Measuring the Alternative Profit X-efficiency Of Namibia's Banking Sector

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Abstract

Central bankers recognise that efficiency in the banking sector is a key contributor to macroeconomic stability, which is a precondition for economic growth and is important for the effectiveness of monetary policy. While this report does not attempt to empirically assess the relationship between banking sector efficiency and economic growth in Namibia; empirical studies in other countries, such as Italy, have incorporated the measure derived in this report into the growth model and find that efficiency of the banking sector in allocating credit to investment opportunities that offer the highest returns positively contributes to economic growth.

A banking sector's efficiency can be represented by the average efficiency of its individual banks. This research report adopted the alternative profit concept, specified a transcendental logarithmic (translog) function and applied the distribution free approach to a panel dataset of banks in Namibia that were in continuous existence from the first quarter in 1998 to the fourth quarter in 2003 to empirically measure the X-efficiencies of the individual banks and the overall banking sector in Namibia.

Using this methodology the report found that Nedbank Namibia was the most alternative profit, X-efficient bank in Namibia from 1998 to 2003. Bank Windhoek, Standard Bank Namibia, the Agricultural Bank of Namibia and First National Bank of Namibia closely followed it, respectively.

The high ranking of Nedbank Namibia should be viewed in light of the fact that it had the lowest branch network of all the commercial banks in Namibia between 1998 and 2003. The low rank of First National Bank of Namibia could be attributed to its expansion strategy that resulted in it having the largest branch network of all the commercial banks in Namibia between 1998 and 2003. Its merger and acquisition (M&A) activity over the sample period makes it impossible for this report to isolate the effects of pure X-efficiency from the effects of its M&A activity in order to make a judgement on the cost or benefits of this expansion strategy.

Although Nedbank Namibia also participated in M&A activity in 2002, through its acquisition of the micro lending arm of SAAMBOU Bank housed in Finance in Education (Pty) Ltd., this did not have the same effect as in the case of First National Bank of Namibia because the newly acquired institution was not incorporated into the banking operations of Nedbank Namibia but was left as an independent subsidiary, regulated by the Namibia Financial Institutions Supervisory Authority.

This report also found that the mean level of alternative profit X-efficiency in Namibia's banking sector from 1998 to 2003 was 83% suggesting that banks in Namibia lost approximately 17% of their potential profits between 1998 and 2003 due to X-inefficiency. This finding shows that Namibia fares well relative to other profit efficiency studies that had been conducted internationally, using the distribution free approach, as of 1997. These studies found that the mean level of

potential profits lost by banking sectors in all profit efficiency studies, regardless of approach used, was 55%.

Since the Namibia panel dataset is small, the findings need to be tested in a more statistically, robust environment that includes more banks. In recognition of this, the research report is designed as a pilot initiative that aims to provide a template for a future continental study covering all financial intermediaries, excluding insurance companies, in Africa. The findings of this continental study should result in a robust, empirical tool that will assist institutions such as NEPRU to monitor the impact of various events, such as regional integration and M&A activity, on bank efficiency on the continent.

In an attempt to serve as a continental template, this report extended its methodology to a panel dataset consisting of all financial intermediaries in Botswana, excluding insurance companies and a cross-country panel dataset for Namibia and Botswana.

This exercise finds that widening the scope of the study to include all financial intermediaries, excluding insurance companies would provide more robust findings. It also finds that the translog function does not perform well in the cross-county panel and the fourier-flexible functional form should be investigated as an alternative in the continental study.

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List of Acronyms

$a\pi x$	Alternative Profit X-efficiency
BCBS	Basel Committee on Banking Supervision
BoN	Bank of Namibia
BWP	Botswana Pula
CMA	Common Monetary Area
CPI	Consumer Price Index
DEA	Data Envelopment Analysis
DFA	Distribution Free Approach
FDH	Free Disposable Hull
FFF	Fourier-Flexible Function
H-Index	Herfindahl-Hirschman Index
ICT	Information and Communication Technologies
K	Capital
L	Labour
LIMDEP	Limited Dependent Variables
M&A	Mergers and Acquisitions
NAD	Namibian Dollars
NBFI	Non-Bank Financial Institutions
NEPRU	Namibian Economic Policy Research Unit
Netputs	Fixed Inputs and Outputs
NPL	Non-Performing Loans
NSX	Namibia Stock Exchange
ROA	Return on Assets
ROE	Return on Equity
ROI	Return on Investment
SADC	Southern African Development Community
SFA	Stochastic Frontier Approach
SME	Small and Medium-Scale Enterprises
SWABOU	South West Africa Building Society
TFA	Thick Frontier Approach
USD	United States Dollars

1. INTRODUCTION

Efficiency in the banking sector is recognised by central bankers in the Southern African Development Community (SADC) as a precondition for macroeconomic stability (Ngalande, 2003) and important for effective monetary policy execution (Hartmann, 2004). In addition, a banking sector's ability to allocate credit efficiently is expected to have positive implications for economic growth (Galbis, 1977). Luccheti, Papi & Zazzaro (2000) empirically justified this in a study on the Italian banking sector.

Credit allocation efficiency is defined as the directing of mobilised savings to investment opportunities offering the highest return (Luccheti, Papi & Zazzaro, 2000). Due to the difficulty of obtaining data on individual returns for all investments made by banks, this report adopted intra-bank efficiency as a proxy for its efficiency in credit allocation. It is essentially an assumption that efficiency at the intra-bank level represents efficiency in credit allocation and is adopted in various empirical studies including Luccheti, Papi & Zazzaro.

The main goal of this report was to measure the alternative profit X-efficiency of Namibia's banking sector as a pilot initiative that aims to provide a template for a future continental study covering all financial intermediaries in Africa, excluding insurance companies. This involved modelling a bank's internal activities using the input-output production function and then applying frontier analysis to estimate the alternative profit X-efficiency of individual banks in Namibia. The average of these individual, numerical, objectively determined efficiency values represented the alternative profit X-efficiency of Namibia's banking sector.

It is hoped that the findings of this report will lead to a continental study that will result in a robust, empirical macroeconomic measure, based on microeconomic foundations; which will assist institutions such as the Namibian Economic Policy Research Unit (NEPRU) to monitor the impact of various events, such as regional integration and M&A activity, on bank efficiency on the continent. To achieve this aim the report extended the methodology to Botswana and a cross-country panel dataset for Namibia and Botswana.

The remainder of this paper is organised as follows: Section two provides a background to the measurement of X-efficiency in the context of Namibia. Section three goes on to describe the methodology used to measure X-efficiency in the Namibian banking sector. This is followed by section four, which presents the results of an application of the methodology and an associated discussion. Finally, section five presents the conclusions.

2. BACKGROUND

A positive link between financial intermediation and economic growth is empirically supported, widely accepted and has been increasingly incorporated as a determinant in the growth model over the past several decades (Gurley & Shaw, 1955 and Goldsmith, 1969). Empirical studies indicate that this link could occur through two channels - factor accumulation and changes in efficiency (Collins, 2002).

Studies that have empirically attempted to investigate the efficiency channel find that efficiency in the financial sector has positive implications for economic growth (Luccheti, Papi & Zazzaro, 2000). Therefore, even though an economy has enough savings to generate adequate factor accumulation (capital accumulation specifically), such as Namibia (Shiimi & Kadhikwa, 1999 and Uanguta, 2000), its growth potential can be hindered if the domestic financial intermediation mechanism fails to allocate these savings to available investment opportunities efficiently (Stulz, 2001).[1] An efficient financial intermediation mechanism also increases the expected returns to investment, which can promote innovation resulting in further positive implications for economic growth (Collins, 2002). [2]

Banks, as financial intermediaries, provide various services for depositors and borrowers. They provide liquidity and safekeeping for savings, which allows depositors to smooth consumption over time. They also conduct credit analysis, disburse loans and monitor outstanding credits for borrowers who require more financing than they can generate from internal sources or from alternative sources of finance such as financial markets (Berger & Humphrey, 1993). In addition to this, they provide payment services, trade finance, leasing and factoring solutions that finance the inventory and fixed asset needs of borrowers. The efficiency of individual banks in providing these services and conditions in the external environment determine the efficiency of the overall banking sector, which influences the effectiveness of the domestic financial intermediation mechanism.

2.1. X-efficiency

The level of intra-bank efficiency can be represented by X-efficiency. This is defined as the general efficiency of a firm judged on managerial and technological criteria in transforming inputs at minimum costs into maximum profits. It includes intra-bank economic efficiency; intra-bank motivational efficiency - individual personality; and external motivational efficiency - arising from management incentives and the

[1] A discussion on the availability of labour (the other factor of production) is beyond the scope of this paper.

[2] This assumes the that perfect markets exist where contracting is costless and the Coase theorem applies i.e. whenever there is a reallocation of resources that creates value it can be implemented at no cost (Stulz, 2001).

environment (Leibenstein, 1978). Banks that exhibit X-inefficiency are either wasting resources (technical inefficiency), or are using inefficient business processes (allocative inefficiency), or both, which is attributed to employee, management or environmental factors. [3]

X-efficiency captures the effects of the amount of technology adopted relative to the number of staff and the way this technology is used (Frei, Harker & Hunter, 1998). How effectively technology is used depends on how employees are introduced to new technologies and how these technologies are integrated into the business process. Another important factor captured by X-efficiency is how well employee contracts are drawn up and how effectively policy and procedures are implemented. These factors are determined by a bank's management, who are responsible for selecting the right staff and setting appropriate incentives aimed at influencing the behaviour of employees.

The effectiveness of management can also be affected by its own preferences. Publicly traded banks may be subject to the principal-agent problem, where managers pursue objectives that differ from those of shareholders such as empire-building - defined as the pursuit of inefficient mergers to gain larger scale and presumably prestige in having large staffs or other 'perks' (Hughes, et al., 2003).

At the external level, the pressure applied by its operating environment arising from regulation, innovation and concentration influences a bank's X-efficiency.

Innovations arising from advances in information and communication technology (ICT) enable the introduction of new financial products developed by financial engineers.

The level of concentration in a banking industry determines the pressure on banks to increase efforts to innovate and improve their business processes. In an oligopolistic industry, defined as a market structure in which a few banks dominate the industry (Griffiths & Wall, 1996),[4] there is low pressure to increase performance from the environment. The result is a quiet life effect where low levels of competition can cause relatively lower X-efficiency levels (Berger & Hannan, 1993). This can be exacerbated by the interdependence among oligopolistic banks that cooperate tacitly and imitate each other to some extent. Under these conditions, higher costs can be passed on to consumers who do not understand the nature of the service offered or lack alternative sources of finance.

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[3] X-inefficiency may also arise because inputs are theoretically assumed to have a fixed specification and yield a fixed performance, which is unrealistic (Leibenstein, 1966).

[4] A less formal definition of oligopoly is where two banks alone hold more than 75 percent of the market share, the remaining 25 percent of which is shared by less than ten banks (Athanassopoulos, Soteriou & Zenios, 1997).

2.2. Why X-efficiency

A decade of econometric research has shown that X-efficiency dominates scale and scope economies (Frei, Harker & Hunter, 1998).

Box 1: Economies of Scale and Scope

Scale economies refer to how the bank's size (scale of operations) is related to its profit. It focuses on technical efficiency, which is the ability of a bank to produce maximal output from a given set of inputs over a certain time period.

Scope economies refer to changes in product mix related to cost. It focuses on allocation efficiency, which is the ability of a bank to use inputs in optimal proportions, given their respective prices and the production technology i.e. input-mix efficiency. [5]

The concept of X-efficiency, which takes the output bundle as given, differs from that of scale and scope efficiency. Scale economies assume that banks are already on the efficient frontier, where banks are fully X-efficient and minimise costs for every scale of output. [6] Analysing banks other than those on the frontier confound scale effects with differences in X-efficiency (Berger & Humphrey, 1993).

Scope efficiency is concerned with movements along the frontier, while X-efficiency relates to an outward shift in the frontier (Frantz, 1992). Although, both scope and X-efficiency presume that inputs will be allocated to the right decision and performance units, X-efficiency does not presume the decision and performance units involved will decide and actually use inputs as effectively as possible.

X-efficiency, in addition to including scale and scope effects, also takes into account the external environment that a bank operates in. Due to the negligibility of scope economies, X-inefficiencies are usually found to arise from scale diseconomies, suggesting that it arises due to poor choice of inputs as a result of poor reaction to the prices faced.

2.3. Importance of X-efficiency

An increase in the X-efficiency of the banking sector has positive implications for economic growth. The most X-efficient banks should be better at loan targeting than their counterparts and allocate credit to the most productive uses i.e. those yielding the highest return.[7] By bringing about a change in ownership and composition of a given amount of savings, they enhance the productivity of the capital stock leading to higher levels of economic growth (Bhatia & Khatkhate, 1975). This mechanism is

[5] These concepts are described relative to the profits, but they can also be described relative to the costs or revenues.
[6] The most X-efficient bank in a sample defines an efficient frontier.

