BANK EFFICIENCY AND NON-PERFORMING LOANS IN NAMIBIA: A TWO-STAGE DEA BOOTSTRAPPING APPROACH

A Dissertation

Submitted to

The **Development Finance Centre (DEFIC)**
Graduate School of Business
University of Cape Town

In partial fulfilment

of the requirements for the degree of

Master of Commerce in Development Finance

by

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February 2022

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ABSTRACT

In the banking industry, non-performing loans are an undesirable by-product of producing loans and may lead to inefficiency. Therefore, it is important that NPLs are accounted for in the analysis of the efficiency of banks. This paper investigated the relationship between non-performing loans and bank efficiency in Namibia by using a two-stage approach, which was applied on quarterly data spanning the period 2010Q1 to 2020Q4. In the first stage, the Data Envelopment Analysis technique was employed to estimate efficiency scores of the eight commercial banks in Namibia, with and without non-performing loans as an undesirable output variable. The efficiency scores obtained in the first stage were then used in the second stage truncated bootstrapped regression model to determine the effect of non-performing loans on bank efficiency.

The study found that there was low variability in the technical efficiency scores of the Namibian banking industry for the study period, where the trend was unevenly constant with a slight drop after 2016. Furthermore, the results indicated that leaving out non-performing loans as an output variable leads to the under-estimation of the efficiency results. From the second-stage regression results, the study found a negative significant relationship between bank efficiency and non-performing loans, which indicated that an increase in non-performing loans decreases bank efficiency. This signifies the role that credit risk management plays on the efficiency and stability of banks, in which case should be closely monitored. The result also confirmed the bad management hypothesis, as proposed by Berger and DeYoung (1992), which highlights that a lack of efficiency in management of banking institutions will result in bad loan quality. The study also identified bank size, ROA and overhead costs as other significant determinants of efficiency. From a strategic standpoint, the study suggests that the Namibian banking industry invest in systems and processes that are technologically efficient to enhance efficiency, seeing that the study observed a considerable amount of inefficiency on average, for the study period.

ACKNOWLEDGEMENTS

Foremost, I would like to thank God, for the countless blessings that He has bestowed upon me in every step of life, and especially during this master's journey. His grace is indeed sufficient. It has been one of the most exciting journeys of my life, filled with a wealth of knowledge, growth, and challenges along the way.

Furthermore, I would like to acknowledge the support and encouragement rendered to me by my family, friends, and colleagues. Thank you for understanding when I could not make one commitment or another. A special word of gratitude goes to my friends and classmates -- Someleze, Thomas, Lethu, Mpumi, Nolitha and Sabina -- for holding my hand ever so closely when the journey got tough. To my younger brother, Tangi, thank you for all the help throughout my studies.

And finally, I would like to extend my sincere gratitude to my supervisor, Prof. Abdul Latif Alhassan, for his guidance, support and all contributions made to this paper. Thank you for being patient with me.

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LIST OF ABBREVIATIONS

BCC	Banker, Charnes and Cooper (model)
BID	Banking Institutions Determination
BoN	Bank of Namibia
CAMEL	Capital Adequacy, Asset Quality, Management Efficiency, Earnings Ability and Liquidity
CAR	Capital Adequacy Ratio
CCR	Charnes, Cooper and Rhodes (model)
CMA	Common Monetary Area
CRS	Constant Return to Scale
DDF	Directional Distance Function
DEA	Data Envelopment Analysis
DMU	Decision-Making Units
D-SIB	Domestic Systematically Important Banks
FIA	Financial Intelligence Act
GDP	Gross Domestic Product
IMF	International Monetary Fund
NPLs	Non-Performing Loans
PTE	Pure Technical Efficiency
ROA	Return on Assets
SAP	Structural Adjustment Programs
SE	Scale Efficiency
SFA	Stochastic Frontier Approach (/Analysis)
SCF	Stochastic Cost Frontier
TE	Technical Efficiency
VIF	Variance Inflation Factors
VRS	Variable Return to Scale

CHAPTER 1: INTRODUCTION

1.1 Introduction and Background of the Study

The subject of bank efficiency and Non-Performing Loans (NPLs) is paramount as these two elements are directly linked to a country's financial system as well as its economy in a broader sense. A productive and efficient banking sector can help to stimulate economic growth through a reduction in the gap between lending and deposit rates, which promotes development through increased savings and investment. As in most countries with well-functioning financial sectors, banks play an important role in the Namibian financial sector. Among other roles, banks fund small businesses, which helps them to enhance their operations, especially when they have constrained access to sources of finance. (Huljak et al., 2020)

Understanding the efficiency and the economies of scale of banks in Namibia is crucial, especially when trying to comprehend Namibia's financial system. A stable banking system is required to translate surplus funds into investments, which, in turn, will ensure the efficiency of financial intermediation and economic growth (Alhassan et al., 2014). Banks, as financial intermediaries, create and disburse loan facilities to participants in the economy. While this is good for the economy, the creation of these loan facilities exposes banks to credit and liquidity risk (Partovi & Matousek, 2019).

