-2004. His results suggested that pure technical inefficiency rather than scale inefficiency largely resulted in the country's overall inefficiency. He also found that overall efficiency was positively and significantly associated with all other efficiency measures. This study, however, while assuming variable returns to scale, did not consider productivity changes over the period of investigation. This is because higher efficiencies from one period to another do not necessarily suggest that the institution achieves higher productivity, since the technology may have changed. This is one of the gaps that this particular study seeks to fill in the literature. Table 4.2 gives a summary of the studies reviewed on the efficiency of financial institutions in developed and developing countries.

Table 4.2: Studies on Efficiency of Financial Institutions: Application of DEA

Author	Country	Data and data period	Methodology	Average efficiency estimate
Favero and Papi (1995)	Italy	Banks 1991	DEA	0.88, 0.91, 0.79, 0.84
Rangan *et al* (1988)	US	Banks 1986	DEA	0.70
Sherman and Gold (1985)	US	Bank branches 1982	DEA	0.96
Wheelock and Wilson (1994)	US	Bank 1984-1993	DEA	0.84,0.77,0.69,0.59,0.46
Tylor *et al* (1997)	Mexico	Banks (1989-1991)	DEA	0.72
Barr *et al* (1999)	US	Banks 1984-1998	DEA	N/A
Mendes and Rebelo (1999)	Portugal	Banks 1990-1995	DEA	0.94
Katib and Mathews (2000)	Malaysia	Banks 1989-1995	DEA	0.68-0.80
Sathye (2001)	Australia	Banks 1996	DEA	0.58

Table 4.2 Continued

Author	Country	Data and data period	Methodology	Average efficiency estimate
Drake (2001)	UK	Banks 1980-1990	DEA	0.87,0.88,0.56,0.57
Neal (2004)	Australia	Banks 1995-1999	DEA	0.79,0.74,0.712,0.769, 0.826
Das and Ghosh (2006)	India	Banks 1992-2002	DEA	0.78,0.91,0.74
Sufian (2006)	Malaysia	Non-bank financial institutions 2000-2004	DEA	0.78,0.91
Canhoto and Dermine (2003)	Portugal	Banks 1990-1995	DEA	0.59

Source: Compiled by the author.

4.4 Efficiency and Productivity

Productivity change over time is another indicator of the performance of financial institutions. The Malmquist index for measuring productivity change has been used in a variety of studies related to financial sector efficiency (Bauer *et al.* (1993); Berg *et al.* (1992); Avkiran (2000); Isik and Hassan (2003); Mukherjee *et al*. (2001); Jeanneney *et al*. (2006); Worthington (1999)). This literature, however, provides no conclusive evidence on the relationship between efficiency and productivity.

Bauer *et al*. (1993) used a panel data set of 683 banks with over $100 million in assets to estimate total factor cost productivity growth for the best-practice banks during 1977-1988. Over that period, their estimates ranged from an average annual growth rate of -2.28 percent to 0.16 percent depending on the estimation method used. The poor productivity growth was attributed to higher costs of funding due to high market rates, the elimination of deposit rate ceilings and increased competition from non-bank financial intermediaries, which increased demand for funds and reduced the supply of deposits. Hence, during the 1980s the banks increased the number of branches in

addition to paying higher deposit rates and providing ATM innovation. The increase in deposit rates, increase in non-bank competition and greater convenience all made consumers of bank services better off, but because quality of service is difficult to account for in the estimation, the higher quality showed up as a decrease in productivity.

The Malmquist index was first introduced in productivity literature by Caves *et al.* (1982). Nischimizu and Page (1982) used a parametric programming approach to compute the index for the first time in the empirical context. Fare *et al.* (1989, 1994) decomposed productivity change into efficiency change and technical change and used non-parametric mathematical programming models for its computation. Berg *et al.* (1992) used non-parametric Malmquist index for the first time in the banking sector.

Avkiran (2000) investigated the productivity of four major trading banks and six regional banks in Australia using Malmquist indices. His results indicated an overall rise in total productivity driven more by technological progress than by technical efficiency. The performance of major trading banks on technical efficiency was similar to that of regional banks but higher on technological progress.

Utilising a DEA-type Malmquist total factor productivity change index, Isik and Hassan (2003) examined productivity growth, efficiency change and technical progress in Turkish commercial banks. They found that all forms of Turkish banks recorded significant productivity gains, driven mostly by efficiency increases rather than technical progress. They assigned this to improved resource management practices rather than improved scale. Mukherjee *et al.* (2001), in their study of productivity

growth in 201 large US banks, uncovered evidence that productivity grew, on average, 4.5 percent per year. They also found that banks with a large asset size experienced higher productivity growth.

After decomposing the overall productivity change into efficiency change and technological change in measuring productivity growth in the republic of China, Jeanneney *et al*. (2006) found that the country recorded an increase in total factor productivity. However, productivity growth was mostly attributed to technical progress rather than to an improvement in efficiency. This finding is substantiated since China has advanced technology. Worthington (1999) found that efficiency gains in Australia were largely the result of improvements in technical efficiency rather than scale efficiency. However, Worthington (1999) asserted that productivity growth due to an increase in efficiency over the period tended to be in credit unions with a small number of members and a large asset base. On the other hand, technological progress was most pronounced in institutions with a relatively high proportion of residential and commercial loans.

Drake (2001) studied efficiency and productivity changes in UK banking. Unlike the evidence which emerged from U.S banking studies, scale inefficiencies were a more severe problem in UK banking than X-inefficiencies, particularly for very small and very large banks. However, in line with evidence from US banking studies, some tentative evidence emerged to suggest that very large banks may be more X-efficient than their smaller competitors, particularly in the latter years of the study period. The evidence from Malmquist productivity indices suggested that, on the whole, UK banks

exhibited positive productivity growth over the period. For most banks, the productivity growth was the net result of a mixture of a positive frontier shift and negative catch-up.

In investigating X-efficiency and productivity change in Australian banking, Neal (2004) applied DEA and Malmquist productivity indexes. He found that banks exhibited a higher level of allocative efficiency than of technical efficiency. Large banks were found to be on the best practice frontier for most years in the sample. The Malmquist indices of productivity change suggested a significant improvement in the efficiency of the banking sector over the period 1995-1999. Total factor productivity grew by an annual average of 7.6 percent. Neal (2004) also found that technological change led to an annual 11.5 percent shift in the frontier. The mean catch-up of the banks showed a negative component with only one bank having a positive catch-up. This was similar to Drake's (2001) study for the UK, where negative catching up was found. The studies on productivity and efficiency in financial institutions are summarised in Table 4.3.

Table 4.3: Applications of Productivity and Efficiency in Financial Institutions

Author	Country	Data and data type	Approach	Main conclusions
Berg *et al* (1992)	Norway	Banks 1980-1989	Value added	Productivity regressed in the pre-deregulation period due to increased competition.
Isik and Hassan (2003)	Turkey	Banks 1980-1990	DEA-Malmquist Index	Banks recorded productivity gains due to efficiency increase.
Mukherjee *et al* (2001)	US	Large banks 1984-1990	Malmquist Index	Productivity grew by 4.5% and banks with large assets experienced higher productivity growth.

Table 4.3 Continued

Author	Country	Data and data type	Approach	Main conclusions
Jeanneney *et al* (2006)	China	Banks 1993-2001	Malmquist indices	Productivity growth was mostly due to technical progress rather than improved efficiency.
Worthington (1999)	Australia	Credit unions 1995	Malmquist Indices	Productivity growth was due to an increase in the efficiency of credit unions with a smaller number of members.
Neal (2004)	Australia	Banks 1995-1999	Malmquist index	Significant improvement in efficiency, but a negative catch up.
Avkiran N.K (2000)	Australia	Banks 1986-1995	Malmquist index	Overall rise in total productivity driven more by technological progress than technical efficiency.

Source: Compiled by the author.

4.5 Efficiency Related to Financial Liberalisation in the Financial Institutions

Given that the initial goal of deregulation and financial liberalisation is to improve efficiency, studies have however, shown mixed results regarding deregulation and efficiency (Bhattacharya *et al.* (1997); Leightner and Lovell (1998); Gilbert and Wilson (1998); Hao *et al*. (2001); Yildirim (2002); Isik and Hassan (2003); Maghyereh (2004); Ataullah and Le (2006)). The mixed results are in line with one of the direct implications of Berger and Humphrey's (1997) review of efficiency studies, that is, the deregulation might not always improve efficiency and productivity. However, an important aim of most financial sector reforms is to enhance the level of competition amongst them, and to exert more pressure in efficiently utilising their resources.

Some recent empirical studies on financial institutions have provided some support for a positive relationship between competition and efficiency. For example, using the Indian

banking industry as a case study, Ataullah and Le (2006) proposed and tested hypotheses regarding the possibility of a relationship between bank efficiency and three elements of economic reform, namely, fiscal reforms, financial reforms and private investment liberalisation, in developing countries. Their results showed an improvement in the efficiency of banks, especially that of foreign banks, after the economic reforms. They also found a positive relationship between the level of competition and bank efficiency. However, a negative relationship between the presence of foreign banks and bank efficiency was found, and this was attributed to a short-run increase in costs due to the introduction of new banking technology by foreign banks.

Chen *et al*. (2005) investigated the impact of deregulation on Chinese banking efficiency from 1993-2000. Cost, technical and allocation efficiency were estimated using DEA. Efficiency performance results were measured both before and after the 1995 deregulation program. The results revealed that the deregulation initiated in 1995, appeared to have had a significant impact initially on the overall efficiency of Chinese banks. However, in the third and fourth years of post-deregulation, efficiency levels declined. Thus, deregulation appeared to have enhanced the performance of Chinese banks, especially in the early deregulation period.

Portugal rapidly transformed rapidly its repressed banking system with deregulation, the opening of borders, the granting of new banking licenses and privatisation. Canhoto and Dermine (2003) alleged that the rapid deregulation in Portugal was accompanied by a major increase in the efficiency of banks over the period 1990-1995. Evanoff and Ors (2002) also found that competition increased as a result of the entry of new banks into the market, as incumbent firms responded by increasing their level of cost efficiency.

Thus, consistent with economic theory, new entrants and the reductions in entry barriers led incumbent firms to increase their productive efficiency, which enabled them to be viable in a more competitive environment.

The impact of the liberalisation initiated before the deregulation of the nineties on the performance of the Indian commercial banks was assessed by Bhattacharya *et al.* (1997). They employed advances, investments and deposits as outputs, and interest expenses and operating expenses as inputs. They found that foreign banks were the least efficient at the beginning of the sample period, but by the end of the period they were nearly as efficient as public sector banks, which exhibited a temporal decline in performance. Bhattacharya *et al.* (1997) asserted that the performance of foreign banks was hindered by the existing regulations constraining their operations and also to a significant degree by capital adequacy requirements. The rise in the performance of foreign banks at the end of the sample period was a result of a significantly positive temporal effect, which is interpreted as an efficient adaptation to an increasingly competitive environment. They did not consider technical change explicitly in their model.

Leightner and Lovell (1998) measured the total factor productivity growth of Thai banks during 1989-1994 to evaluate the effects of financial liberalization on these banks. They applied two alternative input-output models, one based on the commercial banks' objective to generate revenue and the other based on the banks' objective to intermediate funds. They constructed a Malmquist total factor productivity index for the Thai banks and found that the productivity of banks improved after liberalization. Using the same approach, Gilbert and Wilson (1998) also found that financial liberalization in

Korea had positive impacts on the productivity of the Korean banking industry during the early 1990s. In contrast, Hao *et al.* (2001) used a parametric stochastic frontier approach to measure the efficiency of Korean banks, but did not find any positive relationship between measured efficiency and financial liberalization.

By employing DEA, Isik and Hassan (2003) constructed a Malmquist total factor productivity index for Turkish banks during 1980-1990, and found that the performance of banks improved after the implementation of financial liberalization. However, earlier on, Yildirim (2002), in his analysis of the technical efficiency of Turkish banks using non-parametric DEA found that Turkish banks did not achieve any sustained efficiency gains between 1988 and 1998. Kumbhakar and Sarkar (2003) also found little evidence to suggest that liberalisation enhanced the productivity of banks in India. They measured total factor productivity (TFP) growth by estimating a translog cost function and decomposed TFP growth into technological change and a scale component. They also found considerable over-employment of labour in Indian banks. In countries where the population is not so high, like Botswana, this finding may be otherwise.

In Jordan, Maghyereh (2004) conducted a study to assess the effect of financial liberalization on the efficiency of Jordanian banks. He employed a non-parametric mathematical programming model (DEA) using data from 1984-2001 to determine whether or not the liberalization program improved the efficiency of the Jordanian banking sector. He hypothesised that after liberalization, with the entry of new banks and relaxed regulations, competition would intensify, requiring discipline by banks in their resource management and forcing them to be more efficient. The total efficiency scores suggested that liberalisation provided the anticipated efficiency gains.

Applications of financial liberalisation and its impact on efficiency are summarised in the following table.

Table 4.4: Applications of Financial Liberalisation and its Impact on Efficiency

Author	Country	Data and data type	Approach	Main conclusions
Bhattacharya *et al* (1997)	India	Banks 1986-1991	DEA	Public sector banks had higher efficiency compared to private and foreign banks after liberalisation.
Leightner and Lovell (1998)	Thailand	Banks 1989-1994	Malmquist indices	Productivity improved after liberalisation.
Gilbert and Wilson (1998)	Korea	Banks 1980-1994	Malmquist indices	Financial liberalisation had positive impacts on productivity.
Hao *et al* (2001)	Korea	Banks 1985-1995	SFA	Did not find any positive relationship between efficiency and financial liberalisation.
Yildirim (2002)	Turkey	Banks 1988-1998	DEA	Banks did not achieve any sustained efficiency gains.
Isik and Hassan (2003)	Turkey	Banks 1980-1990	Malmquist index	Performance of banks improved after the implementation of financial liberalisation.
Maghyereh (2004)	Jordan	Banks 1984-2001	Intermediation	Liberalisation led to improved efficiency of banks.
Ataullah and Le (2006)	India	Banks 1992-1998	DEA and OLS	Positive relationship between competition and efficiency.
Chen *et al* (2005)	China	Banks 1993-2000	VRS- DEA	Deregulation had a positive impact on efficiency but the effect of the impact declined in the third and fourth years of post deregulation.
Canhoto and Dermine (2003)	Portugal	Banks 1990-1995	DEA	Deregulation was accompanied by a major increase in efficiency.
Kumbhakar and Sartar (2003)	India	Banks 1985-1996	Translog cost function	Found little evidence that liberalisation enhanced the productivity of banks.

Source: Compiled by the author.

4.6 Determinants of Efficiency

For financial institutions, few analyses on efficiency have been informative in identifying exogenous determinants of efficiency because of a lack of detailed data (Berger and Humphrey, 1997). When available, most analyses focus on managerial decisions, size factor, institutional age, regulation and ownership as determinants of financial institution efficiency.

Regarding the effect of ownership on an institution's performance, previous research has revealed different results between developed and developing economies. Domestic institutions in developed countries were generally found to be more efficient than their foreign-owned counterparts. For example, Chang *et al.* (1998) conducted a comparative analysis of the productive efficiency of foreign-owned and US-owned multinational commercial banks operating in the US between 1984 and 1989 time period. A multi product translog stochastic cost frontier model was applied to estimate cost inefficiency scores, while ordinary least squares and Tobit regressions were utilized to identify key factors associated with the inefficiency. Their results indicated that foreign-owned multinational banks operating in the US were significantly less efficient than were their US-owned counterparts. They also found that large multinational banks in holding company networks carrying fewer foreign assets were more efficient.

Hassan and Hunter (1996) also found that domestically owned US banks were substantially more cost effective than were Japanese banks operating in the US. These results are consistent with the notion that foreign banks that aim at increasing their market share expansion rely heavily on purchased funds, which is a relatively more expensive way of financing their investments compared to core deposits, and which

require setting up an extensive delivery capacity and establishing a broad customer base (DeYoung and Nolle, 1996). Peek *et al*. (1999) believe that the inefficiency of foreign banks that enter the US market through acquisition could be attributed to the low performance and efficiency of target banks compared to other domestic banks prior to acquisition.

In contrast, most studies that compared bank efficiency across different ownership groups in developing countries revealed that foreign banks were more efficient than were domestic banks (Jemric and Vujcic, 2002; Sathye, 2003; and Shanmugam and Das, 2004). They asserted that foreign investors bring state of the art technology and human capital to domestic banks. If foreign banks use modern technology and rely on the human capital of their parent banks, they should perform better than government-owned or domestic private banks in transition countries. They argued that, by the same token, private banks should perform better than government-owned banks.

Sathye (2003) measured the productive efficiency of banks in a developing country, India, using DEA. Efficiency scores for three groups of banks, that is, publicly-owned, privately-owned and foreign-owned were measured, and it was found that the efficiency of privately-owned banks was lower than that of foreign banks. Chen *et al.* (2005) found that foreign ownership was significantly and positively correlated with bank level efficiency, while government ownership had the opposite influence on Chinese banks after financial liberalization. Using the SFA approach to examine bank efficiency in Croatia, Kraft and Tirtiroglu (1998) found that newly organized private banks were more efficient than were state-owned institutions.

In Africa, Figueira *et al*. (2006) investigated the extent to which the ownership structure of banks in Africa affected their performance. The study addressed two research hypotheses: firstly, that state-owned banks will perform less efficiently than privately-owned banks in Africa, and secondly, that domestically-owned banks will perform more efficiently than foreign-owned banks in Africa. The study found little evidence that privately owned banks in Africa performed better than their state-owned counterparts, and foreign-owned banks were more efficient than domestically-owned banks. They alleged that the differences in performance may not only be related to bank ownership but to the environment in the countries in which the banks operate. This conclusion supports this particular study's submission that an exclusive study is required to assess a country's efficiency, and hence not rely on cross country studies.

The existing literature demonstrates differences in the relationship between size and efficiency. Mester (1996) and Avkiran (1999), for example, did not detect any significant relationship between size and efficiency. Bauer *et al.* (1993) reported that inefficiency increased with size. However, Chen *et al.* (2005) found that large banks and small banks were most efficient. This is contradictory to the US experience where the average cost curve has a flat U-shape indicating the efficiency of medium-sized banks.

Elyasiani and Mehdian (1995) employed a flexible non-parametric approach to contrast the productive efficiency of a sample of 150 small and large banks in order to examine the relationship between size and productive performance. Furthermore, they investigated whether the relative efficiency of small and large banks had changed following the changes in the banking environment in the 1980s. The definition of a small bank was one that had assets worth less than 50 million and assets worth 400

million to 10 billion for large banks. They found that under the hypothesis of identical frontiers for the two groups, the efficiency measures for each were similar in 1979 but separate in favour of large banks in 1986. This finding is consistent with Shaffer (1989) and Paxton (2007). It was also found that large and small banks possessed separate and dissimilar best practice frontiers. Thus, the efficiency patterns of the two groups may be said to be correlated with distinct characteristics of the markets and environments in which the two operate.

The viability of small banks has also been assessed (Rogers, 1998) by examining their X-efficiency relative to larger institutions. A balanced panel of 8386 banks over the years 1991 to 1996 was used to estimate cost and profit frontiers using the translog specification of the distribution free approach. Results suggested that after adjusting the frontier for size, small banks were found to be less profit efficient than were larger institutions, but more cost efficient. It was posited that this would allow small banks to compete with large banks in terms of costs, but could affect their profitability as industry consolidation continues. Mendes and Rebelo (1999) found no clear relationship between size and cost efficiency. Efficiency and scale economies also seemed not to be related to size as less efficient institutions were the ones facing economies of scale. This study was, however, conducted using a cost function.

On the issue of efficiency and institutional age, Paxton (2007) found that new banks in Mexico were more efficient than old ones, which are often burdened with old debt. Reddy (2005) pointed out that the foreign banks and the new private sector banks have embraced technology right from the inception of their operations. This, therefore, allowed them adapt easily to the changes in technology whereas old private sector banks

had not been able to keep pace with these developments. Paxton (2007) asserted that while managers cannot change the number of years that the institution has been operating, it is possible for policy makers to create a financial landscape that is more amenable and supportive of the institutions. For example, networking and technical support may strengthen fledgling institutions.

In Portugal, Canhoto and Dermine (2003) quantified the impact of deregulation on technical efficiency over time across groups of banks from different generations, both old and new. The DEA results showed an improvement in efficiency for the overall sample over time of the order of 59 percent over the years 1990-1995. The new banks dominated the old ones in terms of efficiency, with an average efficiency score of 77 percent compared to 62 percent. They also found that the Malmquist productivity index for the new banks was higher than that for old banks, thus indicating a superior improvement in efficiency over time. Table 4.5 summarises the findings of the above studies reviewed.