[7] This does not consider opportunities that may be more productive from a social welfare perspective.

illustrated in a theoretical framework of capital intermediation, attributed to Galbis (1977).[8]

The implication of Galbis' model for small-scale enterprises is that banks that are X-efficient are able to identify those that have projects that yield high returns and direct credit to them. This finance injection should enable these enterprises to grow and move to the medium and large-scale segments of the enterprise spectrum, where it is easier to obtain additional finance.

Furthermore, improved loan targeting by X-efficient banks should lead to lower default levels on disbursed loans. The reduction in non-performing loans (NPLs), coupled with higher returns on disbursed loans should increase profits in the banking sector.

The main role of the Bank of Namibia (BoN) – Namibia's Central Bank - is to promote monetary and financial stability in the interest of the nation's sustainable economic growth and development. According to the Post-Keynesian view, money supply is endogenous (Moore, 2002). Therefore, BoN can influence monetary policy in Namibia through the success of its efforts to ensure stability and efficiency in the banking industry. From this perspective, X-efficiency is also important for the effectiveness of monetary policy. This is because the structure of the banking system and its overall level of efficiency have a direct effect on monetary variables in the domestic economy.

X-efficiency is also important where the pace of financial sector liberalisation is high (and arguably irreversible), increasing integration into the international financial system is accompanied by within and cross-country M&As. This is expected to improve the stability of financial intermediaries because they will be able to fund themselves from abroad and diversify their risks abroad, which should lead to their insulation from local shocks. Another expected benefit of financial liberalisation is the resulting price reductions, product expansion and service improvements caused by more options for financial service provision (Stulz, 2001).

The effect of stability in the payments system on overall macroeconomic stability has an impact on a society's welfare. Whether, the resulting liberalisation has positive or negative impacts on stability in the payments system depends on the strength of the banking sector in general (Lowell, Neu & Tong, 1998) and pre-M&A levels of X-efficiency in the banking industry in particular.

In an X-inefficient banking sector the absence of systematic internal controls, inappropriate sequencing of stages of financial liberalisation, central decisions that do not make any provisions for the wave of reorganisation that ought to take place at the banks' branch level prior to and during liberalisation and the intervention of

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[8] Banks may not conduct effective loan targeting due to risk aversion as opposed to inefficiency (Adenso-Diaz & Gascón, 1997).

other incentives may result in the a lack of realisation of the positive expectations of liberalisation (Berger & Humphrey, 1997; Athanassopoulos, Soteriou & Zenios, 1997 and Frenkel & Menkhoff, 2004).

In some cases, liberalisation has led to rapid branch expansion, excessive asset growth. In a situation where there is an oversupply of finance (too much money chasing too few investment opportunities), low X-efficiency could result in an increase in NPLs, a run-up in bank failures and macroeconomic instability (Berger & Humphrey, 1997).

In other cases, the elimination of loan interest rate ceilings resulting in higher market rates and increased competition from non-bank financial institutions (NBFIs) can lead to higher costs of funding, increased demand for funds and a reduction in the supply of deposits per bank. This may result in poor total factor productivity growth, which has negative implications for economic growth (Berger & Mester, 1999).

These and other negative aspects of inappropriate financial liberalisation particularly affect small-scale enterprises because the intermediated finance that they are eligible for cannot be provided from abroad, as opposed to medium and large-scale firms that can bypass much of the local financial structure (Jun-Koo, Yong-Choel, Park & Stulz, 1995).

Finally, X-efficiency is important if banks are to survive over the long-term. The competitive landscape has been greatly altered by the innovative financial products accompanying the proliferation of NBFIs and new financial service distribution channels enabled by advances in ICT. The competition from existing banks, new entrants, international banks and NBFIs such as leasing companies, grocery chains, mobile phone companies, furniture companies and automotive giants (Athanassopoulous, Soteriou & Zenios, 1997 and National Treasury, 2004) requires banks to compete to maintain their existing market share. This will require them to choose cost-effective delivery systems and make human resource changes and appropriate technology investments (Frei, Harker & Hunter, 1998). Their success in these efforts directly depends on their X-efficiency.

2.4. Purpose of an X-Efficiency Measure

Measuring the X-efficiency of banks in Namibia is important for policymakers and practitioners.

First, after a period of no growth between 1998 and 1999, the size of the banking sector in Namibia, measured in terms of total assets, had increased by 28.85 percent by 2003 in real terms.[9] This is illustrated in Figure 1 below.

[9] Real values are obtained by normalising using the Consumer Price Index (1995=100)

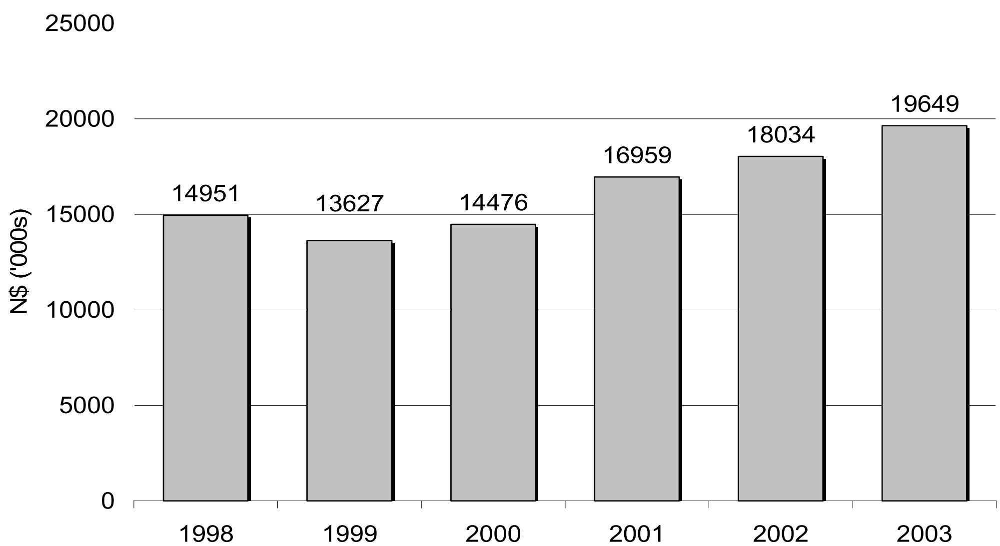

Figure 1: Size of Namibia's Banking Sector from 1998 to 2003 in Real NAD

This growth can be attributed to various factors (Kamberoglou, Liapis, Simigiannis, Tzamourani, 2002):

- The growth of local markets due to a larger pool of income earners as historical inequalities continued to be addressed, which led to an increase in the demand for banking services;
- The use of new service delivery channels in new market areas (*de novo* expansion);
- The expansion by banks into assurance in search of alternative sources of funds and profits from synergies and cross-selling of banking and insurance products and for a cost-effective way to insure deposits in a banking environment that lacks an explicit deposit insurance mechanism; [10]
- The domestic and cross-border M&A activities of banking entities arising from the need to obtain a size that would enable them to increase or, at least, maintain their domestic market shares and reduce operating costs by exploiting economies of scale.

Empirical evidence indicates that the increasing consolidation in the banking industry had an effect on the level of concentration in the banking industry (Okeahalam, 2002 and Adongo & Stork, 2005).

If this consolidation is to continue, X-efficiency measures will be increasingly important for better antitrust policy making. Antitrust policy relies heavily on the use

[10] South Africa and Namibia do not have an explicit deposit insurance scheme.

of the H-Index, which uses ex ante information to assess the market power and efficiency effects of M&A deals. If anti-trust policy does not control for efficiency, the observed relationship between market power and prices or profits may not be easily separated from the effects of market power and efficiency (Akhavein, Berger & Humphrey, 1997).

Second, X-efficiency measures can also improve the predictive accuracy of failure prediction models, which is useful for regulators such as the BoN (Barr, Seiford, & Siems, 1994). Various empirical studies have shown that banks display low efficiency prior to failure and those with relatively low efficiency levels have a higher probability of failure than their more efficient counterparts (Berger & Humphrey, 1992a; Cebenoyan, Cooperman, and Register, 1993 and Hermalin & Wallace, 1994).

Third, X-efficiency measures can also be of assistance in monitoring the dynamics in the banking sector in the context of various external events such as regional integration. This is important for SADC in measuring its objective of fostering competition and improving efficiency in the regional banking sector (SADC, 2003).

Fourth, the BoN inherited its legal framework from the Banks Act 23 of 1965, for the banking industry, and Building Societies Act of 1986, for building societies. In 1998, the Banking Institutions Act 2 of 1998 replaced these. This Act represents a legal framework encapsulating internationally adopted banking standards and supervisory practices that are based on the Core Principles for Effective Banking Supervision recommended by the Basel Committee on Banking Supervision (BCBS). Provisions of the Act include the implementation of prudential requirements, regulations and guidelines and a bank risk reporting system. The Basel Committee reviews the provisions regularly and makes recommendations that conform to local and international developments in banking practice.

The Banking Institutions Act in Namibia is set to change following its conformity to the Basel II Capital Accord. X-efficiency measures will be important for monitoring the impact of the regulatory changes instituted by Basel II on the banking sector. These changes are expected to arise from the different uses of the risk measurement framework stipulated by the new Accord relative to the Basel I Capital Accord on which the Banking Institutions Act of 1998 is based (Saidenburg & Schuermann, 2003).

Fifth, X-efficiency measures can be used to generate rankings of the relative efficiencies of individual banks. This can motivate a bank's management to adopt "best practices" that are found among banks on or near the X-efficient frontier.[11] It can also assist managers in adjusting their policies and procedures to avoid "worst

[11] A best practice bank is defined as one that has the highest expected profits, given the business conditions specified in its profit function and reflects the best attempts to use technology and respond to market prices and other business conditions (Berger & Mester, 1999).

practices" that are relatively common among banks that are far from the X-efficient frontier.

The information provided by the X-efficiency measures on the relative efficiencies of banks in the industry can be useful in supporting Pillar 3 on public disclosure in the Basel II Capital Accord. This pillar depends on the financial market to apply pressure on banks (Saidenburg & Schuermann, 2003). An X-efficiency measure is important where some banks are not listed on the Namibian Stock Exchange (NSX) or where there is no active investor community.

Sixth, the BCBS, through the Advanced Measurement Approach, seeks to provide flexibility for banks to use their own internal measurement approaches subject to meeting rigorous qualitative and quantitative standards (Saidenburg & Schuermann, 2003). It is hoped that the method used to measure X-efficiency in this report will support this effort and will be a first step towards determining areas for which more advanced risk measures can be applied in the banking industry.[12]

Finally, when X-efficiency measures are regressed on potential determinants they may highlight relationships with various internal organisational and external environmental factors that suggest managerial arrangements and environmental conditions that are associated with X-efficiency (Berger & Humphrey, 1997). This is important for policy makers and practitioners to identify potential areas of intervention that can boost efficiency in a banking sector.

2.5. Alternative Ways to Measure Efficiency

Besides the use of frontier analysis to measure X-efficiency, various other approaches to measuring bank efficiency exist.

2.5.1. Banking Productivity per Employee Hour

Some government agencies collect productivity statistics on various sectors, including banks. These statistics view efficiency from the production approach, which we describe in the methodology section. A typical measure used captures banking productivity per employee hour. However, bank employee labour hours may be an inaccurate indicator of efficiency because of trends towards outsourcing of back-office operations to holding company affiliates and service bureaus. Failure to account either for the labour used elsewhere in the holding company but effectively working for the bank or for the cost of this labour and capital could bias government productivity measures toward 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.

[12] Currently models from the insurance industry are being applied (Saidenburg & Schuermann, 2003).

2.5.2. Minimum Reserves

Bank regulatory agencies use a comparison of actual reserves (required as well as excess reserves) held against the regulatory minimums as an alternative measure of efficiency and use this as a legal basis for taking supervisory action (Demigürç-Kurt & Huizinga, 1998). A high ratio of actual reserves over the regulatory minimum would be an indicator of financial repression and inefficiency.

2.5.3. Risk Ratings

The Basel II Capital Accord advocates the use of risk ratings as an alternative way to measure bank efficiency. One measure used under this approach is the value-at-risk, which is defined as the loss to an investment portfolio due to an adverse market move (Saidenburg & Schuermann, 2003). It is a scalar measure and may not incorporate all the different aspects of the highly dimensional problem that it summarises. Risk ratings also capture credit risk, concentration risk, interest rate risk and business risk (operational risk). Operational risk is defined as the risk of direct or indirect loss resulting from inadequate or failed internal processes, people and systems or from external events, thus capturing X-efficiency (Basel Committee on Banking Supervision, 2001).