The efficiency of banks can be traced to NPLs. NPLs are loans whose principal and payment of interest is outstanding for a period of at least 90 days (Badar & Javid, 2013). Hence, the term non-performing loan is attributed to them being in, or close to, default. NPLs allow one to determine whether resources are allocated to sectors that are considered to be the most productive in the economy. This is done through categorisation of these bad loans by sector, as well as assessing the quality of credit risk. NPLs can be understood by considering two factors: the macroeconomic factors and the bank specific factors. The macroeconomic factors can be attributed to Sheefeni's (2015) study on the impact of macroeconomic determinants of NPLs in Namibia, whose cointegration test found that there exists a long run relationship between NPLs and the log of the Gross Domestic Product, interest rate and inflation rate. The bank- specific factors on the other hand can be attributed to studies by Sabbah (2013), Berger and Deyoung (1997), and

Louzis et al. (2012), who examined the relationship between loan quality, cost efficiency and bank capital. The study by Berger and Deyoung (1997) attributed the level on NPLs to skimping, moral hazard and bad management.

Credit risk of commercial banks is generally attributed to the loans that are financed by commercial banks. These loans make up most of the asset base and are also where interest is derived from. The interest that is generated from these loans contributes largely to the income of commercial banks because their core business is lending. In this regard, the credit risk component that is associated with commercial banks in terms of non-performing loan dynamics is understood to be too important to ignore when the topic of bank efficiency is examined (Partovi & Matousek, 2019).

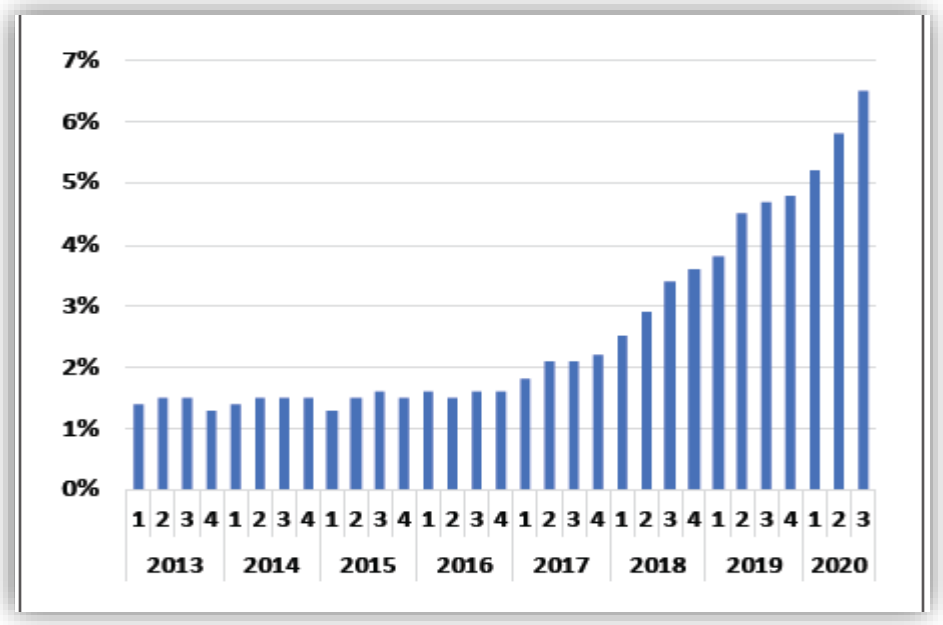
In recent years, the discourse on bank efficiency paid specific consideration to asset liquidity as a variable for NPLs. Mester (1996) argues that if such a variable is not considered, this may lead to erroneous bank efficiency measures. Assets of banking institutions, which are highly concentrated in mortgages, still need monitoring on a continuous basis. This is because, any failure in the financial sector, where commercial banks are mostly dominant, can potentially affect the whole economy of the country.