Table 4.5: Application of Determinants of Efficiency – Summary of Contributions

Author	Country	Data and data period	Approach	Main findings
Chang *et al* (1998)	US	Banks 1984-1989	OLS and Tobit regression	Foreign-owned multinational banks operating in the US were less efficient than US-owned banks.
Hassan and Hunter (1996)	US	Banks	SFA	Domestically-owned US banks were more cost effective than Japanese banks operating in the US.
Peek *et al.* (1999)	US	Banks 1984-1997	OLS regression	Foreign banks that enter the US market are less efficient.

Table 4.5 Continued

Author	Country	Data and data period	Approach	Main findings
Shanmugam and Das (2004)	India	Banks 1992-1999	SFA	State bank groups and foreign banks were more efficient than domestically owned private banks.
Kraft and Tirtiroglu (1998)	Croatia	Banks 1994-1995	DEA	Newly organised private banks are more efficient than state-owned institutions.
Figueira *et al* (2006)	Various African countries	Banks 2001-2002	Parametric and non-parametric estimations	Foreign-owned banks are more efficient than domestic banks.
Mester (1996)	US	Banks 1991-1992	SFA	No significant relationship between size and efficiency.
Avkiran (1999)	Australia	Banks 1986-1996	DEA	No significant relationship between size and efficiency.
Bauer *et al.* (1993)	US	Banks	SFA	Inefficiency increased with size.
Chen *et al.* (2005)	China	Banks 1993-2000	DEA	Large and small banks were most efficient. Foreign ownership was positively correlated with bank-level efficiency while government ownership had the opposite influence on the banks.
Elyasiani and Mehdian (1995)	US	Banks 1979-1986	DEA	Both large and small banks showed similar efficiencies in 1979 but larger banks had higher efficiencies in 1986.
Paxton (2007)	Mexico	Semi-formal financial sector 2001	SFA	Large banks were more efficient than were small banks. New banks were more efficient than were old banks.
Rogers (1998)	US	Banks 1991-1996	DFA	Small banks were less profit efficient than were large banks.

Table 4.5 Continued

Author	Country	Data and data period	Approach	Main findings
Conhoto and Dermine (2003)	Portugal	Banks 1990-1995	DEA	New banks dominated old ones in terms of efficiency.

Source: Compiled by the author.

4.7 Summary

Over the years, DEA has been applied in financial sector efficiency studies. The literature on the efficiency of financial institutions in the US and other well developed countries is substantial. However, these particular studies are lacking for most developing countries, Botswana included. This study, therefore, contributes to a sparsely researched issue from the perspective of developing economies, particularly Botswana.

Most studies employed a variety of inputs and outputs in order to assess efficiency. The most common inputs employed include number of employees, fixed capital and total value of deposits. Outputs include mostly loans and other investments. Some studies established the inefficiency of financial institutions. Most studies adopted more than one approach to specifying inputs and outputs in order to check the sensitivity of the results.

Majority of studies showed that efficiency improved after financial liberalisation. This is because the main aim of financial liberalisation was to enhance the level of competition amongst the institutions and to exert more pressure in the efficient utilisation of their resources. Some studies employed the Malmquist index to assess financial sector productivity over time. The results showed that productivity improved

over most periods of investigation. Productivity gains were driven mostly by efficiency improvements rather than by technical progress.

Some studies used efficiency measures to establish their correlation with various efficiency determinants, such as ownership, size of the institution, the market specific and regulatory environments of their operation. Foreign banks and private banks were found to be more efficient than were domestic banks in developing nations. The existing literature differs on the relationship between size of the institutions and efficiency. Some of the studies did not detect any significant relationship between size of an institution and its efficiency. However, new firms were found to be more efficient than were old firms.

The literature shows no one study that assessed efficiency, productivity and their determinants together. This study will actually provide a complete picture of the situation where issues of static and dynamic efficiencies are taken into consideration. In sum, the contributions of this study to the existing literature are a) to add to the empirical literature on the efficiency of financial institutions for the case of a developing country, Botswana, and b) to extend the literature by assessing the efficiency, productivity and their determinants in the case of financial institutions.

The results found in these empirical studies will form a basis to explain some efficiency levels of financial institutions in Botswana. That is to say, the results of the above studies will help to compare their findings with those for Botswana. The studies reviewed above adopted DEA in carrying out their analysis. This study also adopts DEA to assess technical efficiency and productivity in Botswana's financial institutions.

The following chapter details the procedure of estimating the efficiency scores and productivity for Botswana's financial institutions by using DEA.

Chapter Five

Methodology

5.1 Introduction

It is common to measure the performance of financial institutions using financial ratios, but these measures do not capture the long-term performance of institutions (Sherman and Gold, 1985). In recent years, there has been a trend towards measuring the performance of financial institutions using the frontier analysis method, for example, Rangan *et al*. (1988); Favero and Papi (1995); Taylor *et al*. (1997); Kraft and Tirtiroglu (1998); Mendes and Rebelo (1999); Canhoto and Dermine (2003); McAllister and McManus (1993); Wheelock and Wilson (1999); Katib and Mathews (2000); Sathye (2001); Drake (2001); Das and Ghosh (2006). With frontier analysis, institutions that perform highly are separated from those that perform poorly. Such a separation is undertaken either by applying a non-parametric or parametric (econometric) frontier analysis to firms within an institution or industry. No consensus exists in the literature about the preferred method of analysis. In general, non-parametric analysis imposes a more flexible structure on the frontier function, but has the shortcoming of assuming no random error.

In this study, a non-parametric Data Envelopment Analysis model is adopted. Even though DEA assumes no random error, its advantages in the context of this study are five fold. One of them, which is more relevant to this study, is that DEA works well with small sample sizes. As mentioned before, there are relatively few financial institutions in Botswana. Thus the industry is less suited to analysis using parametric techniques than are financial systems in countries such as the United States, where there

are a very large number of institutions. DEA has frequently been used with small sample sizes, for example, Drake (2001) used a sample size of nine banks to study technical and scale efficiencies and productivity gains in UK banking. His models successfully discriminated between the efficiencies of different banks.

The second advantage of DEA relates to the fact that, unlike parametric frontiers, it does not require a specific form for the production function (Favero and Papi, 1995). Third, it places no restrictions on the functional form of the production relationship. This means that more than one production function can be utilised. Fourth, according to Coelli *et al.* (2005), DEA deals with individual units rather than population average and, therefore, utilizes *n* optimizations, one for each decision-making unit (hereafter DMU). Regressions used in econometric efficiency analyses utilise a single optimization. Hence, the DEA solution is unique for each DMU under investigation, which allows direct comparison to be made against a peer or a combination of peers. Finally, DEA uses data on various inputs and outputs (sources) and shows the magnitude of inefficiency. A deficiency of the econometric approaches is their inability to identify sources and estimate the inefficiency amounts associated with these sources.

This chapter is structured as follows: Section 5.2 presents a framework for measuring efficiency by the use of DEA. A DEA model is also formulated in this section. Section 5.3 presents the measurement of scale efficiency. A review of peers and targets using the DEA method is presented in section 5.4. Section 5.5 focuses on the theoretical background of the Malmquist indices and how to measure them. Section 5.6 deals with the sensitive issue of the specification of inputs and outputs employed in the evaluation of efficiency and productivity in the financial institutions. The issue of the sample, data

and its sources is discussed in section 5.7. The penultimate section gives a review of the determinants of efficiency based on developing and developed countries. The last section summarises the chapter.

5.2 Efficiency Measurement Using DEA[10]

DEA is a flexible non-parametric efficiency measure that is based on plotting inputs and outputs in a multidimensional space. It is typically used to measure technical efficiency and scale efficiency. According to Coelli *et al.* (2005) technical efficiency is defined as the ability of a firm to use minimal amount of inputs to produce the optimum output. With efficient production, it is impossible to produce a set of outputs without an alteration of inputs. In a DEA model, technical inefficiency can be deduced by using either input or output orientation measures. An input orientation measure identifies technical inefficiency as a proportional reduction in input usage while holding output constant. In contrast, an output-orientated measure identifies technical inefficiency as a proportional increase in output with input levels held fixed (Coelli *et al*. 2005). Most studies in financial institutions, including the present one, follow the input-orientated approach due to the interest in the sector in reducing costs. For example, Fukuyama (1995) used an input-orientated approach to measure the efficiency and productivity in the Japanese banking system, and Worthington (2000) employed the same technique to measure technical efficiency and technological change in Australian building societies.

DEA compares the output and input levels of all DMUs in the analysis set, and defines the efficient frontier by identifying the relatively best practice DMUs (Emrouznejad 1995-2000). It specifies the relatively inefficient units and their level of inefficiency

[10]Sections 5.2-5.4 are based on Thanassoulis (2001).

compared to the relatively efficient ones (the best practice units). In this study, best practice defines an institution that uses the least amount of resources to provide its volume of service at or above the level known as the business standard (Ozkan-Gunay and Tektas, 2006). The best practice units are relatively efficient and are identified by a DEA efficiency rating of unity, and inefficient units are identified by an efficiency rating of less than unity. For each inefficient DMU, DEA identifies an efficiency reference set of relatively efficient units, with which inefficient ones have been most directly compared in calculating their efficiency rates. This comparison helps determine the amount of resource over-use and resource under-use by inefficient DMUs.

The DEA approach is based on a mathematical model developed by Charnes *et al.* (1978). Since then, several different mathematical programming DEA models have been proposed in the literature (Barr *et al.* 1999). Each of these models seeks to establish which of the *N* DMUs determines the envelopment surface (the best practice efficiency frontier). The geometry of this envelopment surface is prescribed by the specific DEA model adopted. In order to make a detailed analysis of inefficient units and take corrective actions to improve their performance, this study uses the following form for the analysis, firstly, assuming constant returns to scale (CRS).

$$\text{Min} \qquad l_0 - \varepsilon\left[\sum_{i=1}^{M} S_i^- + \sum_{r=1}^{S} S_r^+\right] \tag{5.1}$$

$$\text{Subject to:} \qquad \sum_{f=1}^{N} \lambda_f x_{if} = l_o x_{if_o} - S_i^- \qquad \text{where} \quad i = 1...M$$

$$\sum_{f=1}^{N} \lambda_f y_{rf} = S_r^+ + y_{rf_o} \qquad \text{where} \quad r = 1...S$$

$$\lambda_f \geq 0,\ f = 1...N, S_i^-, S_r^+ \geq 0 \forall i \text{ and } r$$

Where x_{if} and y_{rf} are levels of the i[th] input and r[th] output, respectively, for DMU f . N is the number of DMUs and each consumes varying amounts of M different inputs to produce S different outputs. ε is a very small positive number (non-Archimedean) used as a lower bound to inputs and outputs. λ_f shows the contribution of DMU f in deriving the efficiency of the rated DMU f_o (a point on the envelopment surface). S_i^- and S_r^+ are slack variables showing extra savings in input i and extra gains in output r. l_o is the radial efficiency factor that shows the possible reduction of inputs for DMU f_o. In other words, it is an efficiency rating that measures the distance that a particular DMU lies from the frontier. If l_o^* (optimal solution) is equal to one and the slack values are both equal to zero then DMU f_o is efficient. Positive S_i^- or S_r^+ values at the optimal solution means that the corresponding input or output of DMU f_o can improve further, after the input levels have been contracted to the proportion l_o^*.

The CRS model is only appropriate for measuring technical efficiency[11] among firms that are operating at their optimal scale. However, this assumption is unrealistic empirically given input constraints and imperfect competition; see for example, McAllister and McManus (1993); Wheelock and Wilson (1999); Katib and Mathews (2000). Banker *et al.* (1984) suggested an extension of the above model to take into account variable returns to scale (VRS). The VRS model does not make the assumption that all DMUs are operating at an optimal scale, by incorporating a convexity constraint. This constraint results in a convex hull that envelops the data points more compactly resulting in efficiency scores greater or equal to those in a CRS model.

[11] In a CRS model, efficiency is referred to as technical efficiency.

VRS model permits constant but also increasing and decreasing returns to scale at varying scale sizes. On the one hand, production correspondence is said to exhibit increasing returns to scale if a radial expansion in inputs leads to a more than proportionate radial increase in output levels. On the other hand, if a radial increase in output level is less than proportionate to an increase in input levels, then decreasing returns to scale are exhibited. If a convexity constraint is incorporated in model (5.1), a DEA (VRS) model can be formally written as follows:

$$\text{Min} \qquad l_o - \varepsilon\left[\sum_{i=1}^{M} S_i^- + \sum_{r=1}^{S} S_r^+\right] \tag{5.2}$$

$$\text{Subject to:} \qquad \sum_{f=1}^{N} \lambda_f x_{if} = l_o x_{if_o} - S_i^- \qquad \text{where} \quad i = 1...M$$

$$\sum_{f=1}^{N} \lambda_f y_{rf} = S_r^+ + y_{rf_o} \qquad \text{where} \quad r = 1...S$$

$$\sum_{f=1}^{N} \lambda_f = 1$$

$$\lambda_f \geq 0,\ f = 1...N, S_i^-, S_r^+ \geq 0 \forall i \text{ and } r$$

This model differs from model (5.1) in that it includes the so-called convexity constraint, $\sum_{f=1}^{N} \lambda_f = 1$. The convexity constraint prevents any interpolation point constructed from the observed DMUs from being scaled up or down to form a reference point, which is not permissible under the VRS. In this model, the set of λ values minimise l_o to l_o^* and identify a point within the VRS model whose input levels reflect the lowest proportion of l_o^*. At l_o^* the input levels of DMU f_o can be uniformly contracted without detriment to its output levels. Therefore, DMU f_o has efficiency

equal to l_o^*. The solution to model (5.2) is summarized as follows: DMU f_o is pareto-efficient if $l_o^*=1$ and $S_r^{+*}=0,\ r=1...S,\quad S_i^{-*}=0,\quad i=1...M$. Technical efficiencies assessed under VRS are referred to as pure technical input efficiency as they are net of any scale effects.

If the convexity constraint in model (5.2) is dropped, model (5.1) is obtained, which is technical input efficiency under CRS. This implies that the pure technical input efficiency of a DMU is always greater or equal to its technical input efficiency. Under both CRS and VRS assumptions, the resulting scale efficiency can be measured.

5.3 Scale Efficiency

One of the major advantages of DEA over other methods is its ability to determine scale efficiency. In most cases, the scale of operation of the firm may not be optimal. The firm involved may be too small in its scale of operation, which might fall within the increasing returns to scale part of the production function. Similarly, a firm may be too large and may operate within the decreasing returns to scale part of the production function. In both cases, efficiency of the firms may be improved by changing their scale of operation. If the underlying production technology is a constant returns to scale technology, then the firm is automatically scale efficient. Under the CRS and VRS assumptions, technical efficiency scores for each method can be compared. The ratio illustrates scale efficiency, which is the impact of scale size on the productivity of a DMU. Formally, the scale input efficiency of DMU f_o is given as:

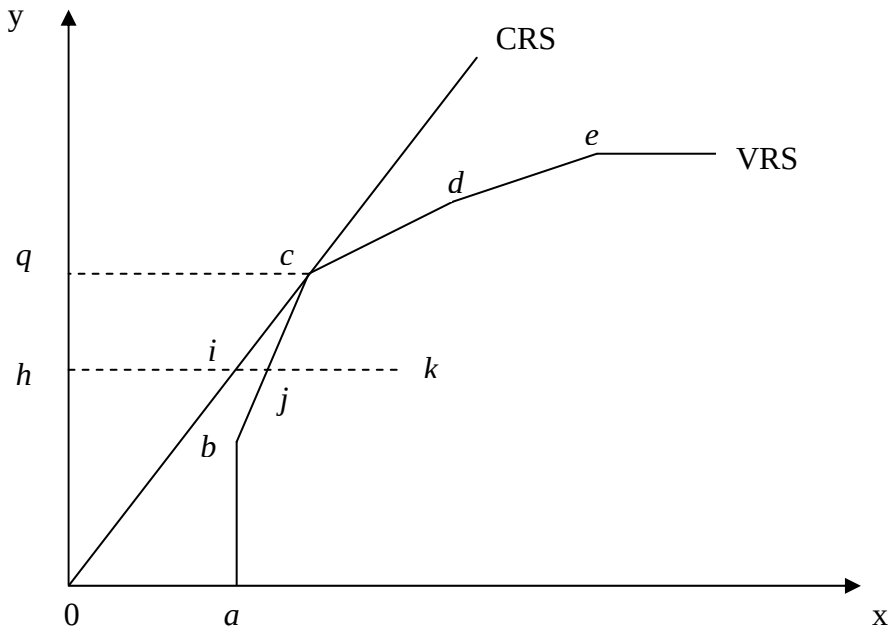
$$\frac{TIE}{PTIE} \tag{5.3}$$

Where, *TIE* and *PTIE* are technical input efficiency and pure technical input efficiency of DMU f_o respectively. Scale efficiency measures the discrepancy between the efficiency rating of a DMU under CRS and VRS. The VRS rating controls the scale size of the DMU. Since pure technical efficiency is always greater than or equal to technical efficiency, it means that scale efficiency is less than or equal to unity according to (5.3). If the technical efficiency and pure technical efficiency of a DMU are equal, then scale efficiency is equal to unity. This means that irrespective of whether or not scale size is controlled (since it gives the same view of a DMU's technical efficiency), scale size has no impact on efficiency. If CRS is less than VRS, then scale efficiency will be below unity, meaning that the scale of operation does impact on the productivity of the DMU.

The discussion of CRS, VRS and scale efficiency is illustrated in Figure 5.1, following Favero and Papi (1995) and Coelli *et al.* (2005). For simplicity, scale inefficiency calculations are illustrated using one-input (x) and one-output (y). The DEA frontier under the CRS assumption is shown by a straight line 0*ic*, whereas the DEA frontier assuming VRS is given by the *abcde* convex curve. The firms operating at points a*bcde* are all efficient because they are operating on the production frontier. However, it can be noted that even though these five firms are all efficient, they are not equally productive due to the scale effects. For example, firm *b* is operating on the increasing returns to scale portion of the production frontier. It could become more productive by increasing its scale of operation towards point *c*. Firms *d* and *e* are operating on the decreasing returns to scale portion of the production frontier. They can each become more productive by decreasing their scale of operation towards point *c*. The firm operating at point *c* is unable to become more productive by changing its scale of

operation. It is said to be operating at the most productive scale size (MPSS), or, equivalently, at the technically optimal productive scale.

Figure 5.1: Measuring Technical and Scale Efficiency



A scale efficiency measure can also be used to indicate the amount by which productivity can be increased by moving to the point of the technically optimal productive scale. In the graph, an inefficient DMU is represented by point *k*. Under the CRS assumption the input oriented technical inefficiency for this point is *ki*, whereas under the VRS assumption, technical inefficiency would only be *kj*.

The difference between the two measures, *ij*, is due to scale inefficiency. In ratio form, these concepts can be expressed as:

TIE = *hi/hk*

PTIE = *hj/hk*

SE = *hi/hj*

Where SE denotes the scale efficiency and other variables are as defined previously. All these measures are bounded by zero and one. For a DMU that is on the frontier (efficient DMU), such as that denoted by point *c*, its technical efficiency ratio under both CRS and VRS is given by *qc/qc*, which is equal to one. The scale efficiency would also equal one in this case.

5.4 Identification of Peers and Targets in DEA

Inefficient DMUs can identify target input-output levels that would give them pareto-efficiency and efficient peers that they could emulate to improve their performance.

5.4.1 Targets

The following discussion is based on model (5.2), which assesses the pure technical input efficiency of DMU f_o. Superscript * denotes the optimal levels of variables in model (5.2) with respect to DMU f_o. A set of pareto-efficient input-output levels are x_i^t and y_r^t where superscript *t* denotes target inputs/outputs. These are defined as follows:

$$x_i^t = \sum_{f=1}^{N} \lambda_f^* x_{if} = l_o^* x_{if_o} - S_i^{-*} \quad \text{where} \quad i = 1....M$$

$$y_r^t = \sum_{f=1}^{N} \lambda_f^* y_{rf} = S_r^{+*} + y_{rf_o} \quad \text{where} \quad r = 1....S \qquad (5.4)$$

The input-output levels in (5.4) are the co-ordinates of the point on the efficient frontier used as a benchmark for evaluating DMU f_o. Therefore, when a DMU is pareto-inefficient, the input-output levels in (5.4) can be used as the basis for setting its targets to improve its performance.

5.4.2 Efficient Peers

From model (5.2), efficient peers for DMU f_o are those DMUs that correspond to positive $\lambda^* s$. The practical significance of efficient peers is seen by looking again at targets in (5.4), which model (5.2) yields for DMU f_o. The target level for DMU f_o on a given input (output) is a linear combination of the levels of that input (output) at its efficient peers. Again from (5.4), l_o^* of DMU f_o is the maximum of the ratios $\frac{x_i^t}{x_{if_o}}$. The target input-output levels of DMU f_o and its efficiency rating are therefore exclusively dependent on the observed input-output levels of its efficient peers and on no other DMU.