2.5.4. Monetary Aggregates

Macroeconomic studies use monetary aggregates to represent efficiency. These aggregates include the ratio of bank credit granted to the private sector to GDP, as an explanatory variable in the growth model (King & Levine, 1993). This assumes that pure size of the financial system is closely related to quality of financial services or efficiency, which may not be so. In addition, the level of bank credit may simply reflect the demand for bank services, which may have nothing to do with the banking sector's own efficiency. The use of monetary aggregates is only justified if there is an absence of reliable data on the number and size of deposits and loans available or commercial banking interest rates.

2.5.5. Interest Spreads and Margins

The most common macroeconomic measure of efficiency is the interest spreads. It is a direct measure of banks' mark-up over cost. The justification for using interest spreads to measure efficiency is because financial intermediation affects the net return to savings, and the gross return for investment. Interest spreads can either be ex ante or ex post. The former is the more common one and is calculated from the contractual rates charged on loans and rates paid on deposits. They are biased to the extent that differences in perceived risks are reflected in the ex ante yields, which tend to distort spread comparisons. Ex ante spread data are also generally put together from a variety of different sources at the aggregate industry level and are not completely consistent.

Ex post spreads, on which this report focuses, consist of the difference between a bank's actual interest revenues and actual interest expenses. A problem with ex post spreads is that the interest income and drawdowns from the loan loss provisions materialise in different time periods. This may lead to inaccuracies in reflecting efficiency differences due to differences in NPLs and monitoring costs associated with loan quality (Demirgüç-Kurt & Huizinga, 1998).

Another common macroeconomic measure of efficiency is the net interest margin. It is argued that net interest margins mirror the interest spreads. However, they also reflect a variety of other factors including bank characteristics, macroeconomic conditions, taxation, deposit insurance regulation, overall financial structure, and several underlying legal and institutional indicators (Demirgüç-Kurt & Huizinga, 1998). Therefore, a change in the interest margins may be a result of changes in factors other than efficiency which interest margins cannot account for, because they only capture scale and scope economies.

2.5.6. Accounting Ratios

Some microeconomic studies use accounting ratios such as return on assets (ROA), return on investment (ROI) and return on equity (ROE) to represent efficiency (Ikhide, 2000 and Bedari, 2004).

Accounting ratios are limited as measures of efficiency. Since they do not control for output mix or input prices, they do not enable the determination of whether X-efficiency or scale and scope efficiency are the source of variation in bank performance (Akhavein, Berger & Humphrey, 1997). Also, ratios that contain assets, such as ROA, assume that all assets are equally costly to produce and all locations have equal costs of doing business. In addition, many accounting ratios exclude interest expenses, which comprise most of total bank costs and often represent operating expenses incurred elsewhere in the banking system (Berger & Humphrey, 1993).[13] Furthermore, changes in accounting ratios may reflect a change in the numerator or denominator values as opposed to changes in the overall ratio (Demirgüç-Kurt & Huizinga, 1998). Finally, accounting ratios do not capture long-term performance, and aggregate many aspects of performance such as operations, marketing and financing (Sathye, 2001).

Ikhide (2000) argues that use of total assets, loans or deposits, as in this report, does not sufficiently capture bank output, which he defines as the value of services rendered by banks. However, this definition only applies if the bank's provision of financial services is viewed in terms of the production approach, as opposed to the intermediation approach that is adopted in this paper.[14]

[13] ROA includes interest expenses as part of operating expenses

[14] More on these approaches is presented in the methodology section.

2.5.7. Frontier Analysis

Other studies apply frontier analysis, which captures the deviation between actual and desired performance. They measure efficiency relative to an objective function for output (product) maximisation and profit maximisation.[15] In the case of profit maximisation, the bank is viewed as a black box, where the production function is a simple relationship between inputs and outputs (Farrell, 1957) and the issue facing banks is to maximise profits while reducing costs. This is done by selecting: (Frei, Harker & Hunter, 1998)

- The levels of inputs: physical capital (K), labour (L) and technology, which depends on the next three choices;
- The input transformation function;
- The production function for the organisation;
- The mix of outputs that will maximise profits.

The bank that is best at executing these four choices within its environment will be the most X-efficient.

2.5.7.1. Market-based Approaches

Some microeconomic studies use a market-based approach. This measures efficiency in terms of the percentage of expected profit being earned for a given level of risk relative to a best practice bank on a risk-expected return, efficiency frontier (Hughes, Lang, Moon & Pagano, 1997). A bank with too little profit for the amount of risk it is taking is deemed inefficient. Banks that achieve efficient allocations maximise the market value of their assets and are more profitable.[16]

Hughes, Lang, Moon & Pagano (1997) argue that profit X-efficiency may be inadequate because it does not take into account sub-optimal choices of risk and quality that affect prices. When uncertainty exists, the objective of profit maximisation fails to account for the riskiness of the production plan and the rate of interest at which the stream of profits is discounted (Modigliani and Miller, 1958). In addition, profit X-efficiency does not reflect all relevant expected future cash flows and expected costs of financial distress but focuses on current prices and quantities of inputs and outputs.

The use of the market-based efficiency measure assumes the existence of at least a semi-strong, efficient financial market. This market structure is the minimum that provides the best measure of estimating whether firms are creating value for

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[15] These three concepts are not independent. Duality theory can be used to derive the cost function from the production function, and cost is a component of profit.

[16] Note that profit maximisation will differ from value maximisation to the extent that banks are not risk-neutral (Berger & Mester, 1999).

shareholders or not because most of the information is incorporated into prices (Brealey & Myers, 1991). Under this financial market structure the relative efficiencies of banks will be reflected in market prices, directly through lower costs or higher output or indirectly, through higher customer satisfaction and higher prices that translate into better stock performance (Adenso-Diaz & Gascón, 1997). Since all banks in Namibia were not listed on the NSX in 2003, the use of this measure was not pursued in this report, even though the authors recognised that it may be a more robust measure of bank efficiency.

The choice of measure that one uses to measure efficiency is important because each one has different implications in efforts to investigate its relationships with other economic variables. The alternative profit X-efficiency measure, which this report adopted, is attributed to Farrell (1957). It models the bank's activities using the production function and measures how close a bank's profit is to what a best practice bank's profit would be for producing the same output bundle under similar conditions. The best practice bank defines the frontier that represents the best practice observed in the industry and not the theoretical maximum profit possible, which is not easily observable.

Besides the economic approaches used to measure efficiency summarised above, many banks have their own internal benchmarking procedures that are mostly used at the branch level. These consist of relatively simple comparisons or rankings of offices according to a set of performance measures, which include the stock of accounts serviced or the values within various accounts. These efforts lack a powerful and comprehensive optimising methodology similar to the frontier analysis approach used in this report (Berger & Humphrey, 1997).

3. MEASURING ALTERNATIVE PROFIT X-EFFICIENCY

There is no agreement in frontier analysis literature on the best methodology that can be used to measure bank efficiency. The problem arises because even though the different methods yield quite similar X-efficiency estimates for the overall banking sector when applied to the same data set, they produce different results when ranking individual banks in the sector (Berger, 1994). This suggests that alternative profit X-efficiency for the overall banking sector may be a more appropriate guide for policy purposes than rankings (Berger & Humphrey, 1997).

This section begins by selecting an efficiency concept, estimation technique, approach and functional form and then goes on to describe the sample, data, model and procedure that this report adopted to achieve its main goal.

3.1. Efficiency Concept

Concepts for measuring efficiency fall into three categories: revenue, cost and profit efficiency. These concepts are based on an economic foundation for analysing bank efficiency because they focus on economic optimisation in reaction to market prices, competition and other business conditions, rather than being based solely on the use of technology.

3.1.1. Revenue Efficiency

Revenue efficiency measures the change in a bank’s revenue adjusted for random error, relative to the estimated revenue obtained from producing an output bundle as efficiently as the best-practice bank in a sample facing the same exogenous variables. It is not usually directly measured but is inferred from measurements of an output distance function, which measures output efficiencies.

Revenue efficiency occurs when banks charge higher prices for higher quality services, which result in higher revenues if these banks have the market power to extract some of the consumer surplus that arises. Empirical studies have found that revenue inefficiency can be attributed primarily to technical inefficiency as opposed to allocative inefficiency (Berger, Humphrey & Pulley, 1995).

The main shortfall of the revenue concept is that it does not take into account the increased costs of producing higher quality services and thus focuses on only one side of the overall financial picture of a bank (DeYoung & Nolle, 1996).

3.1.2. Cost Efficiency

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

Ikhide (2000) argues that costs are less vulnerable than revenues and profits to extraordinary factors that can affect different banks or categories of banks disproportionately such as variations in open-market interest rates.

However, by not accounting for the revenue gains from provision of higher quality services, as described above, or from shifts in bank lending portfolios between securities and loans (which have higher returns on average than securities), using costs alone in evaluating efficiency may not be sufficient to make inferences about a bank's overall performance.

Also, cost efficiency evaluates performance holding output quantities statistically fixed at their observed levels, which may not correspond to the optimally efficient levels that involve a different scale and mix of outputs. Therefore, a bank that is relatively cost efficient at its current output may or may not be cost efficient at its optimal output.

In addition, the use of constant outputs prevents the evaluation of whether any revenue changes from shifts in output offset cost changes except in the special case in which outputs remain constant. This hinders the use of cost efficiency in anti-trust policy analysis because it assumes that the output of the consolidated banks equals the sum of the separate outputs of each bank prior to the merger.

3.1.3. Standard Profit Efficiency

In instances where banks provide additional or higher quality services, costs rise but revenues may increase by more than the cost increase. Looking at efficiency from either the cost minimisation or revenue maximisation perspective fails to capture the goal of banks to maximise profits by raising revenues as well as reducing costs and does not account well for unmeasured changes in output quality (Berger & Mester, 1999). This shortfall is overcome by the profit efficiency concept.

Standard profit efficiency measures the change in a bank's variable profits adjusted for random error, relative to the estimated profit needed to produce an optimal output bundle as efficiently as the best-practice bank in a sample, facing the same exogenous variables, which include variable input prices, variable output prices and fixed netputs.

It reflects the goal of profit maximisation by incorporating both cost and revenue issues that result from varying inputs as well as outputs. Therefore, it more completely describes the economic goals of banks, which require that effort be spent to raise revenues as well as reduce costs. This corresponds well with the social benefit concept, which is useful for policy analysis. This concept refers to the real value of output produced and is represented by the change in revenues for given prices less the real value of resources consumed, which is represented by the change in costs (Akhavein, Berger & Humphrey, 1997).

Standard profit efficiency can be described in terms of output and input components. Output (input) profit inefficiency includes the output (input) technical inefficiency, which is the failure to produce as much output as planned and allocative inefficiency, which arises from misresponding to output (input) prices, including the cost and revenue effects of deviating from the profit-maximising production plan.

It can also be described in terms of technical and allocative components. Technical profit inefficiency is defined as the loss of profits from failing 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 netputs in the production plan. It is modelled as if the bank were responding to shadow relative prices rather than actual relative prices.

Even if banks are economically efficient (technically and allocatively efficient), standard profit inefficiency still exists if banks are choosing the wrong mix of output in order to maximise profits (Mester, 2003). The worst a bank can do has no limit because it can always use more inputs without producing more outputs. This means that standard profit efficiency can be negative, since banks can throw away more than 100% of their potential profits (Akhavein, Berger & Humphrey, 1997). In addition, a bank might do a slightly better job at minimising costs than its counterparts, but still make less profit because it does not do a good job in selecting its output mix.

One accounting measure of profit efficiency is the percentage change in a bank's headline earning relative to assets i.e. ROA. This measure may understate profit efficiency because variable profits are measured before taxes and fixed costs while the numerator used in the accounting ratio measures earnings after tax and fixed costs (DeYoung & Nolle, 1996 and KPMG, 2004a & 2004b).

Profit efficiency also uses book values obtained from financial statement data available in banks' annual reports. These values vary with factors such as accounting conventions, capital structures of different banks, market power and macroeconomic conditions in the markets in which the bank operates (Hughes, Lang, Moon & Pagano, 1997).

The use of standard profit efficiency is justified as long as the assumptions on which it is based hold. Where this is not the case, alternative profit efficiency is adopted.

3.1.4. Alternative Profit X-efficiency

Alternative profit X-efficiency measures the change in a bank's variable profits adjusted for random error, relative to the estimated variable profit needed to produce an optimal output bundle as efficiently as the best-practice bank in a sample, facing the same exogenous variables, which include variable input prices, variable output quantities, fixed netput quantities and *environmental factors*. It attributes 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 place of variable output prices and overcomes the shortfalls of the cost function by including profit in its dependent variable.

The standard profit function specification assumes that banks do not have the capacity to fix output prices while the alternative profit specification assumes that banks have no capacity to expand output. Although, it is unrealistic to expect that banks actually take their outputs as given, this cost is outweighed by the benefit the alternative profit concept provides for analysing bank efficiency in developing countries, where the assumptions underlying the cost and standard profit efficiency measures do not hold (Berger & Mester, 1997). Alternative profit X-efficiency is important where the following conditions exist:

3.1.4.1. Substantial Unmeasured Differences in Quality of Output

Inaccuracies in X-efficiency can arise if one does not control for unmeasured differences in quality that are likely to arise because financial statement data do not fully capture the heterogeneity of a bank's output.