When a DMU is pareto-efficient, it is important to know how frequently that DMU is used as an efficient peer, and how strong the influence is on the targets estimated for inefficient DMUs. The relative frequency of the use of a pareto-efficient DMU as a peer has two practical uses. Firstly, it enhances confidence that a DMU that is a frequent efficient peer is genuinely a well performing DMU, because it outperforms other DMUs. Secondly, such a DMU is likely to be a better role model for less efficient DMUs to emulate. This is because its operating practices and environment match more closely with most DMUs than is the case for a pareto-efficient DMU, which is rarely an efficient peer. It is expected that a DMU featuring frequently as an efficient peer to

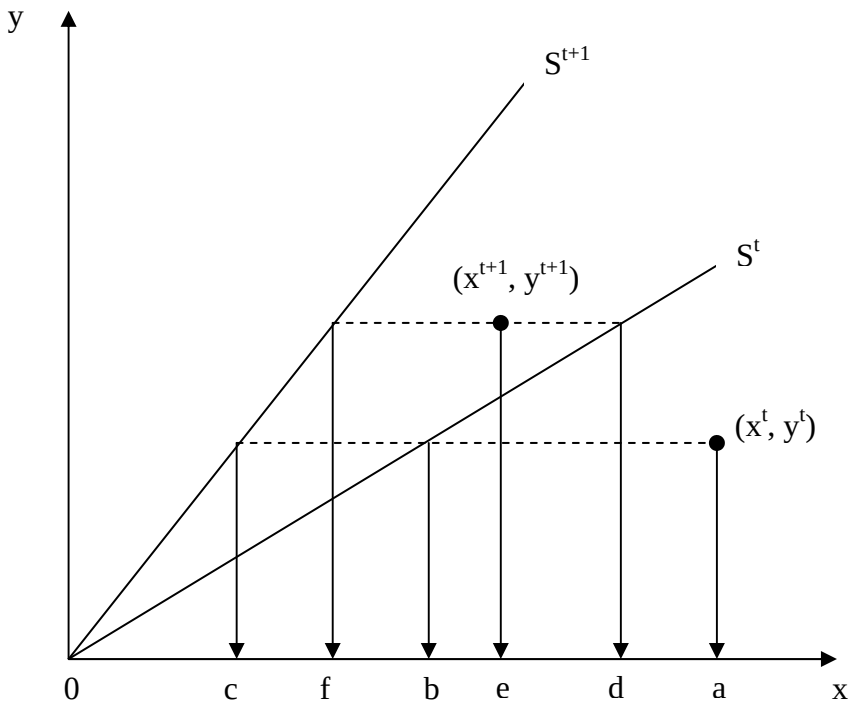
inefficient DMUs will also have a greater impact on the targets estimated for the inefficient DMUs.

5.5 Assessing Productivity Change

DEA only provides a measure of the efficiency of firms relative to the best-practice firms in the sample (static efficiency). Therefore, there is a need to provide evidence of increases in absolute efficiency, that is, whether the efficiency of individual institutions or institutions as a whole has improved over time (dynamic efficiency). Higher efficiency levels from one period to another do not necessarily suggest that the institution has achieved higher productivity, since the technology may have changed. The level of output an institution produces increases due to technological changes, and this causes the production frontier to shift upwards as more outputs are produced from the same level of inputs. Thus, productivity improvement over time may be due to either technical efficiency improvements (catching up with the frontier) or technological improvements (as the frontier shifts up) or both.

Productivity change is illustrated in Figure 5.2, following Fare *et al.* (1990). In the diagram, the efficient output level (y) is produced using the input level (x) under the assumption that the frontier can shift over time. The frontier labelled S^t denotes the current period and S^{t+1} is for the next period. The relative movement of any institution over time depends on both its position relative to the corresponding frontier (technical efficiency) and the position of the frontier itself (technical change).

Figure 5.2: Measuring Productivity Change Overtime



For any financial institution in period (t), represented by an input-output bundle (x^t, y^t), an input-orientated efficiency can be measured by the distance ratio ob/oa. This means that inputs can be reduced in order to make production technically more efficient in period (t). In period (t+1), inputs should be multiplied by the distance ratio od/oe in order to achieve comparable technical efficiency to that of period (t). Since the frontier has shifted, od/oe is greater than one even though it is technically inefficient.

Given the many inputs and outputs that financial institutions consume/produce, the above illustration of productivity change may be difficult. Other methods have since been introduced, among them the Malmquist productivity change index (Thanassoulis, 2001). Following Thanassoulis (2001), the Malmquist productivity change index (MI) may be formally stated as follows:

$$MI^{t+1}\left(y^{t+1},x^{t+1},y^{t},x^{t}\right)=\left[\frac{D^{t}\left(y^{t+1},x^{t+1}\right)}{D^{t}\left(y^{t},x^{t}\right)}\times\frac{D^{t+1}\left(y^{t+1},x^{t+1}\right)}{D^{t+1}\left(y^{t},x^{t}\right)}\right]^{0.5} \quad (5.5)$$

Where *MI* is the productivity of the most recent production point using period (t+1) relative to the earlier production using period (t) technology, *Ds* denotes input distance functions, *y* is the level of outputs and *x* is the level of inputs. A value of *MI* that is greater than unity indicates a growth in total productivity over the two periods. The Malmquist index in (5.5) can be decomposed into a catch-up component and a boundary-shift component as follows:

$$MI^{t+1}\left(y^{t+1},x^{t+1},y^{t},x^{t}\right)=\underbrace{\frac{D^{t+1}\left(y^{t+1},x^{t+1}\right)}{D^{t}\left(y^{t},x^{t}\right)}}_{'Catch-up'component}\times\underbrace{\left[\frac{D^{t}\left(y^{t+1},x^{t+1}\right)}{D^{t+1}\left(y^{t+1},x^{t+1}\right)}\times\frac{D^{t}\left(y^{t},x^{t}\right)}{D^{t+1}\left(y^{t},x^{t}\right)}\right]^{0.5}}_{'Boundary-shift'component} \quad (5.6)$$

That is to say, the Malmquist index can be decomposed into technological change (TC), technical efficiency (TE) and scale efficiency (SE). Formally;

$$MI\ (y_{t+1},\ x_{t+1},\ y_t,\ x_t) = TC \times TE \times SE \quad (5.7)$$

The catch-up component compares the closeness of financial institution f_o in each period to that of another period's efficiency boundary. If the catch-up component value is equal to unity, then financial institution f_o will have the same distance from the respective boundaries in periods (t) and (t+1). A catch-up value that is greater than unity means that financial institution, f_o will perform more efficiently in period (t+1) than in

period (t). Similarly, a catch-up value of less than one indicates that financial institution, f_o has become less efficient in period (t+1) compared to that in period (t).

On the one hand, for the boundary-shift component, a value of one represents a productivity gain by a financial institution f_o, implying that, for a given amount of output, it uses lower input levels in period (t+1) than in period (t). On the other hand a boundary shift value that is less than one means productivity losses are incurred by the financial institution, f_o, in that it uses more inputs in period (t+1) than in period (t) to produce the same amount of output. When the boundary shift is equal to one, this means that there is neither a productivity gain nor loss in both periods.

In order to calculate the Malmquist indices it is necessary to solve several sets of linear programming problems. It is assumed that there are *N* financial institutions and that each consumes varying amounts of *M* different inputs to produce *S* different outputs. The objective is to construct a nonparametric envelopment frontier over the data points such that all observed points lie on or below the production frontier. Assuming constant returns to scale, then the following models for periods (t) and (t+1) can be formulated:

$$\text{Min} \quad l_o \tag{5.8}$$

$$\text{Subject to:} \quad \sum_{f=1}^{N} \lambda_f x_{if_o}{}^{t} - l_o x_{if_o}{}^{t} \le 0 \qquad \text{where} \quad i = 1....M$$

$$\sum_{f=1}^{N} \lambda_f y_{rf}{}^{t} \ge y_{rf_o}{}^{t} \qquad \text{where} \quad r = 1....S$$

$$\lambda_f \ge 0, f = 1....N \ge 0$$

$$\text{Min} \quad l_o \tag{5.9}$$

$$\text{Subject to:} \quad \sum_{f=1}^{N} \lambda_f x_{if_o}{}^{t+1} - l_o x_{if_o}{}^{t+1} \leq 0 \qquad \text{where} \quad i = 1....M$$

$$\sum_{f=1}^{N} \lambda_f y_{rf}{}^{t+1} \geq y_{rf_o}{}^{t+1} \qquad \text{where} \quad r = 1....S$$

$$\lambda_f \geq 0, \; f = 1....N \geq 0$$

Where x_{if} and y_{rf} are levels of the i^{th} input and r^{th} output for financial institution f, respectively. The value of l_o will be the efficiency score for financial institution *f*. In (5.8) and (5.9), each financial institution's production points are compared with technologies from the same time period. Constant returns to scale specification is only appropriate where all the DMUs are operating at the optimal scale (which is unlikely where capital requirements and other regulatory constraints exist). Where this is not the case, the measures of technical efficiency obtained by the constant returns to scale form will be confounded by the presence of scale efficiencies. The procedure itself involves calculating additional linear programs where convexity constraint is introduced to equations 5.8 and 5.9. The cross-time period radial technical input efficiencies are then calculated as follows:

$$\text{Min} \quad l_o \tag{5.10}$$

$$\text{Subject to:} \quad \sum_{f=1}^{N} \lambda_f x_{if}{}^{t} - l_o x_{if_o}{}^{t+1} \leq 0 \qquad \text{where} \quad i = 1....M$$

$$\sum_{f=1}^{N} \lambda_f y_{rf}{}^{t} \geq y_{rf_o}{}^{t+1} \qquad \text{where} \quad r = 1....S$$

$$\lambda_f \geq 0,\ f = 1....N \geq 0$$

$$\text{Min} \qquad l_o \qquad (5.11)$$

$$\text{Subject to:} \qquad \sum_{f=1}^{N} \lambda_f x_{if}{}^{t+1} - l_o x_{if_o}{}^{t} \leq 0 \qquad \text{where} \quad i = 1....M$$

$$\sum_{f=1}^{N} \lambda_f y_{rf}{}^{t+1} \geq y_{rf_o}{}^{t} \qquad \text{where} \quad r = 1....S$$

$$\lambda_f \geq 0,\ f = 1....N \geq 0$$

Models (5.10) and (5.11) present the cross-time period radial technical input efficiency of financial institution f_o. By running these programs with the same data under constant returns to scale and variable returns to scale assumptions, measure of overall technical efficiency and pure technical efficiency are obtained. Dividing the overall technical efficiency by pure technical then yields a measure of scale efficiency (see also Section 5.3 of this chapter). Using these models and Fare *et al.* (1994), it is thus possible to provide efficiency and productivity indices for each firm and a measure of technical progress over time. These are: (a) the technical efficiency change (TEC) measure based on constant returns to scale technology; (b) the measure of technological change (TC); (c) the measure of pure technical efficiency change (PTEC) based on variable returns to scale technology; (d) the measure of scale efficiency change (SEC); and (e) total factor productivity change (TFPC), which quantifies the degree of productivity. If TFPC > 1, then it can be argued that productivity gains have occurred, but if it is less than one then the firm has incurred productivity losses during the period under investigation. Technical efficiency follows an upward trajectory if TEC exceeds one and vice versa.

Similarly, if TC is more than one, this can be seen as evidence of technical progress, but if TC is less than one, the outcome could be technological regress.

The main sources of productivity gain or losses can be identified by analysis of the magnitudes of TEC and TC. For instance, if TEC is greater than TC, then productivity gains are more likely to be as a result of improvements in efficiency. Conversely, if TEC<TC then productivity gains are mostly attributable to technological progress. Given that overall technical efficiency is the product of pure technical change and scale efficiency (i.e., TEC = PTEC x SE), the main determinants of efficiency changes can be numerically traced as follows: if PTEC>SE, then an improvement in pure technical efficiency is highly likely to explain most of the efficiency changes. However, if PTEC<SE, it is highly likely that an improvement in scale efficiency has generated the changes in the resulting efficiency changes.

5.6 Specification of Inputs and Outputs

No consensus exists within the literature about the specification of outputs and inputs in frontier modelling. However, it is commonly acknowledged that the choice of variables in efficiency studies significantly affects the results; see for example, Das and Ghosh (2006); Sathye (2001); Drake (2001). The problem is compounded by the fact that variable selection is often constrained by the paucity of data on relevant variables. The input and output measurements are especially difficult because many of the financial services are jointly produced, and prices are typically assigned to a bundle of financial services. Three approaches dominate the literature: the production approach, the intermediation approach and, more recently, the modern approach (Das and Ghosh, 2006). The first two approaches apply the traditional microeconomic theory of the firm

to banking, and differ only in the specification of banking activities. The third approach goes a step further and incorporates some specific activities of banking into the classical theory, and thereby modifies it.

The production approach, pioneered by Benston (1965), views financial institutions as the providers of services to customers. The inputs set under this approach include physical variables, such as labour, materials, space or information systems or their associated costs. This is because only physical inputs are needed to perform transactions, process financial documents or provide counselling and advisory services to customers. Interest costs are excluded from this approach on the grounds that only the operational process is of relevance. The output under this approach represents the services provided to customers, and is measured by the number and type of transactions, documents processed or specialized services provided over a given period. In case of the non-availability of detailed transaction flows of data, they are substituted by the data on the number of deposit and loan accounts as a surrogate for the level of services provided. Berger and Humphrey (1997) consider that this approach has primarily been employed in studying the efficiency of bank branches.

According to Favero and Papi (1995); Das and Ghosh (2006); Sathye (2001); for example, under the intermediation approach financial institutions are regarded as intermediators that transform and transfer financial assets from savers to borrowers. Financial institutions produce intermediation services through the collection of deposits and other liabilities, and their application in interest earning assets, such as loans, securities and other investments. This approach includes both operating and interest expenses as inputs, whereas loans and other major assets count as outputs. There is,

however, a longstanding debate on whether deposits should be regarded as inputs or outputs. The available literature such as Favero and Papi (1995) and Das and Ghosh (2006) on the identification of financial institutions' output led to the establishment of the asset, user cost and value-added approaches, which can be viewed as variants of the intermediation approach.

The asset approach is a reduced form of modelling institution activity, focusing exclusively on the role of institutions as financial intermediaries between depositors and final users of assets. Inputs in this approach include deposits and other liabilities, together with real resources (labour and capital), whereas bank assets, such as loans comprise output (Sealy and Lindley, 1977). The user cost approach determines whether a financial product is an input or an output on the basis of its net contribution to the institutions' revenue. If the financial returns on an asset exceed the opportunity cost of the funds, or alternately, if the financial costs of a liability are less than the opportunity cost, they are considered as outputs; otherwise they are considered as inputs (Hancock, 1985). Finally, the value-added approach identifies those balance sheet categories (assets or liabilities) as outputs that contribute to the institution's value added. In general, under this approach, the major categories of deposits and loans are viewed as outputs because they are responsible for a significant proportion of value added.

According to Das and Ghosh (2006), the modern approach seeks to integrate some measure for risk, agency costs and quality of an institution's services. One of the most innovative facets of this approach is the introduction of the quality of an institution's assets and the probability of an institution's failure in the estimation of costs. This

approach is best represented through the ratio based CAMEL approach[12] (Adongo *et al*. 2005; Barr *et al*. 1999). In this approach, the individual components of CAMEL are derived from the financial tables of the institutions, and are used as variables in the performance analysis. According to Leightner and Lovell (1998), the operating approach (or income-based approach) views financial institutions as business units, with the final objective of generating revenue from the total costs incurred from running a business. Accordingly, it defines an institution's output as total revenue (interest and non-interest) and inputs as total expenses (interest and operating expenses).

The appropriateness of each approach varies according to the circumstances. Based on practical considerations, and to examine the robustness of the estimated efficiency scores under various alternatives, different approaches are adopted. Since there is a longstanding debate on whether deposits should be regarded as inputs or outputs, this study adopts both the intermediate approach and value-added approach in order to check the sensitivity of the results if deposits are treated as inputs (as in the intermediate approach) and when deposits are treated as outputs (as in the value-added approach). The production approach excludes interest costs, but, according to Avkiran (2000), interest costs form a larger part of costs for financial institutions. The study, therefore, adopts the operating approach in order to analyse the efficiency of financial institutions based on interest income and expenditure. No complete data for CAMEL rating is available for different financial institutions in Botswana, and, therefore, the modern approach of analysis could not be adopted for this study. The present study, therefore, focuses on three major approaches: 1) the intermediation approach, 2) the value-added approach and 3) the operating approach.

[12] CAMEL is the acronym for Capital adequacy, Asset quality, Management, Earnings and Liquidity.

Under the intermediation approach, deposits, labour (salaries) and capital (defined as operating and administrative expenses related to fixed assets) are treated as inputs for producing loans and investment. Previous banking efficiency studies that adopted this approach in developing countries are, *inter alia*, Sathye (2003) and Paxton (2006). Under the value-added approach, labour (salaries), capital (operating and administrative expenses related to fixed assets) and interest expenses are used as inputs producing outputs like deposits, loans and investments. Under the operating approach, three different types of inputs are considered: interest expenses, employee expenses and other operating expenses excluding employee expenses. The relevant outputs are interest-related revenues and non-interest revenues emanating mostly from commission, exchange, brokerage and others. Selected inputs and outputs under various alternative approaches employed in the study are summarized in Table 5.1.

Table 5.1: Input/Output Variables under the Three Approaches (All Measured in Thousands of Pula (P))

Approach	Inputs	Outputs
Intermediation approach	Deposits Labour (salaries) Capital related operating expenses	Loans Investment
Value-added	Labour (salaries) Capital related operating expenses Interest expenses	Loans Investment Deposits
Operating approach	Interest expenses Labour(salaries/employee expenses) Capital related operating expenses	Interest income Non-interest income

5.7 Sample and Data Sources

This study examines major financial institutions within the financial system of Botswana. As mentioned before, DEA is suitable for the analysis of small sample sizes. There are relatively few financial institutions in Botswana, especially non-bank institutions, partly due to the small size of the domestic market. Therefore, distinguishing the banking institutions from the non-bank institutions will lead to a loss of data. For instance, there is only one building society in Botswana. Sufian (2006) asserts that the best way to handle few financial institutions is to assess their efficiency as a group. However, the informal sector is not included due to problems associated with the availability and/or accuracy of financial statement data (Mmolawa, 2003). The Bank of Botswana and Public Debt Service Fund are also excluded because they provide funding to the government or banks, but do not lend directly to the private sector. Another type of institution not included in the sample is the insurance companies, because their assets and liabilities have special characteristics that differ from those of other financial institutions (Berger and Humphrey, 1997). In order to obtain a comprehensive sample, the study uses secondary data for major financial institutions in Botswana. The data are obtained from their annual financial statements available in their annual reports for the years 2001-2006, for which relatively reliable bank balance statements are available.

5.8 Determinants of Efficiency

An observation that firms are technically inefficient might not be a useful exercise unless additional effort is made to identify the determinants of such inefficiency. Hence, in another stage of the analysis, the determinants of firm level inefficiency are investigated. The traditional two-stage approach has been mostly applied in the

literature to evaluate the determinants of inefficiency, for example, Worthington (1999), Sathye (2001); Paxton (2006). In this approach, the efficiency indices estimated in the first step are regressed on a number of firm characteristics by ordinary least squares.

In this particular study, a univariate approach is employed to measure the relative efficiency of financial institutions segmented on the basis of factors such as size, ownership status, age and non-performing loans. Such an approach has been employed in empirical studies on financial institution efficiency by, for example, Wheelock and Wilson (1999) and Das and Ghosh (2006). A univariate approach does not require regression to analyse the determinants of efficiency and, therefore, fits this study well due to the limited sample size. Regression analysis requires a large sample size in order to obtain enough degrees of freedom. Under the univariate approach, the estimates of technical efficiency obtained from the DEA model are cross-tabulated and analysed to examine how technical efficiency varies by size of the institution, ownership, age and so on. The discussion and *a priori* expectations of these factors are discussed below.

(a) Size Factor

According to scale economies in microeconomic theory, size (beyond a certain point) is negatively related to efficiency. Bigger institutions, after crossing a certain threshold, may suffer from scale diseconomies due to difficulties in managing a larger entity. Research by Ferrier and Lovell (1990) on a sample of 575 US commercial banks found that 88 percent of banks exhibited increasing returns to scale. The most efficient banks in the sample belonged to the smallest size class. However, no consistent picture emerges from empirical studies that have investigated the relationship between the size of an institution and its productive, profit or cost efficiency, because larger firms in a concentrated market may be able to influence prices so that they appear to be more

efficient (Mester, 1996). In this study, the size of an institution is determined by the amount of its assets.

(b) Ownership

The reasons why different ownership structures of institutions may produce different efficiency levels have been extensively explored in the finance literature, for example, Jemric and Vujcic (2002); Sathye (2003); and Shanmugam and Das (2004). The dominant model of the effect of ownership utilizes the principal agent framework to highlight the importance of the extent to which management is constrained by capital market discipline. The theoretical argument is that a lack of capital market discipline weakens owners' control over management, enabling the latter to pursue their own interests and thus giving fewer incentives to be efficient. Cross-country findings, for example, Caprio and Peria (2000), have reported that, in general, increased government ownership is a deterrent to the development of the banking system.

c) Age of the Financial Institution

The age of a financial unit is also regarded as being related to efficiency in the literature (Paxton 2006). Mester (1996) states that according to the learning by doing hypothesis, age is expected to positively impact on efficiency since production improves over time. However, other empirical analyses, for example, Das and Ghosh (2006), reveal that new institutions tend to be more technically efficient. The argument is that, economically, new institutions with their leaner and more skilled workforce are better placed to implement sophisticated risk-management techniques and operational innovations, and are also well equipped to internalise recent innovations in the market.

d) Non-Performing Loans

An increase in non-performing loans is often linked to the 'bad management hypothesis' (Berger and DeYoung, 1997). This is because increases in non-performing loans tend to be followed by decreases in measured efficiency, suggesting that high levels of loans cause institutions to increase spending on monitoring, administering and selling off these loans. They therefore, possibly become more diligent in administering the portion of their loan portfolio that is currently performing. Das and Ghosh (2006) showed that, irrespective of the choice of inputs and outputs a high level of non-performing loans is associated with low efficiency estimates and vice versa.

5.9 Summary

In this chapter an overview of the conceptual framework that underpins efficiency and productivity measurement has been provided. Despite the shortcoming that DEA does not assume a random error, it still enables this study to fulfil its objectives. The preferred nonparametric DEA method helps to distinguish between three different types of efficiency, such as technical, pure technical and scale efficiencies, which parametric methods fail to address. This model provides an overall efficiency index and a resulting ranking of DMUs. It helps identify areas of input overuse and/or output underproduction. Identification of peers and targets has also been discussed in this Chapter. These issues will be useful in the improvement of inefficient firms through emulation and targeted production.

Since this study deals with panel data, it is pertinent to check changes in the productivity of firms during the period of study; hence the concept of productivity analysis has also been discussed in this chapter. Finally, the chapter reviewed the major

determinants of inefficiency as flagged in the literature in the context of financial institutions. These include size factor, ownership, age and non-performing loans. These factors are important for this study, as they will help to explain efficiency differences among institutions and they will also form a basis for the policy recommendations at the end of the study. Of course, there are a number of additional factors that are also thought to have an impact on the efficiency of financial services. For example, Rangan *et al*. (1988) included an index of product diversity in their DEA study of US commercial banks, and Ferrier and Lovell (1990) incorporated the average size of loans and deposit accounts across a range of US deposit-taking institutions. These studies highlight the fact that there may be a degree of conflict between strictly efficient performance and compliance with capital adequacy requirements and other regulations. Unfortunately, there is no data set available reflecting all factors relevant to calculating financial institution efficiency at the present time.

Having described how DEA works in estimating efficiency and productivity indices, the next chapter applies this technique to analyse the efficiency and productivity of financial institutions in Botswana. This involves running the data on DEA software and obtaining the resultant indices. The results are analysed and presented in the following chapter.

Chapter Six
Empirical Results and Analysis

6.1. Introduction

This chapter presents empirical findings on the various issues outlined in the previous chapters. In Chapter Five the DEA approach of measuring the efficiency of financial institutions relative to other institutions was discussed. Using this information, two primary issues are addressed in the computation of efficiency indices in this study. The first is technical efficiency and its constituent components; pure technical efficiency and scale efficiency. The second is Malmquist indices of productivity growth and its decomposition into a 'catching-up' effect and a 'frontier shift' effect.

As discussed in the previous chapter, it is apparent that financial institutions undertake simultaneous functions. However, based on practical considerations, and to examine the robustness and sensitivity of the estimated efficiency scores under various alternatives, the present study focuses on three major approaches: 1) intermediation approach, 2) value-added approach and 3) operating approach. Under the intermediation approach, deposits, labour (salaries) and capital (defined as operating and administrative expenses related to fixed assets) are treated as inputs for producing loans and investments. Previous banking efficiency studies that adopted this approach in developing countries include, *inter alia*, Sathye (2003) and Paxton (2006).

The value-added approach employs labour (salaries), capital (operating and administrative expenses related to fixed assets) and interest expenses as inputs producing outputs such as deposits, loans and investments. Under the operating approach, three different types of inputs are considered: interest expenses, employee expenses and other operating expenses. The relevant outputs are interest-related revenues and non-interest revenues emanating mostly from commission, exchange, brokerage and others. This selection of inputs and outputs follows the work of Das and Ghosh (2006). However, these authors classified their deposits into current and fixed deposits. In this study, such a classification has not been undertaken, and all deposits are grouped as one so that the number of inputs and outputs are commensurate with respect to the sample size. The sample size in this study is larger than those used in some of the previous studies in the DEA literature. For example, Drake (2001) measured the efficiency of only nine UK banks. Zenions (1998) and Dyson *et al.* (1998), quoted in Sathye (2001), state that DEA can be applied to a small sample size as long as it is larger than the product of inputs and outputs.

The results are classified into three main groups, that are also addressing the three research questions stated in Chapter One: first, the estimates of overall efficiency during the sample period, under the three alternative approaches are described; second, changes in productivity over the 2001/2002-2005/2006 period are analysed; and third, the univariate cross tabulation approach is employed to trace any discernable relationship of efficiency under different financial and prudential parameters. The univariate approach has traditionally been widely employed in empirical studies on financial institutions' efficiency by, for example, Wheelock and Wilson (1999) and Das and Ghosh (2006).

In particular, this chapter is structured as follows. Section 6.2 discusses the efficiency of financial institutions in Botswana. In this section, DEA is utilised to analyse overall technical efficiency and to decompose this concept of efficiency into its constituent components, pure technical and scale efficiencies. In Section 6.3, the productivity growth of Botswana's financial institutions is estimated using Malmquist productivity indices. A univariate approach is employed to investigate the determinants of efficiency/inefficiency in Section 6.4. Section 6.5 concludes with a summary of the major findings of this chapter.

6.2. Efficiency of Financial Institutions in Botswana

In this section the technical efficiency and its components, pure technical efficiency, and scale efficiency for Botswana's financial institutions covering the period 2001-2006 are discussed. Data availability dictated the selection of years and inclusion of financial institutions in the sample. The sample size, therefore, includes ten financial institutions, comprising five commercial banks, two development banks, a building society, a investment bank and a savings bank. The data for the institutions were obtained from their annual financial statements available in their annual reports for the years 2001-2006. A summary of the results for technical efficiency, pure technical efficiency and scale efficiency estimates under the corresponding three approaches (namely, value-added, intermediation and operating) using equations 1 and 2 (see Chapter Five) are presented in Tables 6.1, 6.3 and 6.4, respectively. The empirical results suggest some asymmetry between institutions regarding their technical efficiency. In particular, the different approaches to measuring inputs and outputs of institutions produced different efficiency estimates.

Table 6.1: Average Technical Efficiency of Botswana's Financial Institutions, (2001-2006)

Year	No. of institutions	No. of efficient institutions	Average efficiency (E)	Average inefficiency [(1-E)/E]
Value-added approach				
2001	10	2	0.706	0.416
2002	10	2	0.658	0.520
2003	10	2	0.663	0.508
2004	10	3	0.754	0.326
2005	10	3	0.637	0.570
2006	10	2	0.615	0.626
Average			0.672	0.488
Intermediation approach				
2001	10	2	0.600	0.667
2002	10	2	0.602	0.661
2003	10	2	0.565	0.770
2004	10	3	0.644	0.553
2005	10	3	0.669	0.474
2006	10	3	0.723	0.383
Average			0.634	0.577
Operating approach				
2001	10	2	0.586	0.706
2002	10	2	0.591	0.692
2003	10	2	0.548	0.825
2004	10	2	0.519	0.927
2005	10	2	0.522	0.916
2006	10	2	0.577	0.733
Average			0.557	0.795

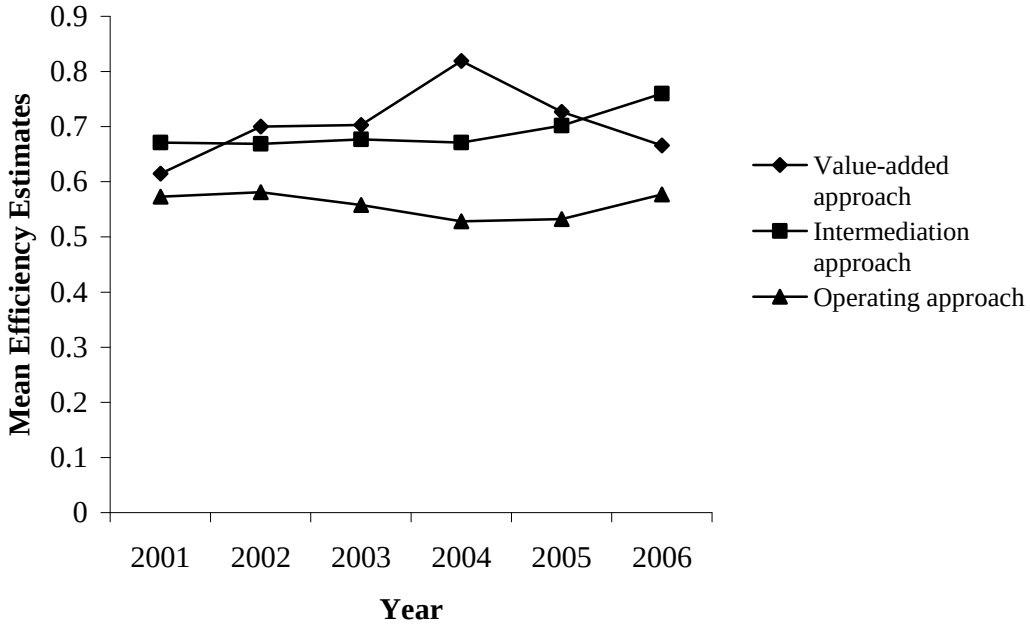
Source: Author's DEA calculations.

The different results obtained under the approaches indicate that DEA is a flexible technique that produces efficiency scores that are different when alternative sets of inputs and outputs are used. As can be seen from Table 6.1, the estimates of technical efficiency are observed to be, on average, higher under the value-added approach (67 percent) than under the intermediation (63 percent) and operating (56 percent) approaches. This is not counter-intuitive as, in general, the use of a larger number of input/outputs leads to a higher efficiency score. According to Das and Ghosh (2006),

this issue is known in the literature as the ‘curse of dimensionality’, when few firms have many dimensions (inputs and outputs). This is particularly the case in the context of this study under the value-added approach. At best, the mean value of *E* under the value-added approach is 67 percent, implying that there is considerable scope for financial institutions in Botswana to reduce the use of their inputs by at least 33 percent without having to reduce their outputs over the period under investigation. In other words, this suggests that Botswana’s financial institutions needed only 67 percent of the resources actually consumed in generating their output.

Figure 6.1 clearly shows the trend in the mean technical efficiency of financial institutions in Botswana. As can be seen in the figure, on the one hand, efficiency estimates under the operating approach lie below those of other approaches for all the years. On the other hand, efficiency estimates under the value-added approach are higher for all other years except in 2001 and 2006.

Figure 6.1: Technical Efficiency of Financial Institutions in Botswana, 2001-2006



Source: Author's DEA results.

The financial institution specific results for technical efficiency estimates under each of the three approaches (namely, value-added, intermediation and operating) are presented in Table 6.2. An efficiency index of one indicates that the financial institution lies on the production frontier, that is, it is a 'best-practice' institution relative to other institutions in the sample. An efficiency index of less than one indicates that the financial institution is less efficient than the 'best-practice' institutions in the sample. The lower the efficiency score is, the less efficient is the financial institution relative to other institutions.

Table 6.2: Performance Trend of Botswana's Financial Institutions, 2001-2006

Approach/Year	2001	2002	2003	2004	2005	2006	Average efficiency (*E*)
Value-added							
Bank of Baroda	1	1	1	1	1	1	1
Botswana Savings Bank	1	1	1	1	1	1	1
First National Bank	0.775	0.715	0.798	1	1	0.936	0.871
Botswana Building Society	0.782	0.665	0.678	0.812	0.645	0.588	0.695
Standard Chartered Bank	0.856	0.873	0.689	0.522	0.495	0.630	0.678
Stanbic Bank	0.697	0.528	0.52	0.866	0.839	0.555	0.668
Barclays Bank	0.786	0.715	0.689	0.648	0.570	0.566	0.662
Botswana Development Corporation	0.654	0.588	0.712	0.645	0.558	0.662	0.634
African Bank Corporation	0.287	0.266	0.291	0.850	0.133	0.105	0.322
National Development Bank	0.221	0.233	0.248	0.200	0.133	0.104	0.190
Average	0.706	0.658	0.663	0.754	0.637	0.615	0.672
Intermediation							
Bank of Baroda	1	1	1	1	1	1	1
Botswana Savings Bank	1	1	1	1	1	1	1
First National Bank	0.712	0.782	0.736	1	1	1	0.872
Barclays Bank	0.639	0.629	0.654	0.718	0.741	0.723	0.684
Standard Chartered Bank	0.627	0.632	0.616	0.654	0.630	0.632	0.632
Botswana Building Society	0.446	0.459	0.425	0.672	0.716	0.778	0.583
Botswana Development Corporation	0.313	0.330	0.326	0.342	0.554	0.922	0.465
Stanbic Bank	0.650	0.610	0.332	0.318	0.303	0.439	0.442
African Bank Corporation	0.345	0.343	0.308	0.432	0.402	0.399	0.372
National Development Bank	0.256	0.231	0.251	0.305	0.340	0.338	0.287
Average	0.600	0.602	0.565	0.644	0.669	0.723	0.634
Operating							
Bank of Baroda	1	1	1	1	1	1	1
Botswana Savings Bank	1	1	1	1	1	1	1
First National Bank	0.702	0.678	0.862	0.941	0.976	0.977	0.856
Stanbic Bank	0.917	0.882	0.507	0.477	0.504	0.465	0.625
Standard Chartered Bank	0.516	0.588	0.634	0.344	0.343	0.502	0.488
Botswana Building Society	0.482	0.493	0.429	0.411	0.485	0.574	0.479
Barclays Bank	0.538	0.597	0.416	0.397	0.369	0.454	0.462
National Development Bank	0.401	0.367	0.332	0.309	0.303	0.434	0.358
African Bank Corporation	0.203	0.202	0.204	0.208	0.123	0.187	0.188
Botswana Development Corporation	0.104	0.098	0.099	0.102	0.113	0.174	0.115
Average	0.586	0.591	0.548	0.519	0.522	0.577	0.557

Source: Author's DEA calculations.

It should be noted that all of the columns of Table 6.2 have been sorted in a descending order according to the magnitude of the average efficiency index (2001-2006) reported in the last column, so that the most efficient institutions appear at the top under each of the three approaches. The technical efficiency estimates reported in Table 6.2 represent

all optimal values based on the assumption of the constant returns to scale model (equation 1 in Chapter Five) for each of the ten financial institutions.

During the period under investigation, most financial institutions in Botswana performed marginally well in augmenting their deposit base (output) and thereby recorded moderate efficiency levels under the value-added approach. This is, however, with the exception of the African Bank Corporation (ABC) and National Development Bank (NDB), both of which failed to reach a 50 percent efficiency rate. Bank of Baroda (BB) and Botswana Savings Bank (BSB) made the largest contribution to efficiency gains, whereas the NDB appears to have experienced a reduced efficiency over the period 2001-2006 under the value-added approach. In terms of annual sector performance, the year 2004 is associated with high efficiency levels under the value-added approach, where even the ABC registered tremendous efficiency of 85 percent and First National Bank (FNB) also registered its highest efficiency level (100 percent). The year 2006 is associated with lower efficiency levels under the value-added approach (see bottom row of average values in Table 6.2).

Under the intermediation approach, Botswana's financial institutions are characterised by relatively low levels of efficiency. For example, as can be seen in Table 6.2, only 60 percent of the institutions registered 50 percent or better levels of efficiency. Unlike in the value-added approach, the year 2006 is linked with higher efficiency levels (on average), and low levels of efficiency were registered in 2003. Results obtained from the operating approach indicate an even weaker performance. In this approach, only five out of ten institutions registered 50 percent or better levels of efficiency. The Botswana Development Corporation (BDC) showed the lowest efficiency level under this

approach (11.5 percent). Between 2001 and 2006, the mean technical efficiency index ranged between 51.9 and 59.1 percent (see bottom row of Table 6.2 under the operating approach). This suggests that financial institutions needed only between 52 and 59 percent of the resources actually consumed in generating their output.

Despite the fact that DEA is a flexible technique that produces efficiency scores that are different when alternative sets of inputs and outputs are used, a number of observations are worthy of emphasis. First, based on the institution-specific results in Table 6.2, the Bank of Baroda and BSB are technically efficient on the basis of all of the three approaches. It should be noted that Bank of Baroda is a foreign bank and, according to Sathye (2003), it also performs efficiently in its head office in India whereas BSB is the only public deposit-taking bank in Botswana, and, as such, this bank is regarded as the largest provider of banking services to rural areas through its collaboration with Botswana Postal Services. Siphambe *et al.* (2005) argue that the extension of service delivery and the success of BSB is largely attributable to government monitoring and control of this bank.

Second, according to the results in Table 6.2, First National Bank (FNB) improved its status after 2003 from a low to high efficiency level based on all three approaches. It is interesting to note that the year 2003 coincides with the introduction of self-service technologies (SSTs), such as the internet and telephone banking, which are highly likely to have contributed to the increased efficiency of FNB. Third, the National Development Bank possessed the lowest efficiency scores under the first two approaches, and, even if the operating approach does not rank this bank last in terms of efficiency, it performed poorly under the third approach. This is a public development

bank with the purpose of investing in agricultural activities, which are inherently unpredictable because of climatic changes and, hence, the sector is associated with increasing default risks. Das and Ghosh (2006) argued that default risks are one of the contributing factors to inefficiencies within the banking industry.

Overall, the findings presented in Table 6.2 clearly show a high degree of inefficiency of several financial institutions in Botswana during the sample period. The worst performance is depicted under the operating approach, where eighty percent of the institutions depict inefficiency in the use of resources across all the years. Based on all the approaches and years the overall efficiency score of 0.62 (mean of 0.672, 0.634 and 0.557) lies below an acceptable range reported in other studies (see, for example, Sathye, 2003 and Table 4.2 in Chapter Four of this thesis). One then can conclude that financial institutions in Botswana need to utilise their resources more efficiently to improve their efficiency status further.

While most of these inefficiencies stem from the non-optimal use of inputs they could also be attributed to adverse macroeconomic conditions and financial instability, particularly following the introduction of the value-added tax (VAT) in 2002 and the devaluation of the Pula (Botswana's currency) in 2005. The devaluation of the Pula and the introduction of VAT were followed by a bout of inflationary pressures that resulted in further exchange rate depreciation, high taxes and eventually poor loan portfolios and a non-competitive financial system (Siphambe *et al.* 2005).

Once pure technical efficiency for each institution is estimated using VRS (equation 2 in Chapter 5), scale efficiency is derived by dividing technical efficiency (CRS DEA

indices) by pure technical efficiency (VRS DEA indices). The estimates of pure technical efficiency and scale efficiency are presented in Tables 6.3 and 6.4 respectively.

Table 6.3: Average Pure Technical Efficiency of Botswana's Financial Institutions, 2001-2006

Year	No. of institutions	No. of efficient institutions	Average efficiency (E)	Average inefficiency [(1-E)/E]
Value-added approach				
2001	10	8	0.926	0.080
2002	10	8	0.923	0.083
2003	10	8	0.914	0.094
2004	10	8	0.937	0.067
2005	10	6	0.852	0.174
2006	10	6	0.824	0.214
Average			0.896	0.116
Intermediation approach				
2001	10	5	0.848	0.179
2002	10	6	0.846	0.182
2003	10	6	0.857	0.167
2004	10	4	0.860	0.163
2005	10	6	0.909	0.100
2006	10	9	0.971	0.030
Average			0.882	0.134
Operating approach				
2001	10	6	0.906	0.104
2002	10	5	0.881	0.135
2003	10	5	0.830	0.205
2004	10	5	0.792	0.263
2005	10	5	0.812	0.232
2006	10	6	0.865	0.156
Average			0.848	0.179

Source: Author's DEA calculations.