Alternative profit X-efficiency controls for the unmeasured differences in quality by considering the additional revenue that covers the cost of generating higher quality output through its dependent variable. Therefore, unlike cost efficiency, it does not penalise banks for producing more costly outputs.

Standard profit efficiency, by holding output prices fixed, is less able to account for differences in revenue that compensate for differences in product quality, since these revenue differences may be partly reflected in measured prices. In addition, by taking output prices as given, it does not account for the effects of service quality where banks are making poor service quality choices relative to a best-practice bank, which is reflected in lower output prices and revenues.

If customers in a competitive banking industry are willing to pay for the additional services provided by some banks, they (the banks) can survive in competitive equilibrium because they receive higher revenues that just compensate for their extra costs. However, by taking output prices as given, the standard profit efficiency function, assumes that a bank can sell as much output as it wishes without having to lower its prices. This may be unrealistic and could lead to an understatement of standard profit efficiency for banks with output below efficient scale that have to reduce their prices to increase output.

Other approaches to controlling for unmeasured differences in quality include directly incorporating variables that are intended to control for the quality of bank output (Mester, 1996).

3.1.4.2. Output is not Completely Variable

Alternative profit X-efficiency includes output quantities as an independent variable (as opposed to output prices), which essentially holds outputs statistically constant. Therefore it compares the ability of banks to generate profits for the same levels of output. This controls for the lack of variability in outputs and prevents a scale bias where large banks are labelled as having higher profit efficiencies than smaller banks because the latter cannot adjust their size quickly to reach the same output levels as the former. The standard profit efficiency function does not control for this because it treats large and small banks as if they should have the same variable outputs when facing the same exogenous variables.

3.1.4.3. Output Markets are Oligopolistic

In Namibia, the presence of oligopoly can be empirically assessed using the Herfindahl-Hirschman index (H-Index), which is a microeconomic measure of the concentration of market power in an industry. The H-Index scores range from zero, for a perfectly competitive industry, to 10,000 (100^2), for a pure monopoly. Therefore, the higher the index scores the less competitive the market. According to the interpretation of the United States Department of Justice and Federal Trade Commission, who developed the index, any score above 1,800 represents a highly concentrated industry that indicates the presence of oligopoly. The results of its application to the output market in the Namibian banking sector are illustrated in Figure 2 below.

This figure shows that the output market structure of the Namibian banking sector was oligopolistic over the entire period. However, this is not surprising because evidence exists that indicates that the banking sectors in the CMA are highly concentrated (Okeahalam, 2002). What is important to observe is that the level of concentration increased in tandem with the M&A activity in the Namibian banking sector beginning in 2001. This involved a merger between City Savings and Investment Bank and South West Africa Building Society (SWABOU) in 2001, which resulted in a new banking institution known as SWABOU Bank Ltd., which merged with the First National Bank of Namibia in 2003.

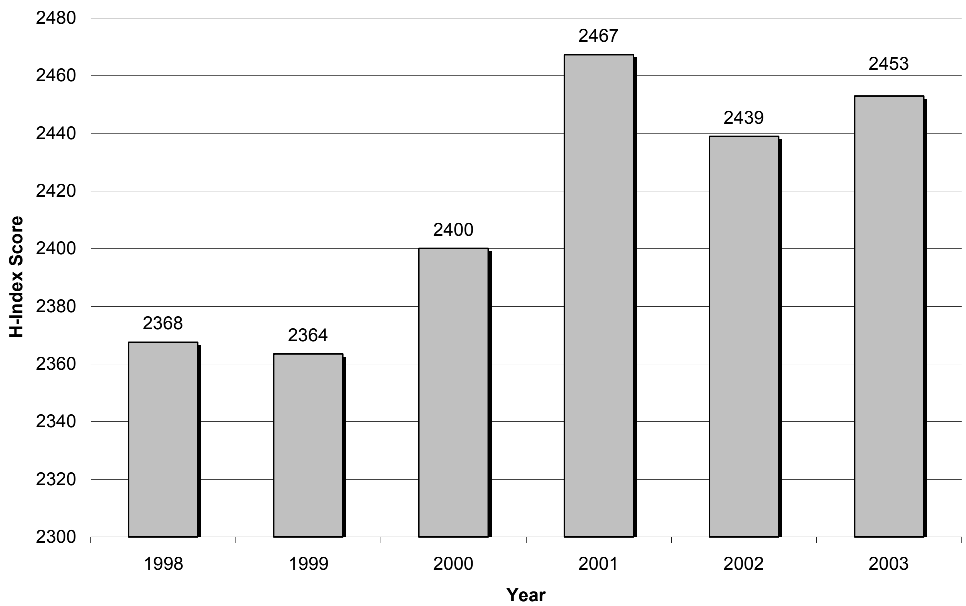

Figure 2: Herfindahl-Hirschman Index Scores for the Loan Market in Namibia's Banking Sector from 1998 to 2003

By including output quantities as an independent variable, the alternative profit X-efficiency function controls for efficiency differences where banks with market power may be able to increase revenues more than costs when increasing service quality because of the inadequate competition in an oligopolistic banking sector.

By controlling for the possibility that outputs are relatively fixed and prices are chosen by the bank in the short run it captures efficiency differences in the setting of prices and service quality, where optimising banks set their prices to the point where the market just clears for their output and choice of service quality. Furthermore, it controls for efficiency differences where banks economise on service quality and keep costs relatively low (skimping), to some extent.

The exercise of market power in an oligopolistic banking sector that raises prices over time may be measured as an exogenous improvement in business conditions when applying the standard profit efficiency concept, but may be measured as an improvement in best practice when applying the alternative profit X-efficiency concept, neither of which is precisely correct.

3.1.4.4. Output Prices are not Accurately Measured

Since engineering information on the technology of banking is not widely available, efficiency studies rely on accounting measures of costs, revenues, profits, outputs and inputs drawn from financial statements in a bank's annual reports. On the balance sheet, the amount of service flow associated with financial products is by necessity usually assumed to be proportionate to the value of the stock of assets or liabilities. In addition, financial statement proxies for prices are often constructed as ratios of revenue flows to stocks of assets.

Because financial statement figures do not directly measure prices, statistical noise may arise due to problems in matching revenue flows with the stock of assets, time periods in which these flows were earned and differences in asset duration, risk, liquidity and collateral. By including output quantities as an independent variable, the alternative profit X-efficiency reduces this effect and controls for inaccuracies in the output price data drawn from financial statements.

Because the alternative profit X- efficiency concept is suited to the idiosyncratic features of developing country banking sectors, this report adopted it to achieve its objectives. However, some studies recommend that one should try to apply all three measures for comprehensiveness and to check for robustness (Berger & Mester, 1997).

Another reason that this report adopts alternative profit X-efficiency is because empirical evidence suggests that this concept is better than standard profit X-efficiency because, theoretically, measured output prices do not have a predicted strong positive relationship with profits while output quantities do strongly predict profits. However, it is argued that this perspective may be the result of the scale bias problem discussed above where output quantities are not completely variable over the short term (Humphrey and Pulley, 1997).

Furthermore, empirical literature shows that the alternative profit X-efficiency function fits the data better than the standard profit X-efficiency function (Humphrey and Pulley, 1997), which implies that when it is applied, output variables as a group are measured with less noise.

3.2. Efficiency Technique

Techniques for measuring efficiency can be distinguished as either non-parametric or parametric. They differ based on the restrictions imposed on the best practice frontier, the distributional assumptions imposed on the random error and inefficiency terms and the degree of dispersion in the estimates of average efficiency (Berger & Humphrey, 1997).

3.2.1. Non-Parametric

Non-parametric techniques impose very few restrictions on the structure of the best practice frontier. They include the data envelopment analysis (DEA) and free disposable hull (FDH) techniques.

DEA is a linear programming technique that maximises an alternative profit X-efficiency function of weighted inputs and outputs subject to given restrictions solely on the basis of the data. It does not impose any distributional assumptions on the error and inefficiency term or require the specification of a particular form for the alternative profit X-efficiency function.

It disentangles efficiency differences from random error by assuming that random error is zero and attributes all deviations from the best practice frontier to inefficiency because it is non-stochastic (Berger & Mester, 1999). This non-stochastic property makes the method very sensitive to outliers, measurement errors and the number of constraints specified. [17]

The FDH frontier is either congruent with or interior to the DEA frontier (Tulkens, 1993).

Although non-parametric techniques do not impose restrictive assumptions on the best practice frontier their non-stochastic property is a key deficiency. This property implies that there is no measurement error in constructing the frontier, no luck that temporarily gives a bank better measured efficiency from one time period to another and that there are no inaccuracies created by accounting rules that would make measured outputs and inputs deviate from economic outputs and inputs.

The non-stochastic property also creates a problem where errors exist in the best practice bank. The existence of such errors may alter the measured efficiency of all other banks that are compared to this best practice bank or linear combinations involving it, with measured efficiency being confounded with random deviations from the efficiency frontier (Berger & Humphrey, 1997).

Prices are necessary for value information on output, without which it is not possible to compare banks that tend to specialise in different inputs or outputs or determine whether the output being produced is optimal. By ignoring prices and revenue the nonparametric techniques only capture technical inefficiency and cannot account for allocative inefficiency. This does not correspond to the alternative profit X-efficiency concept.

3.2.2. Parametric

Parametric techniques pre-specify a functional form for the best practice frontier (Casu & Molyneaux, 2003). They include the thick frontier approach (TFA), stochastic frontier approach (SFA) and the distribution-free approach (DFA).

The TFA identifies a 'thick frontier' consisting of banks that are on a frontier plus those close to it. The functional form it specifies assumes that deviations in potential alternative profit X-efficiency within the highest and lowest quartiles of observations (stratified by size class) represent random error, while deviations in potential alternative profit X-efficiency between the highest and lowest quartiles represent inefficiencies. This reduces the impact of outliers in estimating the best practice

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[17] Bootstrapping techniques have been used to overcome this deficiency.

frontier. However, the TFA only provides an estimate of the general level of alternative profit X-efficiency in the overall banking sector but not for the individual banks.

The SFA, also known as the econometric frontier approach, estimates the alternative profit X-inefficiency for a bank as a conditional mean or mode of the distribution of the inefficiency term, given the observation of the composed error term. It attributes deviations from the best practice frontier to inefficiency or random error or both.

SFA disentangles the inefficiency and random error terms by assuming that inefficiencies cannot be negative and follow an asymmetric half-normal distribution, random error follows a symmetric, standard normal distribution, and that both are orthogonal to the alternative profit X-efficiency function's exogenous variables.

The half-normal assumption for the distribution of inefficiencies is relatively inflexible and assumes that most banks are clustered near full efficiency. In addition, for SFA to yield meaningful estimates, the profit residuals must skew leftward. Where this does not occur it causes a great deal of frustration because panel estimation for the affected period is not possible (Berger & Mester, 1997 and Greene, 2000).

The choice of the half-normal distribution is fairly arbitrary. Empirical studies find that when the inefficiency term is unconstrained, it behaves much more like a symmetric normal distribution. The specification of a truncated normal distribution for inefficiency empirically yields minor, but statistically significant, different results (Berger and DeYoung, 1996). However, the use of this and other alternative, symmetric functions such as the gamma and exponential normal distributions may make it difficult to separate inefficiency from random error in a composed error framework, since it may be close to the symmetric, normal distribution assumed for the random error.

Although the efficiencies estimated by the SFA are reasonably consistent with those of the DFA (Berger & Mester, 1997), the latter is more appropriate where panel data is available, because this enables standard models of fixed and random effects to be estimated without the need to make any assumption about the distribution of the inefficiency term. In a fixed effects model, dummy variables need to be specified for each bank in the panel data set. Differences in the fixed effects estimated across banks represent inefficiencies. In a random effects model the average predicted residual for each bank in the panel is the estimate of that bank's average inefficiency. However, DFA is limited in unbalanced panels because it results in some biases when measuring relative efficiencies of individual banks, which affects their rankings (Akhavein, Berger & Humphrey, 1997).

DFA specifies a functional form for the best practice frontier that estimates alternative profit X-efficiency for each bank. This estimate is then used to determine the difference between its average residual and the average residual of the best practice bank on the frontier, which gives a single alternative profit X-efficiency measure for each bank.

Since it is the average of a bank’s residuals from all of the regressions it estimates how well a bank tends to do relative to its competitors over a range of conditions over time, rather than its relative efficiency at any one point in time. This is useful since relative efficiencies among the different banks may shift somewhat over time because of changes in management, technical change, regulatory reform, the interest rate cycle, and other environmental influences. By averaging over a number of conditions, DFA gives a better indication of a bank’s longer-term performance than any of the other methods, which rely on a bank’s performance under a single set of circumstances (Berger & Humphrey, 1997).