It can be observed that over the sample period, both pure technical efficiency (Table 6.3) and scale efficiency (Table 6.4) measures, especially under the operating approach, display significant variations and the sector did not achieve sustained efficiency gains.

Estimates of pure technical efficiency under the operating approach vary from a low of 79 percent in 2004 to a high of 90 percent in 2001 (see Table 6.3). In most of the years, institutions recorded purely technical efficiency rates of over 70 percent.

Table 6.4: Average Scale Efficiency of Botswana's Financial Institutions, 2001-2006

Year	No. of institutions	No. of efficient institutions	Average efficiency (E)	Average inefficiency [(1-E)/E]
Value-added approach				
2001	10	2	0.762	0.312
2002	10	2	0.713	0.403
2003	10	2	0.725	0.379
2004	10	3	0.805	0.243
2005	10	3	0.748	0.338
2006	10	2	0.746	0.340
Average			0.750	0.333
Intermediation approach				
2001	10	2	0.707	0.413
2002	10	2	0.712	0.405
2003	10	2	0.659	0.517
2004	10	3	0.749	0.335
2005	10	3	0.736	0.359
2006	10	3	0.745	0.343
Average			0.719	0.391
Operating approach				
2001	10	2	0.647	0.546
2002	10	2	0.671	0.491
2003	10	2	0.660	0.515
2004	10	2	0.655	0.526
2005	10	2	0.643	0.556
2006	10	2	0.667	0.499
Average			0.657	0.522

Source: Author's DEA calculations.

It is interesting to note that the number of efficient institutions under CRS (technical efficiency) technology and VRS (pure technical efficiency) technology differs distinctly, irrespective of the choice of various inputs and outputs. This clearly

demonstrates the existence of sizable scale inefficiency among Botswana's financial institutions.[13] Illustratively, under the operating approach, Table 6.3 reveals that six institutions were found to be efficient under VRS in 2006, whereas only two were found to be efficient under CRS in the same year (see Table 6.2). This means that the remaining four institutions (Barclays, Standard Chartered, First National Bank and Botswana Building Society) failed to reach the CRS frontier owing to scale inefficiencies. Therefore, scale inefficiency does appear to be a serious problem in Botswana's financial institutions. In general, average scale efficiency estimates for financial institutions in Botswana were found to be low and varying below 70 percent under the operating approach (Table 6.4).

6.3. Productivity Analysis

In Chapter Five, Malmquist indices of productivity change, relative to reference technology, were defined. Using this information, three primary issues are addressed in the computation of Malmquist indices of productivity growth. The first issue is the measurement of productivity change over the period 2001/2002 to 2005/2006. The second issue is to decompose changes in productivity into the 'catching-up' effect (that is, efficiency change) and a 'frontier shift' effect (that is, technological change). In turn, the 'catching-up' effect is further decomposed to identify the main source of improvement, through either enhancements in technical efficiency or increases in scale efficiency. This section looks at changes in productivity, efficiency and technology for financial institutions covering the period 2001/2002-2005/2006. Similar to the previous sections, inputs and outputs were specified in such a way that they exhibit the three emphasised approaches for sensitivity analysis.

[13] Generally the technical efficiency score will not exceed the pure technical efficiency score. This is intuitively clear since the VRS model analyses each institution locally rather than globally.

Table 6.5 presents the efficiency change, technical change, pure technical efficiency, scale efficiency and finally total factor productivity change for each of the ten financial institutions in Botswana under the three approaches. In order to facilitate comparison between the results obtained from adopting each of the three approaches, all of the columns of Table 6.5 are sorted in terms of the magnitude of the Malmquist total factor productivity index (the last column). It should be borne in mind that for each financial institution in the sample, the total factor productivity change is the product of efficiency and technical change. If this index is greater (less) than unity, it means that there has been a productivity gain (loss), an efficiency increase (decrease) or technical progress (regress). Similarly, the overall efficiency change is the product of pure technical efficiency and scale efficiency changes.

Table 6.5: Malmquist Index Summary of Firm Means, 2001/2002-2005/2006

Firm	Efficiency Change	Technical Change	Pure Technical efficiency	Scale efficiency	Total factor productivity change
			Value-added approach		
Bank of Baroda	1.000	1.333	1.000	1.000	1.333
First National Bank	1.167	0.970	1.024	1.140	1.132
Standard Chartered Bank	0.995	1.093	1.011	0.983	1.087
Botswana Development Corporation	1.109	0.903	1.140	0.972	1.002
Barclays Bank	0.967	1.017	1.000	0.967	0.983
Botswana Building Society	1.035	0.932	1.000	1.035	0.965
Stanbic Bank	1.016	0.909	1.000	1.016	0.924
Botswana Savings Bank	1.000	0.915	1.000	1.000	0.915
African Banking Corporation	0.897	1.003	0.762	1.177	0.899
National Development Bank	0.873	0.982	0.990	0.882	0.857

Table 6.5 Continued

Firm	Efficiency Change	Technical Change	Pure Technical efficiency	Scale efficiency	Total factor productivity change
		Intermediation approach			
First National Bank	1.257	0.980	1.228	1.023	1.231
Botswana Development Corporation	1.241	0.984	1.232	1.008	1.222
Botswana Building Society	1.118	0.957	1.000	1.117	1.070
Bank of Baroda	1.000	0.992	1.000	1.000	0.992
Standard Chartered Bank	1.001	0.965	1.005	0.996	0.966
Barclays Bank	1.025	0.936	1.000	1.025	0.959
Botswana Savings Bank	1.000	0.954	1.000	1.000	0.954
African Banking Corporation	1.015	0.930	1.000	1.015	0.944
Stanbic Bank	0.925	0.917	0.977	0.946	0.848
National Development Bank	0.805	0.898	1.000	0.805	0.723
		Operating approach			
Botswana Building Society	1.006	1.052	1.000	1.006	1.058
Standard Chartered Bank	1.172	0.899	1.003	1.169	1.054
Barclays Bank	1.141	0.903	1.000	1.141	1.031
Botswana Savings Bank	1.000	0.962	1.000	1.000	0.962
Botswana Development Corporation	1.110	0.837	1.083	1.025	0.930
First National Bank	1.135	0.810	1.000	1.135	0.920
Bank of Baroda	1.000	0.883	1.000	1.000	0.883
National Development Bank	0.921	0.959	0.999	0.922	0.883
Stanbic Bank	0.956	0.884	0.925	1.033	0.845
African Banking Corporation	0.818	0.839	0.701	1.168	0.686

Source: Author's DEA results.

The different results obtained under the approaches indicate that DEA is a flexible technique that produces efficiency scores that are different when alternative sets of inputs and outputs are used. As can be seen from Table 6.5, under the value-added approach, for example, Standard Chartered Bank has recorded an average positive increase in total factor productivity of 8.7 percent (1.087-1.000), whereas under the operating approach, this gain is only 5.4 percent. The increase in productivity under the value-added approach (8.7 percent) can then be decomposed into 9.3 percent

technological progress and a loss in efficiency of 0.5 percent. This result contrasts with those under the operating approach, where the corresponding 5.4 percent productivity gain consists of an efficiency gain of 17 percent and technological regress of 10.1 percent. Under the intermediation approach, Standard Chartered Bank registered a 3.4 percent fall in total factor productivity, mainly as a result of technological regress.

According to the results obtained using the value-added approach, six of the ten institutions (see the last column of Table 6.5) exhibited an overall loss in productivity ranging from 1.7 percent for Barclays Bank to 14.3 percent for National Development Bank. The decomposition of this productivity change (the last column) into efficiency change and technical change indicates that for all institutions, with the exception of Barclays Bank, Standard Chartered Bank, Bank of Baroda and African Banking Corporation, there is evidence of negative frontier shifts ranging from a minimum of 1.8 percent (National Development Bank) to a maximum of 9.7 percent (Botswana Development Corporation) (see Table 6.5, column 2). These results indicate that 60 percent of Botswana's financial institutions experienced negative technical change during the period 2001/2002-2005/2006. On the other hand, Barclays Bank, Standard Chartered Bank, National Development Bank and ABC exhibited negative catching up over the same period (see Table 6.5, column 1) ranging from a minimum of 0.5 percent (Standard Chartered Bank) to a maximum of 12.7 percent (National Development Bank). For three of these four institutions a poor scale efficiency performance was the primary culprit.

Results obtained from the intermediation approach in terms of total productivity, efficiency and technical change, indicate an even weaker performance. Only three

institutions achieved a gain in productivity over the period 2001/2002-2005/2006[14], all institutions experienced negative technical change, although eight of the institutions experienced no or positive catch up in terms of efficiency. Of the two institutions that experienced a negative efficiency change, the primary culprit was again a poor scale efficiency performance.

Results from the operating approach are also mixed. Only three institutions achieved an increase in productivity[15], and only one institution achieved positive technical change, while seven institutions experienced no or positive catch up in terms of efficiency. Of the three institutions that experienced a negative efficiency change, the primary culprit for two of these, this time, was a poor technical efficiency performance.

Despite the mixed outcomes from each of the three approaches, a number of observations are worthy of emphasis. First, the National Development Bank is by far the worst performer in terms of efficiency change under both the value-added and intermediation approaches, and both agree that this was primarily due to a poor scale efficiency performance. While the operating approach does not rank this institution as last in terms of efficiency change, it still performs poorly, and, again, this is primarily due to a poor scale efficiency performance. As mentioned previously, this bank is a public sector bank that has the aim of lending for agricultural activities, which are unpredictable, and hence prone to high default risks. Furthermore, it is noticeable that the underperformance of NDB is far more pronounced under the intermediation approach, with a catch-up figure of only 0.805.

[14] Two of which, the First National Bank and Botswana Development Corporation, corresponded with results obtained from the value added approach.

[15] None of these institutions overlapped with those obtained from the value added and intermediation approaches.

Second, Table 6.5 shows that under all three approaches, the Bank of Baroda and the Botswana Savings Bank exhibited no evidence of catching up with the efficiency frontier over the period in question, because they remained on the frontier over the entire period. Third, while no single bank achieved a positive increase in productivity using all three approaches, the value-added and intermediation approaches recognised positive increases for both the First National Bank and the Botswana Development Corporation. Both approaches agree that this was primarily due to positive efficiency changes arising from pure technical efficiency.

Finally, based on all three approaches, the Stanbic Bank, NDB and ABC are the worst performers in terms of productivity. For the Stanbic Bank, this is unanimously due to a poor technical change performance. For the National Development Bank, this is unanimously due to a poor catching up in efficiency change, and, more specifically, a very poor scale efficiency performance. For the ABC, the explanation for the poor productivity performance is more mixed. The value-added and operating approaches suggest that this is primarily due to a poor efficiency change performance while the intermediation approach suggests it is, instead, due to a poor technical change performance. The value-added and operating approaches clearly indicate that the poor efficiency performance is driven by very poor pure technical efficiency outcomes.

Table 6.6 presents the means for all of the financial institutions for each of the sample years based on all three approaches. In addition, for each approach, Malmquist index averages (using geometric means) over the entire period (bottom row) are computed for each of the approaches.

Table 6.6: Malmquist Index Summary of Annual Means, 2001/2002-2005/2006

Year	Efficiency change	Technical change	Pure technical change	Scale efficiency	Total factor productivity change
Value-added approach					
2002	1.008	0.930	0.972	1.037	0.938
2003	0.952	0.955	0.934	1.020	0.910
2004	0.930	1.191	0.937	0.993	1.108
2005	0.998	0.942	1.037	0.963	0.940
2006	1.135	0.999	1.070	1.061	1.134
Mean	1.002	0.999	0.989	1.014	1.002
Intermediation approach					
2002	1.001	0.961	0.996	1.005	0.962
2003	1.010	0.986	1.017	0.993	0.997
2004	0.977	0.888	1.033	0.946	0.867
2005	1.066	0.824	1.065	1.001	0.878
2006	1.104	1.122	1.094	1.009	1.239
Mean	1.031	0.951	1.040	0.991	0.980
Operating approach					
2002	0.978	0.970	0.993	0.985	0.948
2003	1.026	0.941	0.982	1.044	0.965
2004	1.540	0.579	1.077	1.430	0.892
2005	0.791	1.039	0.834	0.949	0.822
2006	0.904	1.078	0.957	0.944	0.974
Mean	1.020	0.900	0.956	1.057	0.918

Source: Author's DEA results.

As indicated in Table 6.6, there was an overall mean annual decrease in total factor productivity over the period ending December 2006 under both the intermediation and operating approaches. The value-added approach indicates a very modest improvement in the mean total factor productivity over the same period. In the case of Botswana's financial institutions, the poor overall productivity performance over the entire period is primarily due to technological regress (downward shift of the frontier). This is particularly noticeable for the intermediation and operating approaches. The reason for this may be due to the fact that most of these institutions have not embarked on the use of new technologies, such as telephone banking and internet banking, which, according

to Avkiran (2000), have been found to be cost effective ways for the delivery of financial services.

6.4. Determinants of Efficiency: Univariate Approach

In this section, a univariate approach is employed to investigate the determinants of efficiency by cross-tabulating it to factors such as size, ownership status, age and non-performing loans. In the literature, a number of other factors have been considered in terms of their impacts on the efficiency of financial services. For example, Rangan *et al*. (1988) included an index of product diversity in their DEA study of US commercial banks, and Ferrier and Lovell (1990) incorporated the average size of loans and deposit accounts across a range of US deposit-taking institutions. Worthington (2000) highlights the fact that there may be a degree of conflict between strictly efficient performance and compliance with capital adequacy requirements and other regulations. Unfortunately, in the context of Botswana, no such data are available at the present time.

6.4.1 Technical Efficiency and Institution Size

The size of an institution in this study is determined by the amount of its assets. In Table 6.7, the ten banks are classified into three categories: category I representing small banks with assets less than 1 million Pula, category II including medium-sized institutions with assets between 1-2 million Pula and category III consisting of large banks with assets greater than 2 million Pula. It should be noted that categorising financial institutions on this basis is entirely arbitrary, and any number of alternative criteria could have been used.

Table 6.7: Technical Efficiency and Institution Size, 2001-2006

Year	Asset size categories		
	I	II	III
Value-added approach			
2001	0.751	0.546	0.806
2002	0.725	0.461	0.768
2003	0.732	0.508	0.725
2004	0.753	0.787	0.723
2005	0.695	0.510	0.688
2006	0.673	0.441	0.711
Intermediate approach			
2001	0.751	0.436	0.659
2002	0.725	0.428	0.681
2003	0.732	0.322	0.669
2004	0.753	0.364	0.791
2005	0.695	0.420	0.790
2006	0.673	0.587	0.785
Operating approach			
2001	0.721	0.408	0.585
2002	0.715	0.394	0.621
2003	0.690	0.270	0.637
2004	0.680	0.262	0.560
2005	0.697	0.247	0.562
2006	0.752	0.275	0.644

Source: Author's DEA calculations.

Note: I = Assets less than 1 million Pula, II = Assets exceeding 1 million Pula and up to 2 million Pula, III = Assets greater than 2 billion Pula.

According to the results presented in Table 6.7, under all of the three approaches, small institutions in category I and large institutions in category III exhibit much higher efficiency levels than do the medium-sized banks. Thus, the size of a financial institution does matter when it comes to its efficiency. As an important finding of this study, it appears that the efficient institutions are either "small" or "large".

Table 6.8: Average Technical Efficiencies, 2001-2006

Institution	Technical Efficiency	Assets (Pula)	Asset size category	Nature of Returns
Barclays	0.603	5,686,125	III	DRS
Standard	0.599	4,202,741	III	DRS
FNB	0.866	3,724,488	III	DRS
Baroda	1.000	270,920	I	CRS
Stanbic	0.578	1,216,603	II	DRS
NDB	0.278	513,153	I	IRS
BDC	0.405	1,327,012	II	IRS
BBS	0.586	673,295	I	IRS
BSB	1.000	541,628	I	CRS
ABC	0.293	1,895,775	II	DRS

Source: Author's DEA calculations and BoB financial reports (various years).
Note: DRS= Decreasing Returns to Scale, CRS= Constant Returns to Scale, IRS= Increasing Returns to Scale.

Table 6.8 indicates that among the large institutions, FNB has a higher efficiency score of 87 percent, and this could be partly explained by the fact that FNB is the only financial institution in Botswana that has ventured into the use of modern technology, such as the internet and telephone banking. As a group the large institutions benefited from their international orientation and goodwill, due to the fact that they are believed to be more stable. The relatively higher efficiency of large institutions could also be attributed to their ability to secure benefits resulting from economies of scale.

However, both Tables 6.7 and 6.8 reveal that small institutions are more efficient than medium-sized institutions. The most efficient small institutions are Bank of Baroda and Botswana Savings Bank (BSB) in category I. One may argue that due to their small scale of operation within a well-targeted market segment, they can be managed more effectively. These results, therefore, suggest the possibility of a U-shaped relationship between the size and efficiency of institutions in Botswana; that is, both small and large banks have higher efficiency and the most dangerous territory belongs to medium banks. However, based on the second and last columns of Table 6.8, one may conclude

that those small institutions experiencing an increasing return to scale phenomenon, such as BBS and NDB, can further improve their efficiency by perhaps increasing their size. On the other hand, large institutions witnessing decreasing returns to scale, such as Stanbic, ABC, Barclays and Standard could boost their current levels of efficiency by trimming down their size or enhancing returns on existing assets. There is no clear pattern to the returns to scale of medium institutions; they range from increasing to decreasing returns to scale. This result provides some evidence supporting scale inefficiencies in the context of Botswana's financial institutions, which is consistent with the findings of Drake (2001) in his similar study of UK banks. Drake (2001) and Chen *et al.* (2005) also found that smaller banks were subject to increasing returns to scale, whereas larger banks mainly exhibited decreasing returns to scale.

6.4.2 Technical Efficiency and Ownership

According to the results presented in Table 6.9, under all of the three approaches, foreign institutions exhibit much higher efficiency levels than do public/domestic institutions. The high efficiency estimates for foreign institutions could be attributed to high management expertise and exposure to world-wide competitive practices, since most of the foreign institutions are multinationals. It is unlikely that public institutions, by virtue of undertaking most of the government borrowing programs, can generate sufficient fee-based income from their activities, and thus tend to be less efficient.

Table 6.9: Technical Efficiency and Ownership, 2001-2006

Year/Institution group	Public	Foreign
Value-added approach		
2001	0.664	0.734
2002	0.622	0.683
2003	0.660	0.665
2004	0.664	0.814
2005	0.584	0.672
2006	0.589	0.632
Intermediation approach		
2001	0.504	0.662
2002	0.505	0.666
2003	0.501	0.608
2004	0.580	0.687
2005	0.653	0.679
2006	0.760	0.699
Operating approach		
2001	0.496	0.646
2002	0.489	0.658
2003	0.465	0.604
2004	0.456	0.561
2005	0.475	0.553
2006	0.546	0.598

Source: Author's DEA calculations.

Under the intermediation approach, the efficiency scores for foreign banks were volatile over the years, while the public institutions showed a continual improvement between 2004 and 2006. On the one hand, under the operating approach, public institutions exhibited deteriorating efficiency levels before they improved in 2005 and 2006. On the other hand, foreign banks showed deteriorating figures of efficiency continually until 2005.

Inter alia, Sathye (2003) and Shanmugan and Das (2004) also found that foreign banks in developing economies were more efficient than were domestic financial institutions, as they bring state of the art technology and human capital into domestic institutions.

On the contrary, domestic institutions in developed countries generally performed more efficiently than did their foreign-owned counterparts. For example, Chang *et al.* (1998) found that foreign-owned multinational banks operating in the US were significantly less efficient than were their US-owned counterparts. Hassan and Hunter (1996) also found that domestically owned US banks were substantially more cost effective than were Japanese banks operating in the US. This may be due to differences in objectives of these firms in terms of, for example, profit versus market-share objectives.

In this study, however, government ownership is observed to be adversely associated with the efficiency of public financial institutions in Botswana. Several reasons can be provided in support of this finding. First, as Das and Ghosh (2006) stated, public institutions are often perceived as having multiple goals. The liberalisation process may have created an overt focus on profit maximisation and certain peripheral objectives, such as encouraging the employment of low skilled workers. Second, it also seems likely that in pursuance of government policy objectives, managers in these institutions might have followed a strategy of advancing a greater quantum of loans by giving a particular sector high priority. Loans are then provided at below market rates and they could end up yielding a low return on advances. For example, as mentioned previously, NDB finances only agricultural projects which are unpredictable and subject to weather conditions and, hence, highly prone to default risks.

6.4.3 Technical Efficiency and Age of the Institution

The age of an institution in this study is determined by the number of years an institution has been operating. In Table 6.10, all ten institutions have been classified into new and old categories: the new category represents institutions that have been in

operation for less than ten years and the old category consists of institutions that have been in the market for more than ten years.

Table 6.10: Technical Efficiency and Age, 2001-2006

Year/Age	New	Old
Value-added approach		
2001	0.644	0.721
2002	0.633	0.665
2003	0.646	0.667
2004	0.925	0.712
2005	0.567	0.655
2006	0.553	0.630
Intermediate approach		
2001	0.673	0.580
2002	0.672	0.584
2003	0.654	0.542
2004	0.716	0.626
2005	0.701	0.661
2006	0.700	0.729
Operating approach		
2001	0.602	0.583
2002	0.601	0.588
2003	0.602	0.535
2004	0.604	0.498
2005	0.561	0.512
2006	0.593	0.573

Source: Author's DEA calculations.
Note: New = Institutions in operation for less than 10 years.
Old = Institutions in operation for more than 10 years.

The results show that only according to the value-added approach do old institutions demonstrate higher efficiencies than do new ones. However, the intermediation and operating approaches generally find that new institutions are more efficient. Economically, new banks with their leaner and more skilled workforce are better placed to implement sophisticated risk-management techniques and operational innovations and are also well equipped to internalise the recent innovation in banking practices. This might be an important factor affecting the results. Canhoto and Dermine (2003) also

found evidence that new banks dominate the old ones in terms of efficiency in Portugal while Paxton (2007) found the opposite result for Mexico.

6.4.4 Technical Efficiency and Non-Performing Loans

Efficiency estimates under various non-performing loan (NPL) classifications are presented in Table 6.11, and are based on the ratio of NPLs as a percentage of total loans. The results show that irrespective of the choice of inputs and outputs, high levels of NPLs are associated with low efficiency estimates and vice versa under the three approaches. Berger and DeYoung (1997) assert that these kinds of results are supportive of the 'bad management hypothesis'. A low measure of technical efficiency is a signal of poor senior management practices, which apply to input usage, day-to-day operations and management of the loan portfolio. Berger and DeYoung (1997) also assert that sub-par managers do not sufficiently monitor and control their operating expenses and do not practise adequate loan underwriting, monitoring and control. This implies that the major risks facing financial institutions are caused internally. That is to say, rising non-performing loans will usually exacerbate the inefficiencies of financial institutions due to the resulting increases in spending on the monitoring, administering and selling-off of these loans.

Table 6.11: Technical Efficiency and Non-Performing Loans, 2001-2006

Year/NPL (%)	Less than 10	10-20	More than 20
Value-added approach			
2001	0.852	0.574	0.221
2002	0.805	0.506	0.233
2003	0.783	0.560	0.248
2004	0.839	0.769	0.200
2005	0.817	0.445	0.133
2006	0.781	0.452	0.104
Intermediation approach			
2001	0.771	0.368	0.256
2002	0.776	0.377	0.231
2003	0.723	0.353	0.251
2004	0.782	0.482	0.305
2005	0.779	0.557	0.340
2006	0.799	0.700	0.338
Operating approach			
2001	0.779	0.401	0.263
2002	0.791	0.367	0.264
2003	0.737	0.332	0.244
2004	0.693	0.309	0.240
2005	0.699	0.303	0.240
2006	0.733	0.434	0.312

Source: Author's DEA calculations.
Note: NPLs are measured as a percentage of total loans.

Of course, the univariate approach does not satisfactorily address the interrelationship among technical efficiency and institutions' financial parameters, since most characteristics considered in this study would be correlated with each other. This aspect could be addressed by carrying out a multivariate regression framework to relate institution level efficiency scores to institutions' characteristics. This study, however, suffers from the problem of small sample size, making it unsuitable to carry out regression analysis.

6.5. Summary

This chapter empirically analysed the technical efficiency and productivity of financial institutions in Botswana using data envelopment analysis, which is a non-parametric approach, covering the period 2001 to 2006. In order to assess the robustness and sensitivity of the results, three approaches, namely, value-added approach, intermediation approach and operating approach, have been employed in defining the inputs and outputs of the institutions. The results suggest an asymmetry between institutions regarding their technical efficiency under different approaches over the years. The yearly technical efficiency estimates under the value-added approach were mostly higher than were the other two approaches. This is because DEA is a flexible technique and produces efficiency scores that are different when alternative sets of inputs and outputs are employed.

Most of the inefficiency identified stemmed from the under utilisation of resources, as well as from the current scale of operation. The empirical results indicate that no matter which approach and year are taken into consideration, Baroda (a foreign bank) and BSB (a publicly owned institution) are consistently among the most efficient institutions and BDC, ABC and NDB are the least efficient ones. The overall average efficiency score under the three approaches during the sample period for Botswana financial institutions is 0.62. This figure lies below scores found in other studies. The government needs to support these institutions, especially those owned by the public sector, such as NDB, by creating an environment that is conducive to effective use of scarce resources. For instance, further monitoring of projects can reduce the default risk and hence improve the efficiency of the institutions concerned.

In terms of productivity analysis, the results indicate that there has been a loss or little productivity growth at the frontier during the period in question, although there has been some improvement in the relative efficiency of most of the financial institutions in Botswana. The loss in total factor productivity has, therefore, been mostly due to technological regress. The reason for this may be that most of these institutions have not embarked on the use of new technologies, such as telephone banking and internet banking, in the delivery of their services. One may therefore conclude that financial institutions in Botswana lack dynamic efficiency. That is to say the financial sector is not engaging actively in product innovation, and financial institutions are not making use of the most cost effective technologies. A lack of competition in the financial sector is likely to be the primary cause of this.

In terms of institution specific performance, Stanbic Bank, NDB and ABC are the worst performers in terms of productivity under all three approaches. The NDB is the worst performer in terms of negative catch-up under the value-added and intermediation approaches. The Bank of Baroda and Botswana Savings Bank exhibited no evidence of catching up with the frontier over the period. This is because these two institutions were on the frontier over the entire period. However, these two banks exhibit a negative frontier shift under the intermediate and operating approaches, leading to their productivity losses.

There are also reported differences in the efficiency performance of the institutions arising from different ownership status, size, age and level of non-performing loans. The empirical results demonstrate that foreign institutions are, overall, relatively more efficient than their public counterparts under the three approaches. It is unlikely that

public institutions, by virtue of undertaking most of the government borrowing programs, can generate significant fee-based income from this source.

It appears that the highly efficient institutions are either small or large in terms of the magnitude of their financial assets. The results, therefore, suggest the possibility of a U-shaped relationship between efficiency and size of the financial institutions in Botswana. However, given the existing scale of operations, small institutions still need to increase their size to reap sustained efficiency gains while large institutions need to trim down their size to overcome their technical inefficiency. Unlike Das and Ghosh (2006), who stated that opening more branches in rural areas can reduce the efficiency level of institutions, this study has provided evidence to suggest that this is not necessarily the case for Botswana. For example, the results indicate that BSB, with many branches in rural areas, still enjoys a high level of efficiency. This is consistent with the findings of Favero and Papi (1995) in the context of India, that location *per se* is not a major determinant of efficiency of financial institutions. The results also demonstrate that the technically more efficient institutions are those that have, on average, lower non-performing loans. The presence of low efficiency (due to non-performing loans) may widen the interest rate spread and hamper the growth of the real sector of the economy.

Other studies corroborated the findings of the univariate approach by following a two-stage multivariate approach based on Tobit regression. In this study, however, this was not possible due to the small sample size. Based on the results of this study, policy implications can be formulated that could help the managers of these specific institutions, and the government of Botswana, identify how best they can improve the

efficiency of these institutions. Also, the results established may help managers of these institutions and the government create an environment that enhances the efficiency of the institutions, which, in turn, could lead to a higher volume of intermediation and improved financial services and products. This is the subject matter of the following chapter.

Chapter Seven

Policy Implications of the Study

7.1 Introduction

The previous Chapter has empirically analysed the technical efficiency and productivity changes of ten major financial institutions in Botswana using data envelopment analysis, a non-parametric approach, for each year covering the period 2001-2006. Most of the inefficiency identified stemmed from the under utilisation of resources by these institutions, as well as from their current scale of operation. The empirical results indicate that no matter which approach and year are taken into consideration, the Bank of Baroda (a foreign bank) and Botswana Savings Bank (a publicly owned institution) are consistently among the most efficient institutions, and Botswana Development Corporation, African Banking Corporation and National Development Bank are the least efficient ones.

The overall average efficiency score under the three approaches during the sample period for Botswana's financial institutions is 0.62. Overall, this figure lies below scores found in other studies (see Chapter Four of this study). This finding places a responsibility on Botswana International Financial Services Centre (IFSC)[16] policy analysts to initiate innovative methods to improve overall economic efficiency levels in the financial sector. This should eventually lead to an increase in the contribution of the formal financial sector to sustainable economic development and growth.

[16] The role of the IFSC is to provide the tax incentives, project approval processes and regulatory structure necessary to create a world-class financial services centre. The range of financial services includes banking, funds management and administration, captive insurance, corporate headquarters and treasury operations and financial intermediaries.

There are also reported differences in the efficiency performance of the institutions arising from different ownership status, size, age and level of non-performing loans (see Chapter Six). The empirical results in Chapter Six of this thesis demonstrated that foreign institutions are, overall, relatively more efficient than are their public counterparts under the three approaches. It also appears that the highly efficient institutions are either small or large in terms of the magnitude of their financial assets. Under the intermediation and operating approaches, new institutions were found to be more efficient. Economically, new banks with their leaner and more skilled workforce are better placed to implement sophisticated risk management techniques and operational innovations, and are also well equipped to internalise recent innovations in banking practices. Therefore, in the future, the financial sector has the potential to become more efficient as these institutions mature and increase their scale of operation. However, the older institutions should also improve their performance. The results also demonstrate that the technically more efficient institutions are those that have, on average, lower non-performing loans.

In terms of productivity analysis, the results indicate that there has been a loss or little productivity growth at the frontier during the period in question, although there has been some improvements in the relative efficiency of most of the financial institutions in Botswana. The loss in total factor productivity has, therefore, been mostly due to technological regress.

There are a number of important policy implications arising from the results of this study. The poor overall efficiency and productivity performance of Botswana's financial sector is a cause for concern, as it is likely to constrain the growth and

development of the overall economy. While it will never be feasible to aim for one hundred percent efficiency (even in developed economies there will always be some inefficiency), there is a strong case that a 'financially developed' economy should be striving for much higher levels of efficiency. As a consequence, the authorities will need to rethink and redesign their reform measures with the objective of stimulating more competition in the marketplace.

7.2 Implications of the Results

There are several implications arising from the inefficient functioning of financial institutions. First, if a firm is not efficient, the consequences are not only for the firm's profitability, but also for its very survival in a competitive market. A firm that is not efficient is a prime target for takeovers, or may be forced out of the market by more efficient firms. Second, from a policy perspective, inefficiency can result in the waste of scarce resources in the economy (both in the banking system itself and in the way such institutions allocate funds more generally within the economy). The challenge for policy makers is, therefore, to create a milieu in which financial institutions have opportunities to become more productive and efficient. There are several policy implications that flow out of this research that could lead to efficiency gains.

7.2.1 Facilitating Institutional Growth can lead to Higher Efficiency

The results on returns to scale for Botswana's financial institutions are important indicators of the challenges facing the sector. From the results presented in Chapter Six, increasing returns to scale were found for most public institutions. This is an important finding for the financial sector where there is a proliferation of small firms, since it suggests that the sector would become more efficient through institutional growth or

mergers. Currently, the majority of institutions have few branches. In coming years the sector faces the challenge of efficient growth and appropriate use of inputs. For most institutions, the source of inefficient input use stems from the overuse of capital infrastructure and/or the over-employment of labour (the two most important inputs). As a way of improving their efficiency levels, individual financial institutions can merge or coordinate activities in order to gain scale economies and spread risks.

As an example, consolidation and merging or coordinating activities have started taking place in Mexican rural financial intermediaries (Paxton, 2006). The World Bank and Inter-American Development Bank together with the Mexican banking authorities have worked towards establishing a new rural lending authority that facilitates the coordination of various rural financial intermediaries that previously competed against one another. The Popular Savings and Credit Law in Mexico effectively serves to unite the sector and facilitate institutional growth and intra-industry growth. Financial institutions in Botswana, such as the Botswana Development Corporation and the National Development Bank, could possibly adopt this kind of consolidation in order to enhance their growth.

However, the merging of firms has to be carried out with caution. For example, any proposed merger has to be opposed if it is believed to reduce competition substantially. In Australia, for example, the Australian Competition and Consumer Commission (ACCC) tests proposed mergers on the basis of a ‘substantial lessening of competition’. The ACCC stipulates that if the market share of the merged firm exceeds 15 percent and the firm concentration ratio exceeds 75 percent, then the ACCC will not allow the merger to proceed without further assessment. Therefore, the authorities in Botswana

need to establish clear criteria for the merging of firms, and perhaps encourage further foreign investment and ownership in the country.

7.2.2 Portfolio Management and Monitoring

Those institutions that had high levels of non-performing loans (and hence are 'burdened by high arrears'), such as the NDB, were unable to be technically efficient. The prevalence of arrears, particularly among state-funded institutions, poses a serious threat to institutional viability, given the historical culture of non-payment in government sponsored programs. Berger and DeYoung (1997) assert that high non-performing loans within an institution are supportive of the 'bad management hypothesis'. As stated previously, a low measure of technical efficiency is a signal of poor senior management practices, which apply to input usage, day-to-day operations and management of loan portfolios. Berger and DeYoung (1997) also assert that sub-par managers do not sufficiently monitor and control their operating expenses and do not practise adequate loan underwriting, monitoring and control. This implies that the major risks facing financial institutions are caused internally. This suggests a need for upgrading internal skills and technology and being exposed to latest management practices. This can be achieved through exerting pressure by stakeholders to improve the performance of institutions.

Better mechanisms to monitor and enforce repayment can improve repayment levels as can as better assessment processes for individual loans. In addition, the creation of business incubators, such as the Business Place established by Investec South-Africa, could help to develop entrepreneurial expertise, which in the future would increase economic efficiency, as funds will find high return destinations provided by skilled

entrepreneurs. Furthermore, an establishment of a venture capital market with foreign investors could also assist local entrepreneurs to acquire better skills.

7.2.3 Risk Spreading and Technical Efficiency

One of the most important outcomes of the analysis is that the NDB is the worst performer in terms of efficiency and productivity under the value-added and intermediation approaches. NDB is a public sector bank that has the aim of lending for agricultural activities, which are both unpredictable and prone to high default risks, and the clientele is quite limited. Consequently, policy-oriented banks such as NDB, whose primary objective is not profits but rather have some social objectives, are inevitably subject to higher risk and lower returns. Perhaps it would be helpful to such institutions to conduct their services in collaboration with the experts in other commercial banks.

The results of this study indicate that BSB, with many branches in rural areas, enjoys a high level of efficiency. This is consistent with the findings of Favero and Papi (1995) in the context of India that location *per se* is not a major determinant of efficiency of financial institutions but inconsistent with Das and Ghosh (2006) who stated that the opening of more branches in rural areas can reduce the efficiency level of institutions. BSB offers a balanced portfolio of rural and urban clients, thus reinforcing the importance of portfolio risk diversification and reduction.

7.3 The Way Forward

In Botswana the challenges facing the banking sector arise from a focus on lending to households rather than businesses, high bank charges, reliance on Bank of Botswana Certificates for assets and income, and from extending banking services to the poor,

especially those in the rural areas (Jefferis, 2007). Other analysts, for example, Siphambe *et al.* (2005) attribute the banking challenges to the lack of innovation in this sector. As Avkiran (2000) stated, technological innovation plays a principal role in shaping financial service delivery.

Developing strategies to make the financial sector more efficient and thereby increase its contribution to the overall economy, could follow a number of different courses (or a combination of them). Broadly, three main approaches could be considered: [17]

1) Regulatory reform
2) Technological innovation
3) Extending services to the unbanked.

7.3.1 Regulatory Reform

The financial sector in Botswana, as in many other countries, is one of the most heavily regulated sectors of economic activity. There are many reasons for this, as the sector has specific characteristics and particular vulnerabilities (whereby problems in one financial institution can cause systematic instability in the entire economy) that require such regulation. The fundamental reason for this prudential regulation is to minimise the risk of financial and macroeconomic crises stemming from the financial sector. A secondary reason is to protect depositors whose savings may be at risk in the event of a banking crisis, and third, to assist in improving market efficiency.

The current regulatory structure for banks in Botswana is laid out in the Banking Act 1995, the substance of which dates back to the establishment of the Bank of Botswana

[17] The three approaches are not mutually exclusive and may overlap in a number of areas.

in 1975 and the original Financial Institutions Act. Banking legislation focuses on deposit-taking institutions, and the key purpose of regulation is to protect depositors and to guard against market failure in the banking system. The banking legislation provides for the issuance of a banking licence, which entitles a bank to carry out a full range of banking activities and imposes a range of requirements on banking institutions designed to protect the public (primary depositors) from risks that may be taken by banks.

This regulatory structure has several consequences. First, the need to acquire a banking licence to carry out banking business provides a barrier to entry to the market, and hence restricts the level of competition. For instance, non-bank companies cannot enter many areas of banking business. Second, any bank wishing to become established in Botswana and acquire a licence essentially has to meet the same regulatory requirements as the existing full-service banks, even if it wishes to undertake only a limited range of business. While some kind of regulation of entry into the banking sector is necessary, excessive regulation may unnecessarily inhibit new entry to the sector and stifle innovation, thus contributing to less competition and more stagnation in the banking sector. Ataullah and Le (2006); Chen *et al*. (2005); Canhoto and Dermine (2003) found that competition is one of the most important factors enhancing firm efficiency and productivity.

Individual financial institutions, at the behest of the central bank, should be encouraged to tackle their individual weaknesses, as identified from this study. For example, the National Development Bank has performed poorly in terms of productivity change using all three approaches. This appears to be due to a combination of both poor efficiency and technical change, but mainly the former. Further analysis suggested that

its poor efficiency performance is primarily related to a poor scale efficiency performance. It is clear, however, that a ‘one size fits all’ approach to financial sector reforms aimed at enhancing the performance of all financial institutions will not be appropriate nor effective in the context of Botswana.

While the current regulatory structure has served Botswana well, and has supported a stable banking sector with orderly restructuring of failing banks and no depositor losses, the banking industry worldwide has changed in many ways since this structure was originated. Therefore, there are reasons to believe that it should be reformed, specifically to permit new entry and innovation in the financial sector, but without introducing unnecessary or excessive risks. One way in which this can be achieved is by encouraging greater competition through greater access by foreign banks. Another way is through a tiered banking approach that allows new banks to enter the market to conduct a limited range of banking activities. As a result they are exposed to less risk and hence there is commensurately less need for capital and technical resources, making it easier to enter the industry. For example, a savings bank that takes deposits but does not lend, and invests only in risk-free government instruments, would require relatively less capital. In principle, this would also permit non-banks, such as retailers, cell-phone companies and insurers, to offer a limited range of banking services, such as transaction facilities, small retail deposits and loans. This would bring more competition to the sector and make the efficiency a principal priority.

The regulatory structure may also need to be revised to accommodate e-money development (see Jefferis, 2007). Such developments use smartcards (or cell-phones) that can be loaded with cash, which in turn can be spent where appropriate terminals or

facilities are available. At present, such card-based cash is likely to be classified as a deposit, and hence restricted to licensed banks. Initiatives such as Globe Telecom's G-Cash e-money account in the Philippines would not be permitted in Botswana under the present legislation and regulations. While there are arguments for ensuring the protection of e-money users, this may not require e-money users to obtain a full banking licence, at present. In the European Union, for instance, the issuance of e-money can be done by banks or by a new category of Electronic Money Institutions licensed specifically (and exclusively) for this purpose, and such an approach could be considered in Botswana.

Changes such as accommodating different types of banks and electronic money institutions could be introduced within the context of the existing Banking Act, through the development of appropriate regulations that would enable the Bank of Botswana to licence new types of banking operations and hence bring competition into the sector. In summary, a regulatory structure that offers efficiency to the financial sector should encompass the following;

a) Creating more competition
b) Improving the existing infrastructure
c) Allowing and encouraging initiatives for innovation
d) Improving consumer education
e) Facilitating entry to the market and institutions' growth.

7.3.2 Technological Innovation

The second approach involves taking advantage of the opportunities offered by new technology in overcoming some of the problems relating to inefficiency. Full service

banks with many branches have high costs and staffing requirements, and are unlikely to be a viable route to increasing efficiency especially in a sparsely populated country such as Botswana. Charges to recover costs would in many cases make services unaffordable to the majority of the clientele. The key is to use new technology to aid the delivery of low-cost (and hence low charge) financial services.