DFA uses less arbitrary assumptions than SFA to disentangle inefficiencies from random error. It assumes that efficiency differences are stable over time resulting in a core or average efficiency for each bank, which persists over time and that random error (including any temporary fluctuations in efficiency) averages out over time. However, in some studies the stability or relative efficiencies across banks do not necessarily carry over to changes in the overall level or distribution of efficiency (Berger & Humphrey, 1997).

The reasonableness of the DFA assumptions depends on the length of period studied. If too short a period is chosen, the random errors might not average out, in which case random error would be attributed to inefficiency. If too long a period is chosen, the bank’s average efficiency might not be constant over the time period because of changes in environmental conditions (possibly due to financial reform) making it less meaningful.

Empirical investigation into the number of years that may be needed to strike a balance between the benefits from having another residual to help average the random error to get more precise estimates of the inefficiency term and the costs of extra information from adding another year, which increases the likelihood that the efficiency in the extra year has drifted further away from its average level, indicates that a six year time period reasonably balances these concerns (Mester, 2003).

For further precision the DFA approach performs a truncation for banks with very low or very high alternative profit X-efficiencies prior to calculating the inefficiency terms. This adjustment is made to assign less extreme values of inefficiency to these banks because the presence of extreme values may indicate that random error has not been completely purged by averaging (DeYoung & Nolle, 1996). This prevents outliers from defining the efficient frontier.

There are two alternative methods for truncation. The first involves truncating residuals at the fifth and 95th percentiles of the sample distributions within their asset deciles. Average residuals for individual banks that are greater than the 95th percentile, or less than the fifth percentile, of the distribution of average residuals within each asset decile are set equal to those threshold values.

The second method truncates residuals uniformly at the fifth and 95th percentiles for the entire sample using the BHHH algorithm. However, if large banks dominate the moments of the distribution, it truncates large bank residuals frequently, but truncates small bank residuals infrequently; creating a bias that overstates estimated inefficiency in small banks relative to large banks (DeYoung & Nolle, 1996).

In addition to these formal methods, some authors use more arbitrary methods of selecting the point of truncation (Maudos et al, 2002).

This report adopted the DFA and applied it to the defined panel data set using the random effects approach. It used the arbitrary technique used by Maudos et al. (2002) to perform additional truncation because of the small number of banks in Namibia.

3.3. Approach

Four main approaches are followed in estimating bank efficiency: the production, user-cost, value-added and intermediation approaches. Although, they all measure bank outputs as transaction-based flows they differ on whether deposits should be considered as inputs or outputs, on which there is a longstanding debate.

The production approach views banks as using K and L as inputs to produce both loans and deposits as outputs. Since bank services are difficult to measure, outputs are measured as a stock of numbers of accounts i.e. by the number of deposits and loans, with average output size being used as a proxy for their characteristics.

However, this approach ignores interest expenses and only incorporates operating costs in the servicing of deposits and loans, although empirical evidence shows that interest costs make up the majority of bank costs, depending on the phase of the interest rate cycle and are included in the profit maximisation plans of any efficient firm (Berger & Humphrey, 1997). Interest expenses are also important because banks often substitute between spending additional real resources to provide better service and paying higher rates on deposits. Moreover, interest expenses are substitutes for directly incurred operating expenses and often represent operating expenses incurred at other banks from which the funds were borrowed (Berger & Humphrey, 1993).[18]

The production approach is preferred if branch level efficiency is being measured to investigate a bank's operational efficiency and productivity because branches primarily process customer documents for the institution as a whole and branch managers typically have little influence over bank funding and investment decisions.

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[18] Interest expenses on purchased funds often represent physical inputs involved in raising the funds at the institutions from which the funds were purchased.

Other approaches that specify deposits as an output are the value added and user cost approaches. The value-added approach considers all liabilities and assets of the bank to have at least some of the characteristics of an output involving the creation of value added, and for which customers bear an opportunity cost through lower interest rates on deposits (Casu & Molyneaux, 2003).

The intermediation approach (also known as the asset approach), views a bank's production process as one of financial intermediation with its inputs as the raw material that is transformed in the financial intermediation process. This approach is attributed to Sealey and Lindley (1977) and focuses on the stock of financial value in accounts because transaction service flow data is not usually available, as discussed in earlier paragraphs.

K and L and the value of all deposits, purchased funds and financial equity capital are considered as inputs that provide funds and generate costs. The value of all loans and securities, including loan origination and monitoring services, are considered as outputs that use bank funds and generate revenues (Mester, 2003). Although the intermediation approach recognises that financial inputs are sometimes paid for with depositor service fees instead of with interest payments (as in the production approach), it considers this as incidental, since the funds raised would be worthless without the assets in which they are invested.

Specifying deposits as a variable input captures a bank's limited ability to substitute between deposits and purchased funds in the short run. Assuming that they are fixed inputs may bias estimates of alternative profit X-efficiency against foreign-owned banks, which are known to use a higher proportion of purchased funds as a source of lending funds as opposed to the domestic counterparts in other countries (DeYoung & Nolle, 1996). In addition, because deposits and other liabilities by themselves generate negative cash flows and reduce profits, there is a practical difficulty in specifying deposits as a variable output, as in other approaches, because it is difficult to generate a positive output price for deposits.

The intermediation approach does not analyse the implications of the fact that a large number of small accounts are much more costly to service than a small number of large accounts because its outputs are computed as outstanding amounts in all these accounts. This is captured under the production approach.[19]

Despite this, its use in studies of bank efficiency is empirically supported (Mester, Nakamura, and Renault, 1998). This approach is also more appropriate for evaluating entire banks because it includes total costs, which include interest expenses, as opposed to only operating costs

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[19] A NAD 1 billion loan issued by a large bank may be a different product requiring different monitoring and screening policies and procedures than 10,000 loans of NAD 10,000 each that may be issued by smaller banks.

Furthermore, the intermediation approach is more appropriate when the purpose of measuring bank efficiency is to evaluate the implications of deregulation (or regulation) on the banking sector, effects of integration into the global financial architecture that accompanies financial liberalisation and for analysing the impact of bank mergers on efficiency (Casu & Molyneaux, 2003).

This report adopted the intermediation approach to achieve its main goal. Despite our preference, neither it nor the production approach is perfect because neither fully captures the dual roles of banks in providing transactions/document processing services and being financial intermediaries that transfer funds from savers to investors. The choice of one over the other is shown to affect inferences regarding efficiency (Berger & Humphrey, 1997).

Some studies resolve this issue with a dual approach that captures both the input and output characteristics of deposits. The former exist because they are paid for in part by interest payments and provide the institution with the raw material for offering loans and investing. The latter exist because they are associated with a substantial amount of liquidity, safekeeping, and payment services provided to depositors. Other studies have first treated deposits as an input and then as an output and find that efficiency is somewhat higher when deposits are specified as an output (Berger & Humphrey, 1997).

3.4. Functional Form

Nonparametric and parametric techniques have different degrees of dispersion and rank the same banks differently. The solution to this problem involves adding more flexibility to the parametric approaches and introducing a degree of random error into the nonparametric approaches.

For parametric approaches the Fourier-flexible function (FFF) has been adopted to solve this problem. It is a global approximation that adds orthogonal, Fourier, trigonometric (sine and cosine) terms to a standard translog function (Berger & Humphrey, 1993). This gives the data more freedom to choose shapes for the best practice frontier, which greatly increases flexibility by allowing for many inflection points that help fit the frontier to the data wherever it is most needed.

Despite the statistical superiority of the FFF, this report applied the translog functional form to the data set and includes second-order terms to account for the theoretically established U-shape of the best practice frontier (Berger & Mester, 1997). The translog function does not adequately fit data that is not near the mean output size or product mix (Mitchell & Onvural, 1996). In addition, by assuming that the average frontier curve has a symmetric U-shape in logs, it forces large and small banks to lie on a U-shaped (or possibly flat) frontier and disallows other possibilities, such as an average frontier curve that falls up to some output point and remains flat thereafter.

Although, the translog form is not as good as the FFF from a statistical viewpoint, the improvement in fit of the latter is not significant from an economic viewpoint. Empirical evidence shows that there is a small difference in average efficiency and very little difference in efficiency dispersion or rankings of alternative profit X-efficiency estimates obtained by using the translog functional form relative to those obtained by using the FFF (Berger & Mester, 1997).

In addition, the FFF consumes a large amount of degrees of freedom (Ikhide, 2000). Therefore, its use is recommended for the future continental study, that this report is a pilot for, but not for the present report that focuses on a relatively small panel dataset.

Other functional specifications used to estimate bank efficiency include the modified, Fuss, normalised quadratic function that includes quantity equations, which embody cross-equation restrictions to help in identification (Akhavein, Berger & Humphrey, 1997) and the managerial expenditure function - the dual to the managerial utility maximisation problem - in which managers trade off risk and return and incorporate revenue and risk terms and the tax rate (Hughes, Lang, Mester, and Moon, 2000).

All the functional forms in current bank efficiency literature cannot fully take into account differences in the products and technologies of small and large banks that balance sheet entries do not distinguish.

3.5. Sample

Between the first quarter of 1998 and the fourth quarter of 2003, the privately owned banks in Namibia included Bank Windhoek, First National Bank Namibia, Nedbank Namibia and Standard Bank Namibia. The publicly owned banks included Agribank and NamPost. With the exception of one institution (Agribank), the sample used in this report included commercial banks in Namibia.

The sample excluded City Savings and Investment Bank, SWABOU Bank, Namibia Development Corporation and the Development Bank of Namibia because these institutions were not in continuous existence between the first quarter of 1998 and the fourth quarter of 2003.

Although, NamPost is a bank that existed over the entire duration of the sample period, it was not included because it did not report a positive amount of net income in any period and its inclusion was not possible because its alternative profit X-efficiency ratio is meaningless (DeYoung and Nolle (1996). The negative net income for Nampost can be attributed, to some extent, to its regulation, which prohibits it from lending to borrowers either in the private or public sector. Therefore, it invests its mobilised deposits in government stock and treasury bills, guaranteed, short term, call deposits and funds with the National Housing Enterprise and short-term call deposits and funds with banks and building societies, which have lower returns than loans. Therefore, it is at a relative disadvantage when compared to the other banking institutions because it cannot offset the interest expenses arising from its mobilised savings and its relatively high branch network costs - Nampost has the widest network of distribution outlets of all banking institutions in Namibia. This is illustrated in Table 1 below.

Also, the sample in this report does not include the BoN because it does not lend directly to the private sector but lends to the Government or banks. Therefore, it does not provide the type of financial services that conform to intermediation theory. Due to its uniqueness in the banking system, the difficulty in measuring some of its outputs and the complicated and multiple objectives it pursues, it is not easy to apply the standard techniques of measuring efficiency described in this report. However, certain central bank activities such as payment services provision do lend themselves to efficiency measurement and this has been attempted in some studies (Mester, 2003).

In addition, the sample excludes banks with less than twenty full time employees in any year during the sample period (micro banks).[20]

Our sample period begins in 1998, in part because it was the year that the Banking Institutions Act was enacted based on the introduction of the Basel I Capital Accord. This report expects that this had an impact on how banks in Namibia operated, relative to previous years. Investigation of its effect is beyond the scope of this research report.

The choice of a six-year period - 1998 to 2003 - is based on the adoption of the DFA. This period length ensures that external factors do not have a substantial effect on internal firm performance (Berger & Mester, 1999). Some authors argue that this period is too short for any meaningful trend analysis or statistical robustness (Ikhide, 2000), which is right in a small panel to some extent.

However, despite the fact that the number of banks is not large which may lead to the consistency of regression estimators being questioned, the results obtained can be considered indicative of conditions in the Namibian banking system. Since this report aims to provide a methodology template that can be rolled out to a continental study of the financial intermediary sector in Africa, excluding insurance companies, it will allow us to revisit the Namibian banking sector findings in the context of this wider study that incorporates more banks.

[20] Some studies exclude all banks with less than USD 50,000 in physical capital (DeYoung & Nolle, 1996).

Table 1: Average Bank Network Distribution in Namibia between 1998 and 2003

Bank	Standard Bank Namibia	Agricultural Bank of Namibia	Bank Windhoek	Nedbank Namibia	First National Bank Namibia	NamPost Savings Bank
Average Branches	21	6	22	10	27	-
Average Service Centres	17	0	12	n/a	11	-
Average Automated Teller Machines	67	0	44	11	77	-
Average Agencies	n/a	0	n/a	3	6	-
Average Mini-ATM	n/a-	0	n/a	n/a	99	-
Average Post Offices, Counter Points and Service Agencies	-	-	-	-	-	92

Note: n/a means that data was not available in the bank's annual reports

Source: Bank Annual Reports, Bank of Namibia and Boer & Sherbourne (2003)

3.6. Data

The banking information and data used in this report is obtained from financial statements contained in each individual bank's annual reports over the period 1998 to 2003. This data is assumed to be relatively accurate and clean as required by generally accepting accounting and auditing principles and legal obligation, which is enforced by the regulator. An assessment of the extent to which transfer pricing strategies are used to shift costs is beyond the scope of this research report.

Due to the need for higher frequency data to enable the analysis of its dynamic structure, this report applied an econometric technique based on exponential interpolation that is linear in logs to create an interpolated quarterly series from the available annual data series (Jefferies & Kayawe, 1998). [21]

Since this report aims to provide a methodology template for a continental study, the use of a single currency is important to enable cross-country comparisons of the alternative profit X-efficiencies of different banking sectors. Therefore, all data is measured in United States dollars (USD) - 1USD = NAD6.2 and 1USD= BWP 5.6.[22]

In addition, the data is in real values, which is obtained by dividing all variable values with the consumer price index (CPI) for the relevant year in each country (1995=100). This controls for the effect of inflation on input and output prices and profitability.[23]

The extension of this data to a continental study is relatively easy because banks in different local markets with various market structures and economic conditions have financial statement data that describe relatively homogeneous products (Akhavein, Berger & Humphrey, 1997).[24] In addition, a continental study could control for inaccuracies in financial statement figures arising from transfer pricing, to some extent. However, data on total deposits, total loans, total securities etc. are still not as precise as data on sub-categories of bank deposits and loans (Akhavein, Berger & Humphrey).

3.7. Model

The alternative profit X-efficiency function aims to maximise variable profits given a set of independent variables, based on the theory of duality. The general functional relationship has the following form:

$$a\pi_{it} = f(w_{it}, y_{it}, z_{it,} v_{it}) + \varepsilon_{it}$$

Equation 1: Alternative Profit X-efficiency: General Function

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[21] The exponential interpolation formula used is $\hat{x}_{t+1} = \sqrt{x_t x_{t+2}}$. It is based on Intriligator (1978). From this we can derive the exponential extrapolation formula $\frac{{x_{t+1}}^2}{x_t} = x_{t+2}$

[22] Botswana's national currency is called the pula (BWP).

[23] Inflation is associated with higher profitability because bank income tends to increase more with inflation than bank costs (Demigurc-Kurt & Huizinga, 1998).

[24] Extensive data on profit X-efficiency variables for each individual country can be obtained from the London-based International Bank Credit Analysis Ltd's Bankscope database. This would be a potential, cost-effective source of data for a continental study.

Where: [25]

$a\pi$ is variable profits (variable revenues less variable costs).

f denotes some functional form.

w is the variable input prices vector, which is closely linked to interest rates.

y is the variable output quantities vector.

z is the fixed netputs vector, which represents factors that the bank cannot adjust in the short-run and for which there is difficulty in obtaining accurate price information. It is included to account for their effects on variable costs and the substitutability or complementarity with variable netputs.

v is the environmental variables vector that represents external influencing factors that the management has no control over.

ε is the composed error term consisting of an X-inefficiency and random error term. This composed error term is assumed to be multiplicatively separable from the rest of the function to simplify measurement and fits an upper boundary to the data as opposed to an average relationship.

i represents each respective bank; i =1…5;

t represents the time period under consideration; t=1…6.

We specify the functional relationship in equation (1) in logarithmic form as follows:[26]

$$\ln(a\pi + \theta)_{it} = \ln f(w_{it}, y_{it}, z_{it}, v_{it}) + \ln u_{it} + \ln e_{it}$$

$$u_{it} \sim N\left[0, \sigma^2{}_{u_{it}}\right] \text{ and } e_{it} = N\left[0, \sigma^2{}_{e_{it}}\right]$$

Equation 2: Alternative Profit X-efficiency: Specific Function

Where:

θ is a constant added to every bank's alternative profit before logging so that the natural log is taken of a positive number (or at least zero), since minimum alternative profits can be negative. It is defined as $\left|\left(\frac{a\pi}{w_3 z_3}\right)^{\min}\right| + 1$ and is the absolute value of the minimum alternative profit over all banks for the same year plus one.

[25] See Appendix A for a presentation of each vector's component variables and their associated descriptive statistics.

[26] See Appendix B for a technical discussion of the specific estimable function.

u_{it} is the alternative profit X-inefficiency term that reduces profits below the best-practice frontier. It can be thought of as the resources that are used inefficiently or wasted and is assumed to be zero for the best-practice bank.[27] It is specified as a half-normal distribution in this report. Since it is a residual term, omitted (or extraneous) variables can have large effects on its value.

e_{it} is the random error term that incorporates measurement error and luck that may temporarily give banks high or low profits. It is assumed to have a mean of zero in each period and is uncorrelated with the other independent variables.

3.8. Procedure

Using Limited Dependent Variables (LIMDEP) version 7.0 – an econometric software, the maximum likelihood technique is adopted to estimate the parameters of the alternative profit X-efficiency function based on a random effects, panel data set for each year's data between 1998 and 2003. This allows greater flexibility in modelling differences in behaviour across individual banks (Gujarati, 2003).

The parameters are allowed to vary with output prices and also reflect changes in the external environment. Their resulting estimates along with their minimum or maximum values are then substituted into the equation below:

$$a\pi x^{b} = \frac{a\tilde{\pi}^{b}}{a\pi^{\max}} = \frac{\left\{w_3 z_3 \times \exp\left[\tilde{f}\left(w^b, y^b, z^b, v^b\right)\right] \times \exp\left[\ln \tilde{u}^{b}\right]\right\} - \theta}{\left\{w_3 z_3 \times \exp\left[\tilde{f}\left(w^b, y^b, z^b, v^b\right)\right] \times \exp\left[\ln \tilde{u}^{\max}\right]\right\} - \theta}$$

Equation 3: Alternative Profit X-efficiency: Definition

The addition of θ to the dependent variable before logging means that $\ln \tilde{u}$ is not multiplicatively separable, as previously assumed. To offset the nonlinearities introduced by this term and by exponentiating, the numerators and denominators are averaged over the sample period before dividing to estimate the average residual for each bank b as an efficiency ratio that represents its alternative profit X-efficiency ($a\pi x$). This corrects the average-practice, alternative profit function such that it predicts the sample's average, alternative profit for each year when evaluated at the mean value of business conditions.

Averaging the numerator and denominator before dividing in equation (3) also ensures that input prices actually faced by a bank are more likely to be exogenous than those actually paid by the bank. It is also likely to average out some of the computational errors in measuring input prices paid by individual banks. In addition, any mistakes the bank makes in setting prices for its inputs given the market price conditions will be counted properly as inefficiencies, rather than just high or low prices or good or bad business conditions.

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[27] The figure in Appendix C shows an example.

Errors in choosing output quantities do not affect alternative profit X-efficiency except through the point of evaluation $\tilde{f}\left(w^b, y^b, z^b, v^b\right)$ and only to the extent that the best-practice bank is not operating at the same (w, y, z, v) as bank b (Berger & Mester, 1997).

An $a\pi x$ ratio of 0.70 indicates that a bank is losing about 30% of the potential profits that it could be earning if it were as X-efficient as the best practice bank i.e. it requires 30% more X-efficiency to meet the same profit objectives as the X-efficient bank on the frontier (Berger & Humphrey, 1997).

For banks with very low or very high alternative profit X-efficiency estimates, a truncation of extreme values is done to account for random error that has not been completely purged by averaging. However, given the small number of banks in this sample we cannot truncate based on bank sizes categorised into deciles as there are not enough banks in Namibia to do this.[28] Therefore, the informal method used by Maudos et al. (2002) is used to obtain the alternative profit X-efficiency estimates for the overall banking sector. This truncation method substitutes the estimate of the most extreme bank closest to alternative profit X-efficiency frontier with the estimate of the second most X-efficient bank. Similarly, it substitutes the least X-efficient bank's profit X-efficiency estimate with the second least X-efficient one.

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[28] Truncation based on size categories divided into deciles can be performed in a continental study

4. RESULTS AND DISCUSSION

4.1. Namibia

The results obtained from applying the methodology described in the previous section to the sample data set for Namibia are presented in Table 2 below.

Table 2: Alternative Profit X-efficiency Regression Results for Namibia

Variables (in Ln)	Coefficient	Standard Error
Constant	-6.491994442***	3.6481008
W	3.218925018*	0.90971514
W^2	-0.401563039*	0.14106463
Y	-3.384456031*	1.0267189
Y^2	1.708635788*	.59161521
Z	-5.289884436*	1.7816972
Z^2	-6.462982631*	1.1251376
WY	-0.05729322818	0.23993992
WZ	1.379548289*	0.30568061
YZ	-0.7409211443**	0.41162025
V	-1.656447375	1.5502722
V^2	0.7607350682	0.70023445
LM Statistic = 23.54392		Log-Likelihood Function = 49.8159
σ^2_v 0.002, σ^2_u = 0.06714		No. of Panel Observations = 120

Note: * significant the 1% level, ** significant at the 5% level, *** significant at the 10% level

This estimated function allows us to obtain the alternative profit X-efficiency estimates for banks in Namibia. These results are summarised in Table 3 below. The differences in the obtained estimates are attributed to managerial best practice, residual X-inefficiency and the change in business conditions that are exogenous to the bank. They are based on the best-practice bank in Namibia as opposed to the best practice theoretically available, which would fully reflect the available technology and optimal responses to market prices and other business conditions (Berger & Mester, 1999). The standard deviation of the individual alternative profit X-efficiency estimates is about 1.4%, which indicates that the alternative profit X-efficiency estimates are quite tightly distributed around the average figure.

Table 3: Ranking of Banks in Namibia according to Alternative Profit X-efficiency

Bank	Individual Alternative Profit X-Efficiency Estimate (%)	Alternative Profit X-Efficiency Estimate Relative to Frontier (%)
Nedbank Namibia	85.3	100
Bank Windhoek	84.1	98.6
Standard Bank Namibia	83.3	97.6
Agricultural Bank of Namibia	82.5	96.7
First National Bank Namibia	81.7	95.8
MEAN	83.4	97.7

Table 3 shows that between 1998 and 2003, Nedbank was the most alternative profit, X-efficient bank in Namibia followed by Bank Windhoek. This finding suggests that a branch level X-efficiency study carried out on Nedbank Namibia and possibly Bank Windhoek may illuminate internal factors that resulted in their relatively higher rankings when compared to their counterparts in Namibia.

According to the model in this report this finding would suggest that Nedbank's management was more successful than its counterparts in stimulating best-practice processes through aligning its inputs with the strategy of the bank, specifying the production function of the bank in the most efficient manner to produce outputs and transforming raw inputs into effective human resources, capital and technology for the given production technology (Frei, Harker & Hunter, 1998). Therefore, according to this report's assumption that credit allocation efficiency is proxied by a bank's own X-efficiency our findings would suggest that Nedbank was more successful at allocating credit efficiently than its counterparts in Namibia between 1998 and 2003.

However, Nedbank Namibia has the lowest branch network of all the commercial banks in Namibia and this reduced rather than increased between 1998 and 2003. In addition, some claim that Nedbank Namibia cherry-picks its loan investment opportunities.[29] Therefore, these features could explain Nedbank's ranking more appropriately than the alternative profit X-efficiency model's assumptions.

Although, an empirical assessment that would allow an evidence-based judgement on the social welfare implications of whether or not Nedbank has made a conscious decision to reduce short-run expenses by cutting back on loan origination and

[29] Comment arising from feedback on working paper by banking practitioners

monitoring resources (skimping), is beyond the scope of this research report, a future effort can test this skimping hypothesis by including both v and NPL in the alternative profit X-efficiency function (See Appendix A).[30]

Table 3 also shows that between 1998 and 2003 First National Bank Namibia was the most alternative profit X-inefficient bank in Namibia. One interpretation of this is that it traded current profits for rapid expansion of market share by participating in more M&As, constructing more physical branches, providing wider ATM facilities and other products of financial engineering aimed at customer convenience relative to its counterparts as illustrated in Table 1 in Section 3. These efforts showed up as lower alternative profit X-efficiency because the higher amount of fixed assets employed to expand market share may have raised costs but not enough revenues to start generating high returns (Berger & Mester, 1999). Since our alternative profit X-efficient function does not fully capture customer satisfaction, which is an important determinant of the revenues and profits of a bank (KPMG, 2004c), whether this strategy is more successful from a customer satisfaction viewpoint is not addressed in this research report. However, it is partly controlled for through the dependent variable because customer satisfaction is assumed to be one factor that determines profit levels.