Many financial transactions do not require staffed-bank branches. For instance, cash can be accessed through ATMs from merchants equipped with point of sale devices, through card-based transactions. The mini-ATMs introduced by FNB in some retail stores are an example of such an approach. A second opportunity arises from cell-phone banking, which has much potential for low cost banking and financial services. Where cell-phone banking exists, transaction costs are typically much lower than those charged by old-style financial institutions. In South-Africa, which has three cell-phone banking providers (as at 2006), the cost of a money transfer by cell-phone banking is approximately one-eighth of the cost of a transfer by money order through a post office (South-African Reserve Bank, 2006). Cell-phone banking is a rapidly evolving business that has considerable potential to transform financial access through extending banking to the unbanked (institutional growth). Cell-phone banking may have a considerable potential in Botswana where cell-phone penetration is among the highest in Sub-Saharan Africa, at 46.6 per 100 people (Jefferis, 2007). The high take up of cell-phones in Botswana suggests that the population is ready to adopt new technology.

New technology may also facilitate the provision of banking by retail agents on behalf of banks. This has already happened to a small degree in Botswana, where Botswana Post provides agency services for BSB, and retail merchants provide agency services

using FNB's mini-ATMs. However, the potential is much greater than this. In Brazil, for example, the use of retail agents by existing banks to deliver financial services through supermarkets, pharmacies and lottery kiosks has transformed the availability of banking services throughout the country (Central Bank of Brazil, 2005), and a similar approach is being tried in India. The efficiency rate of banks in these countries, in particular India, is much higher than that of banks in Botswana (see, for example, Das and Ghosh, 2006). Given the wide spread network of shops, post offices and airtime vendors throughout Botswana, there is scope for the low cost provision of banking services through retail agents, although regulatory issues may still need to be addressed.

Technology-based services, therefore, have the potential to improve the efficiency of the provision of financial services, the development of the telecommunications sector needs to be given priority in government policy deliberations. Current policy documents provide only limited considerations of the potential for telecommunications technology to contribute to the efficiency and productivity within the financial sector. Avkiran (2000), for example, established that technological innovation played a principal role in shaping financial service delivery in Australia. The alternative ways of customer access and product distribution made possible by technological innovation lowered the barriers to entry and reduced banks' profit margins. Avkiran (2000) also asserted technological innovation as a sign of dynamic efficiency in Australian retail banking where banks take advantage of new cost effective technologies and pursue product and market development to be efficient.

7.3.3 Extending Banking Services to the Unbanked

A third approach to improving efficiency is to encourage financial institutions to move in the direction of greater inclusiveness, and enhanced access to financial services. The unbanked population, however, has quite different characteristics; being predominantly rural, less well-educated, unemployed or with irregular incomes, they do not meet the preferred customer profile of conventional banking models.

To a large extent, banks do not see serving the unbanked market as worthwhile given that many banks have struggled to find innovative and profitable ways of serving the low-income market, especially in rural areas. Innovative approaches by commercial banks, other financial institutions and the government may therefore be needed if banking services are to be extended to the unbanked, with potential benefits for economic growth and poverty reduction.

The development of micro-finance institutions could assist in extending banking services to the poor. These could be developed through international donor assistance and Non-Governmental Organisations and in collaboration with domestic commercial banks aimed at satisfying a clientele that previously may have been largely ignored and considered commercially unviable. Alternatively, community-based initiatives, such as *metshelo*[18] in Botswana, could also be encouraged to provide finance to individuals that commercial banks would not normally consider worthwhile.

Encouraging institutions, such as the Botswana Savings Bank, that already deal with the low-income market to broaden their services could also assist in this regard. There is

[18] A savings club to which members contribute an agreed amount every month, and rotationally, they get to borrow against.

considerable potential for developing the position that BSB occupies in the banking market. BSB is already the largest provider of banking services to the rural population, and its relationship with Botswana Postal Services (BPS) offers a great potential for extending this. World wide experience suggests that providing banking services through a post office network can be a viable low cost option. This can benefit both parties, given the scope for economies of scale from a shared infrastructure. The nature of the relationship between postal services and banking components is crucial, and there are strong arguments for providing an ownership link between the two, which can help align objectives. In Botswana, this has implications for the privatisation policy in that consideration should be given to strengthening the links between BPS and BSB.

The challenges and obstacles to financial sector efficiency in Botswana and appropriate policy recommendations in accordance to this study are summarised in Table 7.1.

Table 7.1: Summary of Recommendations

Challenges and Obstacles	Recommendations
Insufficient competition The need to acquire a banking licence to carry out banking business provides a barrier to entry to the market, and hence restricts the level of competition.	a) Reform the existing regulations specifically to permit new entry and innovation in the financial sector, but without introducing unnecessary or excessive risks. One way to achieve this is through a tiered banking approach that allows new banks to enter the market to conduct a limited range of banking activities. b) Increasing the number of foreign banks operating in the economy. c) Eliminating the distinction between banks and non-bank financial institutions to allow competition in all sectors and segments of domestic financial markets.
High costs and staffing requirements Full service banks with many branches have high costs and staffing requirements, and are unlikely to be a viable route to increasing efficiency especially in a sparsely populated country such as Botswana.	a) Use new technology to aid the delivery of low-cost (and hence low charge) banking services. This includes cell-phone banking and internet banking. b) The regulatory structure may also need to be revised to accommodate the development of e-money. Such developments use smartcards (or cell-phones) that can be loaded with cash, which in turn can be spent where appropriate terminals or facilities are available.

Table 7.1 Continued

Challenges and Obstacles	Recommendations
Incomplete access to financial services Low income households are mostly excluded from financial services, whether as individuals or as entrepreneurs.	a) Encouraging institutions that already deal with the low-income market such as the Botswana Savings Bank. b) Development of micro-finance institutions specifically targeting such a customer base. c) Government should encourage banks to innovate and move closer to low income households. This may call for the awarding of banking licences that confer privileges, and awareness that the possession of such a privilege also brings social obligations.
Stagnant institutional growth Most institutions are stagnant in terms of market and services.	a) Encourage consolidation of financial institutions through acquisitions and mergers with the stated objective of achieving clear efficiency outcomes. b) Establish a single publicly owned financial institution with the stated objective of achieving state-determined lending and development objectives, while privatising all remaining state-owned financial institutions.

Chapter Eight
Summary and Conclusions

8.1 Introduction

The productivity and efficiency of the financial sector is pivotal to the attainment of economic growth and development in developed and developing economies alike, and is of particular interest in the wake of financial sector reform and restructuring. The financial system in Botswana has undergone major structural and institutional changes in recent years. Throughout the 1980s, a series of financial reforms were introduced to boost the efficiency and productivity of financial institutions, by enhancing the crucial role of market forces (BoB, 1999). New entrants to the system and new products such as Automated Teller Machines (ATM), credit and debit card services were permitted as a result. To date, no study has been carried out to assess the impact of these reforms on the efficiency of financial institutions in Botswana.

The main aim of this study has been to conduct an empirical investigation of financial institutions in Botswana, with a view to assessing their technical efficiency and productivity. By investigating technical efficiency and productivity among financial institutions in Botswana, this study addressed the following three questions: a) What is the mean efficiency score of financial institutions in Botswana? b) What is the total factor productivity change for Botswana's financial institutions? c) What are the major determinants of efficiency in the context of Botswana's financial institutions? This chapter summarises this study and the findings for each of these research questions. In particular, this final chapter is organised as follows. Section 8.2 summarises the study and the main findings from the previous chapters. Policy implications are highlighted in

Section 8.3. Section 8.4 outlines the specific contributions made by this study. Section 8.5 highlights some limitations of this study. Suggestions for future research are presented in the last section.

8.2 Summary of Major Empirical Findings

Data envelopment analysis, which is a non-parametric approach, was employed in this study to analyse empirically the technical efficiency and productivity changes of financial institutions in Botswana. In order to assess the robustness and sensitivity of the results, three approaches, namely, the value-added approach, intermediation approach and operating approach, were employed in defining the inputs and outputs of the institutions. The results suggested an asymmetry between institutions regarding their technical efficiency under different approaches over the period 2001-2006. Similar to Dos and Ghosh (2006), the yearly technical efficiency estimates under the value-added approach were mostly higher than the other two approaches.

Most of the inefficiency identified stemmed from the under utilisation of resources, as well as from the current scale of operation. This is consistent with results from other studies, for example, Rangan *et al*. (1988); Favero and Papi (1995); Taylor *et al*. (1997); Sathye (2001); Drake (2001) and Neal (2004). The overall average efficiency score under the three approaches during the sample period for Botswana's financial institutions is 0.62. This figure lies below the efficiency indices reported in other studies (see, for example, Sathye (2003) and Section 4.3 of this thesis).

In terms of productivity analysis, the results indicate that there has been a loss or little productivity growth at the frontier during the period in question, although there has

been some improvement in the relative efficiency of most of the financial institutions in Botswana. The loss in total factor productivity has, therefore, been mostly due to technological regress. This result is inconsistent with, for example, Avkiran (2000) who investigated the productivity of four major trading banks and six regional banks in Australia using Malmquist indices. His results indicated an overall rise in total productivity driven more by technological progress than technical efficiency.

The literature in Chapter Four showed that developed economies such as Australia, the USA and the UK, established gains in productivity that were driven more by technological progress. For developing nations like Botswana, productivity losses are evident as most of the institutions have not embarked on the use of new technologies, such as telephone banking and internet banking in the delivery of their services. Therefore, one may conclude that financial institutions in Botswana lack dynamic efficiency. That is to say, the financial sector is not engaging actively in product innovation, and financial institutions are not making use of the most cost effective technologies. A lack of competition in the financial sector is likely to be the primary cause of this productivity loss.

There are also reported differences in the efficiency performance of the institutions arising from different ownership status, size, age and the level of non-performing loans. The empirical results demonstrated that foreign institutions are, overall, relatively more efficient than their publicly owned counterparts under the three approaches. It is unlikely that public institutions, by virtue of undertaking most of the government borrowing programs, can generate significant fee-based income from this source. Previous research, for example, Chang *et al.* (1998); Hasan and Hunter (1996) and Peek

et al. (1999) obtained different results for the developed and developing economies. Domestic institutions in developed countries were generally found to be more efficient than were their foreign-owned counterparts. In contrast, most studies that compared bank efficiency across different ownership groups in developing countries revealed that foreign banks were more efficient than were domestic banks (Jemric and Vujcic, 2002; Sathye, 2003; and Shanmugam and Das, 2004). This is due to the transfer of new technology and human capital to domestic banks by foreign investors.

8.3 Policy Implications

There are a number of important policy implications arising from the results of this study. First, the poor overall productivity performance of Botswana's financial sector is a cause for concern, as it is likely to constrain the growth and development of the overall economy. As a consequence the authorities will need to rethink their reform measures to deal with the objective of stimulating more competition in the marketplace. This could be achieved by increasing the number of foreign banks operating in the economy; eliminating the distinction between banks and non bank financial institutions to allow competition in all sectors and segments of domestic financial markets; encouraging the consolidation of financial institutions through acquisitions and mergers with the stated objective of achieving clear efficiency outcomes; establishing a single publicly-owned financial institution with the stated objective of achieving state determined lending and development objectives while privatising all remaining state-owned financial institutions; encouraging the adoption of self-service technologies, such as telephone and internet banking in order to improve productivity levels through a substantial reduction in service delivery costs. According to Avkiran (2000), the use of new information technology is one of the most cost effective ways for the delivery of

financial services. However, in order to achieve greater competition, a better regulatory framework needs to be introduced in order to make sure that public monopolies are not replaced by private ones.

Second, individual financial institutions, at the behest of the central bank should be encouraged to tackle their individual weaknesses as identified by this study. For example, the National Development Bank has performed poorly in terms of productivity change under all three approaches. This appears to be due to a combination of both poor efficiency and technical change, but mainly the former. Further analysis suggests that poor efficiency performance is primarily related to a poor scale efficiency performance. It is clear, however, that a one-size-fits-all approach to financial sector reforms, aimed at enhancing the performance of all financial institutions, will not be appropriate or effective in the context of Botswana.

8.4 Contributions of the Study

This thesis has made three significant contributions to the analysis of efficiency in financial institutions. First, this is the first study to address the issue of efficiency and productivity in Botswana's financial institutions using DEA and Malmquist indices. After conducting an inclusive review, no study has addressed these issues. As mentioned in the introductory chapter, capital expenditure on equipment may give a poor indication of catch-up of technology. Worthington (1999) argues that expenditure by the financial sector on items such as computer networks and ATMs may not adequately capture the actual change in functionality associated with a shift from labour intensive transaction services. This study conducts an in-depth assessment of financial sector efficiency and productivity by means of adopting a Malmquist index.

Second, this study has employed a larger category of financial institutions than have other studies. The sample data included in this study comes from commercial banks, development banks, a savings bank, an investment bank and a building society. All these categories had similar inputs and outputs and hence it was possible to apply DEA methodology. Finally, no previous study has assessed efficiency, productivity changes and their determinants in one study. This study therefore extends the existing literature by assessing the efficiency, productivity changes and their determinants in one study.

8.5 Limitations of the Study

This study can be improved on several grounds. First, as an efficient frontier technique, DEA identifies inefficiency in a particular DMU by comparing it to similar DMUs regarded as efficient rather than trying to associate a DMU's performance with statistical averages that may not be applicable to that DMU. This, therefore, implies that there may be some outliers in the DEA method that may influence the empirical results, especially in the present study, since the sample used consists of only ten financial institutions.

Second, the present study shares its deterministic nature with other DEA-based approaches in that no allowance is made for measurement or specification errors. However, in terms of productivity analysis, the Malmquist index approach is entirely general and can also be implemented in econometric frontiers such as SFA. Third, another limitation is the failure to incorporate the contextual or nondiscretionary factors into the analysis. This omission is largely as a result of inadequate data, leading to difficulty in understanding why changes in productivity and efficiency have occurred.

Lastly, in this study the sample size was also limited, which has made it impossible to carry out a multivariate analysis of the determinants of efficiency. The univariate approach does not satisfactorily address the inter-relationship among technical efficiency and bank financial parameters, since most bank characteristics considered in the study could be correlated with each other.

8.6 Areas for Future Research

The results and limitations of this study suggest some avenues for further research to deepen the understanding of financial institutions' efficiency in Botswana. This study has assessed the efficiency of the financial sector by applying the DEA model. One possibility for future research, which would address one of the limitations of this study, is to apply different frontier approaches (such as parametric) and compare the results from these different methods.

As noted before, the present study shares its deterministic nature in common with other DEA-based approaches in that no allowance is made for measurement or specification errors. However, in terms of productivity analysis, the Malmquist index approach is entirely general in that it can also be implemented in other frontiers such as Stochastic Frontier Analysis, but, as Worthington (2000) noted, this has rarely been done. This indicates an important area for future research.

Another possibility (if there were many different kinds of financial institutions in Botswana) would be to carry out the tests for different sub-groups of financial institutions, such as commercial banks, credit unions, building societies and development banks, using the same approach rather than aggregating them as one

group. This would highlight the relative patterns of efficiency and productivity changes in these related groups of institutions. If data were available, a longer series of observations on these financial institutions would make possible a closer investigation of efficiency and productivity changes in financial services. This would yield more detailed and specific information about the impact of financial reforms.

The study focused on financial sector efficiency after liberalisation due to the lack of data on the pre-liberalisation period. This limited the study regarding the conclusions that could be drawn about the impact of financial reforms on the efficiency of financial institutions. It is important that a study is conducted on the efficiency levels of financial institutions before and after financial sector liberalisation. This would enable comparison of efficiency in both periods leading to an accurate evaluation of the liberalisation policy.

The results reported in this study need to be benchmarked with those of other developing economies at a similar stage of economic development, with the objective of identifying the areas in which financial sector performance could be improved and what policies should be changed in order to achieve this. Therefore, it would be of interest to expand the methodology to other developing economies at a similar stage of economic development, to compare relative outcomes.

Bibliography

Adongo, J., Stock, C. and Hasheela, E. 2005, "Measuring the Alternative Profit X-efficiency of Namibia's Banking Sector", *NEPRU Research Report No. 36*, Windhoek.

Akhavein, I.A., Lovell, C.A.K. and Humphrey, D.B. 1997, "The Effects of Mega-mergers on Efficiency and Prices: Evidence from a Bank Profit Function", *Review of Organisation,* 12(1), 95-130.

Angelidis, D. and Lyroudi, K. 2006, "Efficiency in the Italian Banking Industry: Data Envelopment Analysis and Neural Networks", *International Research Journal of Finance and Economics*, 5(1), 155-165.

Ataullah, A., Cockerill, T. and Le, H. 2004, "Financial Liberalisation and Bank Efficiency: A Comparative Analysis of India and Pakistan", *Applied Economics*, 36(17), 1915-1924.

Ataullah, A. and Le, H. 2006, "Economic Reforms and Bank Efficiency in Developing Countries: The Case of the Indian Banking Industry", *Applied Financial Economics*, 16(9), 653-663.

Avkiran, N.K. 1999, "The Evidence of Efficiency Gains: The Role of Mergers and the Benefits to the Public", *Journal of Banking and Finance,* 23(7), 991-1013.

Avkiran, N.K. 2000, "Rising productivity of Australian trading banks under deregulation 1986-1995", *Journal of Economics and Finance,* 24(2), 122-140.

Bank of Botswana 1996, *Bank of Botswana Economic Review,* Gaborone.

Bank of Botswana 1993, *Annual Report*, Gaborone.

Bank of Botswana 1999, *Annual Report*, Gaborone.

Bank of Botswana 2001, *Annual Report*, Gaborone.

Bank of Botswana 2002, *Annual Report*, Gaborone.

Bank of Botswana 2003, *Annual Report*, Gaborone.

Bank of Botswana 2005, *Annual Report*, Gaborone.

Bank of Botswana 2006, *Annual Report*, Gaborone.

Bank of Botswana 2007, *Annual Report*, Gaborone.

Banker, R.D., Charnes, A. and Cooper, W.W. 1984, "Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis", *Management Science,* 4(30), 1078-1092.

Barr, R.S., Killgo, K.A. and Siems, T.F. 1999, "Evaluating the Productive Efficiency and Performance of US Commercial Banks", *Financial Industry Studies Working Paper 99-3*, Federal Reserve Bank of Dallas, Dallas.

Bauer, P.W. and Hancock, D. 1993, "Efficiency of Federal Reserve in Providing Check and Processing Services", *Journal of Banking and Finance*, 17(2-3), 287-311.

Bauer, P.W., Berger, A.N. and Humphrey, D.B. 1993, "Efficiency and Productivity Growth in US. Banking", in Fred, H.O., Lovell, C.A.K. and Schmidt, S.S. (eds), *The Measurement of Productive Efficiency: Techniques and Applications*, Oxford University Press, UK.

Bauer, P.W., Berger, A.N., Ferrier, G.D. and Humphrey, D.B. 1998, "Consistency Conditions for Regular Analysis of Financial Institutions: A Comparison of Frontier Efficiency Methods", *Journal of Economics and Business*, 50(2), 85-114.

Beck, T., Demirguc-Kunt, A. and Levine, R. 1999, "A New Database on Financial Development and Structure", *World Bank Working Paper 2146*, Washington DC.

Beck, T., Levine, R. and Loayza, N. 1999, "Finance and Sources of Growth", *World Bank Working Paper 2057*, Washington DC.

Beck T, Levine R, and Loayza, N. 2000, "Finance and Sources of Growth", *Journal of Financial Economics*, 58(2), 261-300.

Beim, D.O. and Calomiris, C.W. 2001, *Emerging Financial Markets*, McGraw-Hill, New York.

Benson, G.J. 1965, "Branch Banking and Economies of Scale", *Journal of Finance*, 20(2), 312-331.

Berg, S.A., Forsund, F.R. and Jansen, E.S. 1992, "Malmquist Indices of Productivity Growth during the Deregulation of Norwegian Banking", *Scandinavian Journal of Economics*, 94(Supplement), 211-228.

Berger, A.N. 1993, "Distribution Free Estimates of Efficiency in the US. Banking Industry and Tests of the Standard Distributional Assumptions", *Journal of Productivity Analysis*, 4(3), 261-292.

Berger, A.N. and DeYoung, R. 1997, "Problem Loans and Cost Efficiency in Commercial Banks", *Journal of Banking and Finance*, 21(6), 849-870

Berger, A. and Hannan, T. 1998, "The Efficiency Cost of Market Power in the Banking Industry: A Test of the 'Quiet Life' and Related Hypotheses", *Review of Economics and Statistics,* 80(3), 454-465.

Berger, A.N. and Humphrey, D.B. 1991, "The Dominance of Inefficiencies Over Scale and Product Mix Economies in Banking", *Journal of Monetary Economies,* 28(1), 117-148.

Berger, A.N. and Humphrey, D.B. 1993, *Bank Scale Economies, Mergers, Concentration and Efficiency: The US Experience,* Wharton Financial Institutions Centre, Pennsylvania.

Berger, A.N. and Humphrey, D.B. 1997, "Efficiency of Financial Institutions: International Survey and Directions for Future Research", *European Journal of Operational Research,* 98(2), 175-212.