In addition, First National Bank Namibia's low ranking may also be due to the effect of its M&A activity on its banking operations over the sample period, as mentioned in Section 3. Although Nedbank Namibia also participated in M&A activity in 2002, through its acquisition of the micro lending arm of SAAMBOU Bank housed in Finance in Education (Pty) Ltd., this acquisition did not have the same effect as in the case of First National Bank of Namibia because the newly acquired institution was not incorporated into the banking operations of Nedbank Namibia but was left as an independent subsidiary, regulated by the Namibia Financial Institutions Supervisory Authority.[31]

In Namibia, the other studies that have attempted to measure X-efficiency in the banking sector (Ikhide, 2000 & Bedari, 2004) use a different time period from that adopted in this report, therefore a rankings comparison is not possible. However, it is argued that the rankings of individual banks obtained differ depending on the concepts or methods used. Therefore, estimates of mean or median efficiency of the overall banking sector are a more reliable guide for policy purposes than the rankings of banks by their relative efficiencies, due to their consistency (Berger & Humphrey, 1997).

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[30] Comment arising from feedback on working paper by banking practitioners

[31] Although it is theoretically argued that First National Bank Namibia should be excluded from the analysis because pure X-efficiency factors cannot be easily isolated from the effects of M&A activity on its operations, its inclusion allow the report to control for sample selection bias to some extent.

The mean level of alternative profit X-efficiency for the overall banking sector in Namibia is 83.4%. This suggests that banks in Namibia were losing 16.6% (100 - 83.4) of their potential profits between 1998 and 2003 due to inefficiency. This estimated level of alternative profit X-efficiency for the overall banking sector in Namibia fares well relative to other studies that had been conducted internationally as of 1997, where the mean level of potential profits lost by banking sectors in all profit efficiency studies, regardless of approach, was 55% (Berger & Humphrey, 1997).

When we perform a truncation similar to Maudos et al. (2002) the profit X-efficiency of the overall Namibian banking industry falls to 83.3%. This minimal reduction suggests that random error has been significantly purged.

Due to the small size of the panel used in Namibia these estimates should be considered as indicative rather than certain. A more robust analysis will result in the context of a continental study that includes more banks, for which this report is a pilot.

4.2. Botswana

To test the effects of widening the scope of the study beyond banks to all financial intermediaries that can be modelled using the methodology described in the previous section we focus on the financial intermediary sector in Botswana, a country with similar geographical and economic features to Namibia. The results obtained from applying the methodology described in the previous section to the sample data set for Botswana are presented in Table 4 below.[32]

[32] The sample dataset for Botswana includes all financial intermediaries except insurance companies (as opposed to banks only).

Table 4: Alternative Profit X-efficiency Regression Results for Botswana

Variable (in Ln)	Coefficient	Standard Error
Constant	-0.707816177	2.7122673
W	-1.11333245**	0.61072994
W^2	0.04291490188	0.090045035
Y	1.352362465	1.3116088
Y^2	-2.596801024*	0.78123596
Z	0.7503976378	2.6378703
Z^2	-1.016202544	1.2907762
WY	0.4181585798**	0.17254441
WZ	-0.06229920393	0.31482461
YZ	0.6482743765	0.81049829
V	4.871371374*	0.98456956
V^2	-1.301346476*	0.31622258
LM Statistic = 79.76773		Log-Likelihood Function = -207.2186
σ^2_v = 0.07598, σ^2_u = 0.94828		No. of Panel Observations =192

Note: * significant the 1% level, ** significant at the 5% level, *** significant at the 10% level

This estimated function allows us to obtain the alternative profit X-efficiency estimates for banks in Botswana. These results are summarised in Table 5 below. They are based on the best-practice bank in Botswana as opposed to the best practice theoretically available (Berger & Mester, 1999). The standard deviation of the individual alternative profit X-efficiency estimates is 10.16%. This indicates that the Botswana estimates are more widely distributed around the average figure than in the case of Namibia.

Table 5: Ranking of Banks in Botswana according to Alternative Profit X-efficiency

Bank	Individual Alternative Profit X-Efficiency Estimate (%)	Alternative Profit X-Efficiency Estimate Relative to Frontier (%)
Botswana Development Corporation	78.9	100
First National Bank Botswana	73.6	93.4
Botswana Savings Bank	67.1	85.1
National Development Bank	65.2	82.7
Standard Chartered Bank Botswana	61.2	77.6
Stanbic Bank Botswana	60	76.1
Barclays Bank Botswana	57.6	73
Botswana Building Society	45.7	58
MEAN	63.7	80.7

Table 5 shows that from 1998 to 2003, Botswana Development Corporation, a domestic, publicly owned, NBFI, was the most alternative profit, X-efficient financial intermediary in Botswana. This may be because it does not take deposits and therefore does not incur costs arising from interest expenses on deposits like its other banking counterparts. Therefore, according to this study's assumption that credit allocation efficiency is proxied by a financial intermediary's own X-efficiency our findings suggests that Botswana Development Corporation was more successful at allocating credit efficiently than its counterparts in Botswana between 1998 and 2003.

The mean level of $a\pi x$ for the overall financial intermediary sector in Botswana was 63.7% between 1998 and 2003. This suggests that financial intermediaries in Botswana were losing 36.3% (100 - 63.7) of potential profits due to inefficiency between 1998 and 2003. The estimated level of alternative profit X-efficiency for the overall financial intermediary sector in Botswana also fares well relative to other studies that had been conducted internationally as of 1997, where the mean level of potential profits lost due to inefficiency in all profit efficiency studies, regardless of approach, was 55% (Berger & Humphrey, 1997).

When we applied the truncation procedure used in Maudos et al. (2002), the alternative profit X-efficiency of the overall financial intermediary sector in Botswana rises to 64.5%. This minimal appreciation suggests that random error has been significantly purged.

The differences between mean alternative profit X-efficiencies in Namibia and Botswana can be attributed to the fact that the sample in Namibia is smaller than that of Botswana, which in addition to banks, includes all NBFIs, except insurance companies that were in continuous existence between 1998 and 2003.[33]

4.3. Namibia and Botswana

A direct comparison between banks in different countries should not be attempted unless the institutions are evaluated relative to the same frontier. This will allow us to compare differences in efficiency based on idiosyncratic, country-specific factors reflecting different regulatory environments, different managerial strategies and different adoption levels of financial and technological innovations to address challenges in different local environments (Casu & Molyneaux, 2003). As a demonstration of how a continental study would be conducted, this report applies the methodology described above to a cross-country panel containing sample data for both Namibia and Botswana.[34] The results of this application are presented in Table 6 below.

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[33] Insurance companies hold privately placed corporate bonds and commercial mortgages as assets and contracts with policyholders and obligations to future retirees as liabilities. This gives them some idiosyncratic features that make them differ from the other financial intermediaries.

[34] v for each country controls for country-specific environmental conditions.

Table 6: Alternative Profit X-efficiency Regression Results for Botswana and Namibia

Variable (in Ln)	Coefficient	Standard Error
Constant	9.704610118*	2.3970396
W	-3.185621862*	0.65617546
W^2	0.3458208499*	0.10601868
Y	3.209260140**	1.2732045
Y^2	-2.862872654*	0.44983346
Z	-0.4252033497	2.5322129
Z^2	0.09521651455	0.69560235
WY	0.2232537609***	0.13354666
WZ	0.3151360175	0.32296242
YZ	0.05837209741	0.53620497
V	0.8181351532	0.81476067
V^2	0.04276390037	0.28056852
LM Statistic = 0.3042449		Log-Likelihood Function = -419.8176
σ^2_v = 0.71788, σ^2_u = 0.40233		No. of Panel Observations = 312

Note: * significant the 1% level, ** significant at the 5% level, *** significant at the 10% level

This estimated function allows us to obtain the alternative profit X-efficiency estimates for banks in both Namibia and Botswana. These results are summarised in Table 7 below. They are based on the best-practice bank in Namibia and Botswana as opposed to the best practice theoretically available (Berger & Mester, 1999).

Table 7: Ranking of Banks in Botswana and Namibia based on a Single Alternative Profit X-efficiency Frontier

Bank	Individual Alternative Profit X-Efficiency Estimate (%)	Alternative Profit X-Efficiency Estimate Relative to Frontier (%)
Agricultural Bank of Namibia	92.1	100
Nedbank Namibia	82.5	89.6
First National Bank Namibia	77.9	84.6
Standard Bank Namibia	74	80.3
National Development Bank Botswana	73.9	80.2
First National Bank Botswana	73.1	79.4
Standard Chartered Botswana	72.4	78.6
Stanbic Bank Botswana	70.7	76.8
Botswana Savings Bank	69.8	75.8
Botswana Development Corporation	68.8	74.7
Bank Windhoek Namibia	64.8	70.3
Barclays Bank Botswana	62.6	68
Botswana Building Society	57.6	62.5
MEAN	72.3	78.5

Table 7 illustrates that the rankings of banks in each individual country changes when DFA is applied to a translog, alternative profit, X-efficiency function in a cross-country panel relative to a within-country panel. In addition, the significance of the results reduces as illustrated in Table 6. This reduced significance of the results could be potentially addressed by adopting the more statistically robust FFF function, which is possible in a cross-country panel due to the larger data set.

This report leaves the discussion of the results for the cross-country panel until a continental study is undertaken that applies DFA to a continental, random effects, panel dataset of financial intermediaries in Africa (excluding insurance companies) using a FFF, alternative profit, X-efficiency function.

5. CONCLUSION

This research report measured the alternative profit X-efficiency in Namibia's banking sector. It modelled the internal activities of banks in Namibia using an input-output, production function and applied frontier analysis to estimate the alternative profit X-efficiencies for banks in Namibia using DFA.

It found that Nedbank Namibia was the most alternative profit X-efficient bank in Namibia between 1998 and 2003. Bank Windhoek, Standard Bank Namibia, the Agricultural Bank of Namibia and First National Bank of Namibia closely followed it, respectively.

The high ranking of Nedbank Namibia should be viewed in light of the fact that it had the lowest branch network of all the commercial banks in Namibia between 1998 and 2003. The low rank of First National Bank of Namibia could be attributed to its expansion strategy that resulted in it having the largest branch network of all the commercial banks in Namibia between 1998 and 2003. Its merger and acquisition (M&A) activity over the sample period makes it impossible for this report to isolate the effects of pure X-efficiency from the effects of its M&A activity in order to make a judgement on the cost or benefits of this expansion strategy.

The report also found that the mean level of alternative profit X-efficiency in Namibia's banking sector from 1998 to 2003 was 83% suggesting that banks in Namibia lost approximately 17% of their potential profits between 1998 and 2003 due to inefficiency. This finding fares well relative to other studies that had been conducted internationally as of 1997, where the mean level of potential profits lost by banking sectors in all profit efficiency studies, regardless of approach, was 55%.

Due to the relatively small size of the panel dataset for Namibia, the results of bank efficiency in Namibia can only be conclusive if more robust findings are obtained in the context of a continental study.

To test the effects of widening the scope of the study beyond banking institutions this report extended the methodology to a panel dataset for all financial intermediaries in Botswana, excluding insurance companies. It found that alternative profit X-efficiency figures in Botswana had wider variation than those in Namibia. This was attributed to Botswana's larger sample size that included both banks and NBFIs. This finding suggests that to improve the within-country findings for Namibia an inclusion of all financial intermediaries i.e. banks and NBFIs may be a better option than a data set consisting of banks alone.

In addition, a cross-country panel dataset for Namibia and Botswana was analysed as a pilot initiative for a future continental study consisting of all financial intermediaries in Africa, excluding insurance companies. It found that the estimates and rankings of banks changed from the within-country sample and that the significance of the results of the cross-country rankings fell.

This finding suggests that the FFF should be explored as opposed to the translog function that was used in this report in a continental study. In addition, a more rigorous truncation technique could also be applied rather than the informal one used in this report in a larger sample size. Finally, financial intermediaries that have been involved in M&A activity should be dropped from the analysis as their alternative profit X-efficiency estimates could be spurious.

It is hoped that the methodology presented and demonstrated in this report will lead to a continental study of all financial intermediaries in Africa, excluding insurance companies. This should generate a robust, empirical tool that will assist institutions such as NEPRU to monitor the impact of various events, such as regional integration and M&A activity, on bank efficiency. In addition, it is hoped that the rankings presented in this report will motivate practitioners to investigate reasons for their relative rankings and use their findings to improve efficiency in Namibia's banking sector.