Berger, A.N., Humphrey, D.B. and Pulley, L.B. 1996, "Do Consumers Pay for One-Stop Banking? Evidence from an Alternative Revenue Function", *Journal of Banking and Finance,* 20(9), 1601-1621.

Berger, A.N., Hunter, W.C. and Timme, S.G. 1993, "The Efficiency of Financial Institutions: A Review and Preview of Research Past, Present and Future", *Journal of Banking and Finance,* 17(2-3), 221-249.

Berger, A.N. and Mester, L.J. 1997, "Inside the Black Box: What Explains Differences in Efficiencies of Financial Institution?", *Journal of Banking and Finance,* 21(3), 895-947.

Bhattacharyya, A., Lovell, C.A.K. and Sahay, P. 1997, "The Impact of Liberalisation on the Productive Efficiency of Indian Commercial Banks", *European Journal of Operational Research,* 98(2), 332-345.

Boss, J. and Kolari, J. 2003, "Large Bank Efficiency in Europe and the United States: Are there Economic Motivations for Geographic Expansion in Financial Services?" *Research Series Supervision No.61,* De Nederlandsche Bank, Netherlands.

Breston, G.J. 1972, "Economies of Scale of Financial Institutions", *Journal of Money, Credit and Banking*, 4(2), 312-341.

Canhoto, A. and Dermine, J. 2003, "A Note on Banking Efficiency in Portugal, New vs. Old Banks", *Journal of Banking and Finance*, 27(11), 2087-2098.

Caprio, G. and Peria, M.S. 2000, "Avoiding Disaster: Policies to Reduce the Risk of Banking Crises", *Working Paper 47,* Egyptian Centre for Economic Studies.

Caves, D.W, Christensen, L.R. and Diewert, W.E. 1982, "The Economic Theory of Index Numbers and the Measurement of Input, Output and Productivity", *Econometrica*, 50(6), 1393-1414.

Central Bank of Brazil 2005, "Report on the Brazilian Retail Payment System", Brasilia: Central Bank of Brazil.

Central Bank of the Philippines 2007, "Circular No. 562", Manilla: Central Bank of the Philippines.

Chang, C.E., Hassan, I. and Hunter, W.C. 1998, "Efficiency of Multinational Banks: An Empirical Investigation", *Applied Financial Economics*, 8(6), 689-696.

Charnes, A., Cooper, W.W. and Rhodes, E. 1978, "Measuring the Efficiency of Decision Making Units", *European Journal of Operational Research,* 3(2), 429-444.

Chen, X., Skully, M. and Brown, K. 2005, "Banking Efficiency in China: Application of DEA to Pre and Post Deregulation Eras 1993-2000", *China Economic Review*, 16(3), 229-245.

Coelli, T. 1996, "A Guide to DEAP Version 2.1, A Data Envelopment Analysis (Computer) Program". CEPA Working Paper 96/08.

Coelli, T.J., Rao, D.S.P., O'Donnell, C.J. and Battese, G.E. 2005, *An Introduction to Efficiency and Productivity Analysis,* Springer Science and Business Media, New York.

Das, A. and Ghosh, S. 2006, "Financial Deregulation and Efficiency: An Empirical Analysis of Indian Banks during the Post Reform Period", *Review of Financial Economics*, 15(3), 193-221.

Debasish, S.S. 2006, "Efficiency Performance in Indian Banking - Use of Data Envelopment Analysis", *Global Business Review*, 7(2), 325-333.

DeYoung, R. and Nolle, D. 1996, "Foreign-Owned Banks in US: Earning Market Share or Buying it?", *Journal of Money, Credit and Banking*, 28(4), 622-637.

Drake, L. 2001, "Efficiency and Productivity Change in UK Banking", *Applied Financial Economics*, 11(5), 557-571.

Elyasian, E. and Mehdian, S.M. 1990, "A Non-parametric Approach to Measurement of Efficiency and Technological Change: The Case of Large US Commercial Banks", *Journal of Financial Services Research*, 4(2), 157-238.

Elyasiani, E. and Mehdian, S.M. 1995, "The Comparative Efficiency Performance of Small and Large US Commercial Banks in the Pre and Post Deregulation Eras", *Applied Economics*, 27(11), 1069-1079.

Emrouznejad, A. 1995-2001, *Ali Emrouznejad's DEA Homepage*, Warwick Business School, Coventry CV4 7AL, UK.

Emrouznejad, A. 2001, *An Extensive Bibliography of Data Envelopment Analysis (DEA), Volume I-V*, http://www.warwick.ac.uk~bsrlu, Business School, University of Warwick, Coventry CV4 7AL, UK.

Emrouznejad, A., Parker, B. and Tavares, G. 2008, " Evaluation of Research in Efficiency and Productivity: A Survey and Analysis of the First 30 Years of Scholarly Literature in DEA", *Socio-Economic Planning Sciences*, 42(2), 151-157.

English, M., Grosskopf, S., Hayes, K. and Yaisawarng, S. 1993, "Output Allocative and Technical Efficiency of Banks", *Journal of Banking and Finance*, 17(2-3), 349-366.

Evanoff, D. and Ors, E. 2002, "Local Market Consolidation and Bank Productive Efficiency", *Federal Reserve Bank of Chicago, WP2002-25*, Chicago.

Fare, R., Grosskopf, S. and Lindgren, P. 1989, "Productivity Developments in Swedish Hospitals: A Malmquist Output Index Approach", *Discussion Paper No. 89-3*, Southern Illinois University, Illinois USA.

Fare, R., Grosskopf, S., Yaisawang, S., Li, S.K. and Wang, Z. 1990, "Productivity Growth in Illinois Electricity Utilities", *Resources and Energy*, 12(4), 383-398.

Fare, R., Grosskopf, B. and Norris, M. 1994, "Productivity Growth, Technical Progress and Efficiency Change in Industrialised Countries", *American Economic Review*, 84(1), 66-83.

Farrell, M.J. 1957, "The Measurement of Productive Efficiency", *Journal of the Royal Statistical Society*, 120(3), 253-289.

Favero, C.A. and Papi, L. 1995, "Technical Efficiency and Scale Efficiency in the Italian Banking Sector: A Non-parametric Approach", *Applied Economics*, 27(4), 385-395.

Ferrier, G. and Lovell, C.A.K. 1990, "Measuring Cost Efficiency in Banking: Econometric and Linear Programming Evidence", *Journal of Econometrics*, 46(1-2), 229-245.

Figueira, C., Nellis, J. and Parker, D. 2006, "Does Ownership Affect the Efficiency of African Banks?", *Journal of Developing Areas*, 40(1), 38-63.

Finscope South-Africa 2005, *Survey Highlights Including FSM Model*, Finmark Trust. www.finmark.org.za.

Fried, H.O., Lovell, C.A.K. and Eeckaut, P.V. 1993, "Evaluating the Performance of US. Credit Unions", *Journal of Banking and Finance*, 17(2-3), 251-265.

Fried, H.O., Lovell, C.A.K. and Schmidt, S.S. 1993, *The Measurement of Productive Efficiency*, Oxford University Press, New York.

Fry, M.J. 1988, *Money, Interest and Banking in Economic Development*, John Hopkins University Press, Baltimore.

Fukuyama, H. 1995, "Measuring Efficiency and Productivity Growth in Japanese Banking: A Non-parametric Approach", *Applied Financial Economics*, 5(2), 95-107.

Gilbert, R.A. and Wilson, P.W. 1998, "Effects of Deregulation on the Productivity of Korean Banks", *Journal of Economics and Business*, 50(2), 133-155.

Gompers, P. and Lerner, J. 2001, "The Venture Capital Revolution", *Journal of Economic Perspectives*, 15(2), 145-168.

Greene, W.H. 1990, "A Gamma-Distributed Stochastic Frontier Model", *Journal of Econometrics*, 46(1-2), 141-165.

Grosskopf, S. 1993, "Efficiency and Productivity", in Fried H.O., Lovell, C.A.K. and Schmidt, S.S. (eds), *The Measurement of Productive Efficiency: Techniques and Applications*, Oxford University Press, UK.

Grosskopf, S. 1996, "Statistical Inference and Nonparametric Efficiency: A Selective Survey", *Journal of Productivity Analysis*, 2(7), 161-176.

Hancock, D. 1985, "Bank Profitability, Interest Rates and Monetary Policy", *Journal of Money, Credit and Banking*, 17(2), 189-202.

Hao, J., Hunter, W.C. and Yang, W.K. 2001, "Deregulation and Efficiency: The Case of Private Korean Banks", *Journal of Economics and Business*, 53(2-3), 237-254.

Harvey, C. 1996, "Banking Policy in Botswana: Orthodox but Untypical", *IDS Working Paper No. 39*, University of Sussex, UK.

Hassan, I. and Hunter, W. 1996, "Efficiency of Japanese Multinational Banks in the US", *Research in Finance*, 14(1), 157-173.

Haynes, M. and Thompson, S. 1999, "The Productivity Effects of Bank Mergers: Evidence from the UK Building Societies", *Journal of Banking and Finance*, 23(5), 825-846.

Hughes, J.P., Lang, W., Mester, L.J., Moon, C.G. and Pagano, M. 2003, "Do Banks Sacrifice Value to Build Empires? Managerial Incentives, Industry Consolidation and Financial Performance", *Journal of Banking and Finance*, 27(3), 417-447.

Hunter, W.C. and Timme, S.G. 1986, "Technical Change, Organisational Form and Structure of Bank Production", *Journal of Money, Credit and Banking*, 18(2), 152-166.

Ikhide, S. 2000, "Efficiency of Commercial Banks in Namibia", *Occasional Paper No. 4*, Bank of Namibia, Namibia.

Isik, I. and Hassan, M.K. 2003, "Financial Deregulation and Total Factor Productivity Change: An Empirical Study of Turkish Commercial Banks", *Journal of Banking and Finance*, 27(8), 1455-1485.

Jeanneney, S.G., Hua, P. and Liang, Z. 2006, "Financial Development, Economic Efficiency and Productivity Growth: Evidence from China", *The Developing Economics*, 44(1), 27-52.

Jefferis, K. 2007, *Enhancing Access to Banking and Financial Services in Botswana*, Finmark Trust and Econsult, Gaborone.

Jemric, I. and Vujcic, B. 2002, "Efficiency of Banks in Croatia: A DEA Approach", *Working Paper 7*, Croatian National Bank, Croatia.

Jensen, M.C. and Meckling, W.C. 1976, "Theory of the Firm: Managerial Behaviour, Agency Costs and Ownership Structure", *Journal of Financial Economics*, 3(3), 305-360.

Kalijaran, K.P. 1990, "On Measuring Economic Efficiency", *Journal of Applied Econometrics*, 5(1), 75-85.

Katib, M. and Mathews, K. 2000, "A Non-Parametric Approach of Efficiency Measurement in the Malaysian Banking Sector", *Singapore Economic Review*, 44(2), 89-114.

King, R.G. and Levine, R. 1993, "Finance and Growth: Schumpeter Might Be Right", *Quarterly Journal of Economics*, 108(3), 717-737.

Kraft, E. and Tirtiroglu, D. 1998, "Bank Efficiency in Croatia: A Stochastic Frontier Analysis", *Journal of Comparative Economics*, 26(2), 282-300.

Kumbhakar, S.C. and Lovell, K. 2000, *Stochastic Frontier Analysis*, Cambridge University Press, London.

Kumbhakar, S.C. and Sarkar, S. 2003, "Deregulation, Ownership, and Productivity Growth in Banking Industry: Evidence from India", *Journal of Money, Credit and Banking*, 35(3), 403-424.

Leibenstein, H. 1978, "On the Basic Proposition of X-Efficiency Theory", *American Economic Review*, 68(2), 328-332.

Leightner, J.E. and Lovell, C.A.K. 1998, "The Impact of Financial Liberalisation on the Performance of Thai Banks", *Journal of Economics and Business*, 50(2), 115-131.

Levine, R. 1997, "Financial Development and Economic Growth: Views and Agenda", *Journal of Economic Literature*, 4(35), 688-726.

Lovell, C.A.K. 1993, "Production Frontiers and Productive Efficiency", in Fried H.O., Lovell, C.A.K. and Schmidt, S.S. (eds), *The Measurement of Productive Efficiency: Techniques and Applications*, Oxford University Press, UK.

Maghyereh, A. 2004, "Effects of Financial Liberalisation on Efficiency – Case of Jordanian Banks", *Journal of Transnational Management Development*, 9(2), 71-106.

Mayer, C. 1988, "New Issues in Corporate Finance", *European Economic Review*, 32(5), 1167-1188.

McAllister, P.H. and McManus, D. 1993, "Resolving the Scale Efficiency Puzzle in Banking", *Journal of Banking and Finance*, 17(2-3), 389-405.

Mendes, V. and Rebelo, J. 1999, "Productive Efficiency, Technological Change and Productivity in Portuguese Banking", *Applied Financial Economics*, 9(5), 513-521.

Mester, L.J. 1996, "A Study of Bank Efficiency Taking into Account Risk-Preferences", *Journal of Banking and Finance*, 20(6), 1025-1045.

Mmolawa, B. 2003, **"**Informal Financial Markets", *Barclays Bank Botswana Economic Review*, Barclays Bank, Botswana.

Mukherjee, K., Ray, S.C. and Miller, S.M. 2001, "Productivity Growth in Large US Commercial Banks: The Initial Post-Deregulation Experience", *Journal of Banking and Finance*, 25(5), 913-937.

Neal, P. 2004, "X-Efficiency and Productivity Change in Australian Banking", *Australian Economic Papers*, 43(2), 174-191.

Ngugi, R.W. 2004, *Determinants of Interest Rate in Kenya*, KIPPRA Discussion Paper No. 41, June 2004.

Nishimizu, M. and Page, J.M. 1982, "Total Factor Productivity Growth, Technological Progress and Technical Efficiency Change: Dimensions of Productivity Change in Yugoslavia 1965-1978", *The Economic Journal*, 92(365), 920-936.

Ozkan-Gunay, E. and Tektas, A. 2006, "Efficiency Analysis of the Turkish Banking Sector in Pre-crisis and Crisis Period: A DEA Approach", *Contemporary Economic Policy*, 24(3), 418-431.

Paxton, J. 2006, "Technical Efficiency in the Rural Financial Sector: Evidence from Mexico", *The Journal of Developing Areas*, 39(2), 101-119.

Paxton, J. 2007, "Technical Efficiency in a Semi-Formal Financial Sector: The Case of Mexico", *Oxford Bulletin of Economics and Statistics*, 69(1), 57-74.

Peek, J., Rosengren, E.S. and Kasirye, F. 1999, "The Poor Performance of Foreign Bank Subsidiaries: Were the Problems Acquired or Created?", *Journal of Banking and Finance*, 23(2-4), 579-604.

Pi, L. and Timme, S.G. 1993, "Corporate Control and Bank Efficiency", *Journal of Banking and Finance*, 17(2), 515-530.

Rangan, N., Grabowski, R., Aly, H.Y. and Pasurka, C. 1988, "The Technical Efficiency of US Banks", *Economics Letters*, 28(2), 169-175.

Reddy, A.A. 2005, "Banking Sector Deregulation and Productivity Change Decomposition of Indian Banks", *Finance India*, 19(3), 983-1001.

Resti, A. 1997, "Evaluating the Cost Efficiency of the Italian Banking System: What can be Learned from the Joint Application of Parametric and Non-Parametric Techniques?", *Journal of Banking and Finance*, 21(2), 221-250.

Rezitis, A.N. 2006, "Productivity Growth in the Greek Banking Industry: A Non-Parametric Approach", *Journal of Applied Economics*, 9(1), 119-138.

Rogers, K.E. 1998, "Non-traditional Activities and the Efficiency of US Commercial Banks", *Journal of Banking and Finance*, 22(4), 467-485.

Sacerdoti, E. 2005, *Access to Bank Credit in Sub-Saharan Africa: Key Issues and Reform Strategies*, IMF Working Paper WP/05/166, Washington DC.

Sathye, M. 2001, "X-Efficiency in Australian Banking: An Empirical Investigation", *Journal of Banking and Finance*, 25(3), 613-630.

Sathye, M. 2003, "Efficiency of Banks in a Developing Economy: The Case of India", *European Journal of Operational Research*, 148(3), 662-671.

Sealy, C.W. and Lindley, J. 1977, "Inputs, Outputs and a Theory of Production and Cost at Depository Financial Institutions", *Journal of Finance,* 32(4), 1252-1266.

Sengupta, J.K. 2003, *New Efficiency Theory with Applications of Data Envelopment Analysis,* Springer-Verlag, New York.

Shaffer, S. 1989, "Challenges to Small Bank Survival", *Federal Reserve Bank of Philadelphia Business Review,* Philadelphia.

Shanmugam, K.R. and Das, A. 2004, "Efficiency of Indian Commercial Banks During the Reform Period", *Applied Financial Economics*, 14(9), 681-686.

Sherman, H.D. and Gold, F. 1985, "Bank Branch Operating Efficiency: Evaluation with Data Envelopment Analysis", *Journal of Banking and Finance*, 9(2), 297-315.

Siphambe, H.K., Narayana, N., Akinkugbe, O. and Sentsho, J. 2005, *Economic Development of Botswana: Facets, Policies, Problems and Prospects*, Bay Publishing, Gaborone.

South-African Reserve Bank 2006, "Banks Act Circular 6/2006: Cell-Phone Banking", Pretoria: SARB Registrar of Banks.

Sowlati, T. and Paradi, J.C. 2004, "Establishing the Practical Frontier in Data Envelopment Analysis", *Omega*, 32(4), 261-272.

Sufian, F. 2006, "The Efficiency of Non-Bank Financial Institutions: Empirical Evidence from Malaysia", *International Research Journal of Finance and Economics*, 6(1), 49-65.

Taylor, W.M., Thompson, R.G., Thrall, R.M. and Dharmapala, P.S. 1997, "DEA/AR Efficiency and Profitability of Mexican Banks: A Total Income Model", *European Journal of Operational Research,* 98(2), 175-212.

Thanassoulis, E. 2001, *Introduction to the Theory and Application of Data Envelopment Analysis*, Kluwer Academic Publishers, USA.

Tortosa-Ausina, E. 2002, "Bank Cost Efficiency and Output Specification", *Journal of Productivity Analysis,* 18(3), 199-222.

Wheelock, D.C. and Wilson P.W. 1999, "Technical Progress, Inefficiency and Productivity Change in US Banking 1984-1993", *Journal of Money, Credit and Banking*, 31(2), 212-234.

World Bank 1987, *World Development Report*, Oxford University Press, New York.

World Bank 1989, *World Development Report*, Oxford University Press, New York.

Worthington, A.C. 1998, "The Application of Mathematical Programming Techniques to Financial Statement Analysis: Australian Gold Production and Exploration", *Australian Journal of Management*, 23(1), 97-114.

Worthington, A.C. 1999, "Measuring Technical Efficiency in Australian Credit Unions", *The Manchester School*, 67(2), 231-248.

Worthington, A.C. 1999, "Malmquist Indices of Productivity Change in Australian Financial Services", *Journal of International Financial Markets, Institutions and Money*, 9(3), 303-320.

Worthington, A.C. 2000, "Technical Efficiency and Technological Change in Australian Building Societies" *Abacus*, 36(2), 180-197.

Yildirim, C. 2002, "Evolution of Banking Efficiency within an Unstable Macroeconomic Environment: The Case of Turkish Commercial Banks", *Applied Economics*, 34(18), 2289-2301.

Yildirim, H.S. and Philippatos, G. C. 2007, "Efficiency of Banks: Recent Evidence from the Transition Economies of Europe, 1993-2000", *The European Journal of Finance*, 13(2), 123-143.

List of Candidate's Publications

Published Refereed Articles

Moffat, B., Valadkhani, A. and Harvie, C. 2009 'Malmquist Indices of Productivity Change in Botswana's Financial Institutions', *Global Business and Economic Review*, 11(1), in press, [ABCD=C].

Articles under Review

Moffat, B., Valadkhani, A. 'Technical Efficiency of Financial Institutions in Botswana: a DEA Approach', *Applied Economics.*

Working Paper Series

Moffat, B., Valadkhani, A. and Harvie, C. 2008, *Identifying Productivity Change in Botswana's Financial Institutions: An Application of Malmquist Productivity Indices*, Working Paper No. 13, School of Economics, University of Wollongong.

Moffat, B., Valadkhani, A. 2008, *Technical efficiency in Botswana's financial institutions: a DEA approach*, Working Paper No. 14, School of Economics, University of Wollongong.

Conference Presentations

Moffat, B., Valadkhani, A. 2009, 'A Data Envelopment Analysis of Financial Institutions in Botswana', Oxford Business and Economics Conference, 24-26 June 2009, Oxford University, Oxford (to be presented).