6. REFERENCES

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Appendix A: Variables in the Alternative Profit X-efficiency Function

Symbol	Definition	Mean	Standard Deviation
	DEPENDENT VARIABLE		
$a\pi$	Variable profits including variable revenues from interest and fee income less variable costs which includes variable operating (including z_2) and interest costs arising from w	45.72	37.6
	INDEPENDENT VARIABLE		
	Variable Input Price Vector (w)		
w_1	Price of purchased funds (all liabilities except deposits).	115.02	60.1
w_2	Price of domestic deposits. [a]	199.75	116.59
w_3	Price of Labour (1000's of constant USD per employee)	0.1	0.02
	Variable Output Quantities		
y_1	Consumer Loans	931.08	606.56
y_2	Business Loans (all other loans excluding loans to the public sector)	1110.56	409.26
y_3	Securities (all non-loan financial assets i.e. Gross Total Assets less y_1, y_2 and z_2.	482.07	351.96
	Fixed Net puts		
z_1	Off-balance sheet guarantees measured using Basel Accord risk weights to be risk equivalent to loans (contingent liabilities such as commitments, letters of credit, etc.) [b]	139.38	95.36
z_2	Physical capital (book value of plant and equipment)[c]	45.57	18.44
z_3	Financial equity capital. [c]	331.85	150.13
	Environmental Variables		
v	Market average non-performing loans to total loans ratio. [e]	1.01	0.02
	Number of Panel Observations: 120		

Note: a. Some studies define the price of core deposits as interest expenses less service charges on deposit accounts, divided by core deposits (DeYoung & Nolle, 1996).

b. Guarantees capture inter-bank differences in loan to asset ratios. They are specified as fixed instead of variable primarily because of the difficulty of obtaining accurate price information Although, they are not a perfect measure of portfolio risk because they make few distinctions between types of loans; risk-weighted assets are included as a fixed factor to control for the costs associated with risky assets. This is because it is assumed that output is proportional to the perceived credit risk on which these risks are based (DeYoung & Nolle, 1996).

c. Including the price of z_3, rather than its level, assumes that banks on the frontier are selecting the cost-minimising level of capital. However, this might not be the case because of regulations that set a minimum capital-to-asset ratio or because of risk-aversion on the part of bank managers (Mester, 2003).

d. z_2 and z_3 are treated as fixed inputs because they are slow to adjust and it is difficult to measure their price. Other studies calculate z_2 as the ratio of depreciation to fixed assets

e. We use the market average rather than each individual bank's NPL ratio because it covers exogenous market condition that affect loan performance and is less likely to reflect bank managers' decisions.

f. All variables are in 1000's of real USD.

Appendix B: Technical Discussion

The specification of included variables is important because it determines the reference point for other banks in the industry. The specific alternative profit X-efficiency function that we estimate is:

$$\ln[(\frac{a\pi}{w_3 z_3})+\theta]=\alpha+\sum_{i=1}^{2}\beta_i\ln(\frac{w_i}{w_3})+\frac{1}{2}\sum_{i=1}^{2}\sum_{j=1}^{2}\beta_{ij}\ln(\frac{w_i}{w_3})\ln(\frac{w_j}{w_3})+\sum_{k=1}^{3}\gamma_k\ln(\frac{y_k}{z_3})$$
$$+\frac{1}{2}\sum_{k=1}^{3}\sum_{m=1}^{3}\gamma_{km}\ln(\frac{y_k}{z_3})\ln(\frac{y_m}{z_3})+\sum_{r=1}^{2}\delta_r\ln\frac{z_r}{z_3}+\frac{1}{2}\sum_{r=1}^{2}\sum_{s=1}^{2}\delta_{rs}\ln(\frac{z_r}{z_3})\ln(\frac{z_s}{z_3})$$
$$+\sum_{i=1}^{2}\sum_{k=1}^{2}\eta_{ik}\ln(\frac{w_i}{w_3})\ln(\frac{y_k}{z_3})+\sum_{i=1}^{2}\sum_{r=1}^{2}\rho_{ir}\ln(\frac{w_i}{w_3})\ln(\frac{z_r}{z_3})$$
$$+\sum_{k=1}^{3}\sum_{r=1}^{2}\tau_{kr}\ln(\frac{y_k}{z_3})\ln(\frac{z_r}{z_3})+\upsilon_1\ln v+\frac{1}{2}\upsilon_{11}\ln(v)\ln(v)+\ln u_{it}+\ln\varepsilon_{it}$$

Equation 4: Alternative Profit X-efficiency: Estimated Function[35]

The variables y_k / z_3, z_r / z_3 and v have 1 added to them before log transformation for every bank to avoid taking the natural log of zero. In addition, we exclude factor share equations, which embody Shephard's or Hotelling's Lemma restrictions, because they assume that banks have perfect allocative efficiency, which is not suitable for this report.

Homogeneity

The dependent and input variables in Equation (4) are normalised by the price of labour (w_3) in order to impose linear homogeneity on the model, so that on the X-efficient frontier, a doubling of all input prices and output quantities doubles alternative profit X-efficiency. Although we impose this normalisation, the homogeneity restriction does not have to be imposed on the alternative profit X-efficiency function, if the FFF is adopted (Berger & Mester, 1997). However, it is required by the translog function to satisfy duality theory.

Heteroscedasticity

One potential difficulty in disentangling the effects of scale inefficiencies from alternative profit X-efficiency in u_{it} is the presence of heteroscedasticity. Although, Berger and Humphrey (1997) argue that the problem of confounding scale and alternative profit X-inefficiencies is not substantial, this report addresses it by

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[35] The standard symmetry restrictions ($\beta ij = \beta ji, \gamma km = \gamma mk, \delta rs = \delta sr$) apply to the function.

controlling for heteroscedasticity. This is done by normalising $a\pi$, y and z with financial equity capital (z_3).

Where banks are of different sizes, large banks tend to have higher profits than small banks for a given set of prices, because they were able to gain size over a period of decades, which is difficult for small banks to do in the short run due to market size or regulatory restrictions that tie the allowable size of the bank to its existing z_3 - reserve levels. Failure to control for heteroscedasticity from this source could result in larger banks being measured as more alternative profit X-efficient because their higher z_3 levels allow them to disburse more loans.

In Namibia, the largest bank in terms of size, measured by average total assets from 1998 to 2003 was Standard Bank Namibia, while the smallest was Agribank. This is illustrated in Figure 3 below.

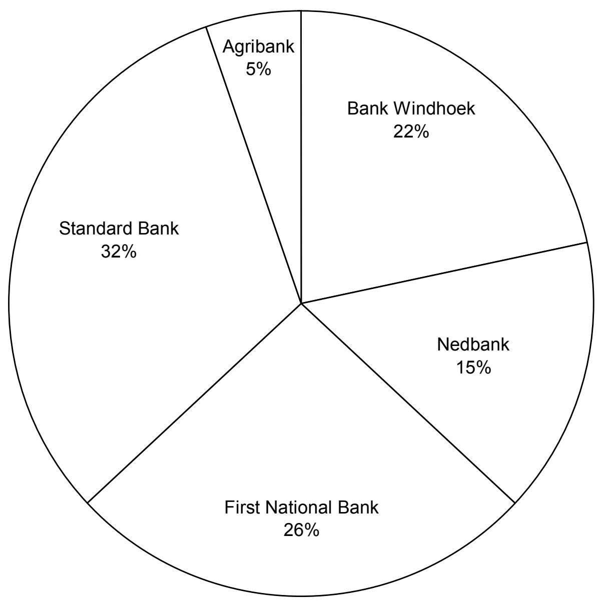

Figure 3: Relative Size of Banks in Namibia from 1998 to 2003

Source: Banks' Annual Reports

A bank's risk depends on the amount of z_3 available to absorb portfolio losses, as well as on the portfolio risks themselves. If some banks are more risk averse than others, they may hold a higher level of z_3 than is needed to maximise profits. All efficiency concepts, including alternative profit, assume that bank's are risk neutral. The incorporation of z_3 in the alternative profit X-efficiency function also enables this report to account for different risk preferences on the part of banks. Ignoring z_3 would result in a mismeasurement of alternative profit X-efficiency, even though banks are behaving optimally given their risk preferences (Hughes, Lang, Mester & Moon, 1997).

A bank's insolvency risk affects bank profits via the risk premium the bank has to pay for purchased funds (w_1), which are usually uninsured, and through the intensity of risk management activities. By including w_1, which captures interest rates paid on purchased funds, this report accounts for differences in risk, to some extent. However, these rates are not always perfectly measured.

A bank's z_3 levels, even apart from risk, directly affects its profits by providing a cheaper alternative to deposits as a funding source for loans because interest paid on deposits counts as a cost, but interest paid on purchased funds do not as they are usually tax-deductible. Since alternative profit X-efficiency is affected by the proportion of equity relative to deposits used by banks to finance lending, incorporating z_3 allows us to control for heteroscedasticity from this source.

In addition, large banks tend to have lower capital to loan ratios than small banks due to the diversification benefits conferred by a large size. This allows them to shift their portfolios toward loans and away from securities for a given level of equity thus allowing them to better manage the increased portfolio risk with the same amount of equity capital and obtain higher returns (Berger & Mester, 1997).

An alternative interpretation of this observation is that the small banks are relatively newly established and thus have a higher capital to loan ratios as they are less affected by past credit restrictions. Since financial markets associate low levels of capital with higher default risk, thinly capitalised large banks may have to pay higher rates for purchased funds.[36] A large, higher-risk bank cannot afford to increase its capital to loan asset ratio as a signal to the market because the opportunity cost of holding this extra capital is greater for them (Hughes, Lang, Moon & Pagano, 1997). The inclusion of z_3 allows us to control for these effects (DeYoung & Nolle, 1996).

Normalising by z_3 implies that this report measures alternative profit X-efficiency by how well a bank is able to earn $a\pi / z_3$ (ROE) normalised by w_3 and with θ added, by using deposit funds and labour to produce loans and securities given a set of external environmental conditions (Akhavein, Berger & Humphrey, 1997).

ROE measures how well a bank is using its financial capital, which has economic meaning and is closer to the goal of the bank than maximising the level of profits, particularly in a highly leveraged industry such as banking. This measure is also of importance to shareholders who will put pressure on publicly traded banks to maximize ROE as opposed to depositors who do not do the same because their

[36] Although financial markets don't consider that some large banks may be able to profitably exploit the deposit insurance subsidy to increase lending and thus take greater risk (Hughes, Lang, Moon & Pagano, 1997), this is not applicable to Namibia, whcich does not have an explicit deposit insurance scheme.

returns are usually guaranteed by deposit insurance, where it exists. Unfortunately, ROE here is an accounting measure, which does not perfectly correspond to the market value of the bank, which is of greater economic interest (Berger & Mester, 1997).

Failure to control for z_3 will result in large banks having much larger random errors and variances than small banks. Since the u_{it} term is derived from a composite residual this large variance will affect its estimation. In contrast, banks of different sizes have ROE ($a\pi / z_3$) that typically varies very little. This keeps the normalised variables from being skewed for large banks so that the dependent and independent variables of large and small banks are roughly of the same order of magnitude.

z_3 is preferred to the value of physical capital as a control for heteroscedasticity because the latter is very small in banking and can be increased much more quickly and easily than the former (Akhavein, Berger & Humphrey, 1997).

We also control for heteroscedasticity by including off-balance sheet guarantees (z_1), which tend to be concentrated in large banks. If this was not included, scale bias may result because larger banks would have to lower profits disproportionately relative to their measured outputs.

Normalisation by z_3 and the inclusion of z_1 in the alternative profit X-efficiency function only partially address the problem of heteroscedasticity because large banks tend to have lower margins, smaller overheads, pay relatively low direct taxes and have lower loan loss provisioning than small banks (Demigurc-Kurt & Huizinga, 1998). This could still introduce heteroscedasticity into the estimated function.

External Environment

Environmental influences on alternative profit X-efficiency may arise either from its own bad management or bad luck from external environmental conditions. By including the market average of the ratio of NPLs to total loans (v) for each year, we control for the external environment (Berger & Humphrey, 1997). This measure is almost entirely exogenous to any individual bank and allows this study to control for negative shocks that impact common macroeconomic conditions that affect all borrowers. However, v is limited because defaults happen rarely in a single year and dependence on common factors makes it difficult to assume within year independence (Saidenburg & Schuermann, 2003).

In principle, v could have included other variables that account for differences in the environment in which the bank operates that are exogenous to its management's decision making but may affect performance, e.g., variables that account for demand, like income growth, unemployment rate or whether the bank is located in an urban or rural area. Alternatively, we could have left these other variables out of the frontier specification, but then determine whether these factors influence alternative profit X-efficiency (Mester, 2003). We used the latter option in this report because these variables are closely related to NPL and would have made interpretation of the coefficients on v more difficult.

Other studies include both v and NPL to test the hypothesis that a management is inefficient in managing its portfolio (bad management) or has made a conscious decision to reduce short-run expenses by cutting back on loan origination and monitoring resources even though its loans are highly risky and of a lower quality than that of another bank (skimping). High NPLs could also reflect a business-intensive loan mix or unfamiliarity with domestic borrowers (relevant to foreign-owned banks). This study does not include NPL on its own because it is endogenous to X-efficiency (DeYoung & Nolle, 1996).

Appendix C: Best Practice Alternative Profit X-efficiency Frontier

The best practice frontier is illustrated below. Firm j is fully efficient. Its actual profit lies below the frontier due only to random error. Firm i is inefficient. The difference in bank i's profit and the frontier value at the same y is due to both random error and inefficiency (Mester, 2003).