The Namibian banking sector, which is the backbone of the financial system in Namibia, is considered to have an oligopolistic market structure (Andongo and Stork, 2005). This is a kind of market structure where very few institutions dominate the industry -- in the Namibian case four banks. This inherently poses a great risk in the form of barrier to entry as there is increased pressure in maintaining the industry's profit. The commercial banks' assets value stood at N$144.0 billion for the year 2020 (Bank of Namibia, 2020). According to the IMF, the commercial banks' assets accounted for an estimated 70 percent of GDP in 2019 (International Monetary Fund, 2019).

In Namibia, only two studies have been conducted on bank efficiency. Ikhide (2000, 2008) used operating ratios and the cost frontier approach, respectively, to assess efficiency of commercial banks in Namibia, whereas Nkabila (2017) carried out an analysis of the efficiency of commercial banks in Namibia using the Data Envelopment Analysis method. Moreover, credit risk, which is the factor to which this study will give specific attention, through the investigation of NPLs' impact on efficiency, is not considered in any of the studies conducted.

Despite that the asset quality of the banking sector as measured by NPLs has been stable historically, the recent upward trend in NPLs warrants a thorough investigation of the macro financial linkages between NPLs and technical efficiency of banking institutions in Namibia. The banking sector's NPL ratios came from 1.0 percent in 2012Q1, to 1.6 percent in 2016Q2, to 4.5 percent in 2019Q2 and 5.8 percent in 2020Q1 (BoN, 2020).

Figure 1.1: Non-Performing Loans (%)



Source: Author's estimation based on data received from the Bank of Namibia

The key objective of this study, therefore, is to evaluate the technical efficiency of Namibian banks while incorporating the impact of NPLs. In addressing this gap on bank efficiency in Namibia, the study employs the two-stage Data Envelopment Analysis (DEA) technique to investigate bank efficiency. A study of this nature is crucial for a country like Namibia, seeing that commercial banks make up a substantial fraction of the financial sector. Although several researchers across the world have explored the discourse of bank efficiency in general, very little is known about Namibia.

1.2 Research Problem and Questions

The efficient use of a bank input to produce optimal output is of utmost importance in countries like Namibia where the financial sector makes up a significant proportion of the country's economy. The services that are provided by the financial sector, such as savings and investment mobilisation, transaction services and financial risk management, are

instrumental in economic development. A study by Ikhide (2008) revealed that input variables in the Namibian banking sector are not entirely substitutable and this may lead to inefficiency due to high operating costs. Consumers also tend to share part of these costs through service fees, as the banks transfer part of their high operating costs to consumers.

While many of the studies conducted on NPLs and bank efficiency such as Partovi and Matousek (2019), Abd Karim et al. (2010), and Ramli et al. (2018) concluded that NPLs contribute to bank inefficiency and stability, little to nothing is known about Namibia. What is however known about Namibia is that the NPL ratio has been on an increasing trend for the past five years, highlighting a persistent deterioration in the quality of the loan book of the Namibian banking industry over the years. This deterioration in NPLs came mainly as a result of the current distress on the domestic macroeconomic environment and the overall impact of the Covid-19 pandemic. During the last quarter of 2020, the NPL ratio stood at 6.4 percent, which was a breach of the central bank's revised trigger ratio of 6.0 percent (BoN, 2020).

Arguably, the economic picture that is painted from an analysis of NPL data is not very encouraging. An increase in NPLs results in constraints in credit supply for banking institutions, which can impede their ability to extend more loans. Nagle (1991) pointed out that the challenges brought about by the deterioration in the quality of the loan book may become the impending time bomb for banks. Notably, in many African countries, such as Ghana, elevated levels of NPLs resulted in the banking crises of 1982 (Kapur et al., 1991). Because of this, monitoring and management of loan performance is considered of particular importance by banks and regulators across the world.

This study is considered to be timely, as there is limited research in Namibia with respect to bank efficiency. Furthermore, there is currently no study in the Namibian literature that has considered NPLs as an undesirable output. Therefore, this study intends to fill this lacuna by accounting for NPLs and their impact on the Namibian banks' efficiency. This will aid the Namibian financial sector in making more-informed decisions regarding the impact of the prevailing trend of NPLs in Namibia. This study will also assist in ensuring that resources are allocated efficiently across all sectors of the economy, be it at a micro or macro level.

This research study explored the following research questions:

a) What is the level of technical efficiency of the Namibian banking industry?
b) What is the effect of NPLs on the technical efficiency of banks in Namibia?

In addressing the above questions, the research will also indirectly address pertinent questions such as whether or not the most recent economic slowdown and rise in NPLs affected the banking sector's efficiency in Namibia and what will be the effect if the current distress on the domestic macroeconomic environment is further protracted.

1.3 Research Objectives and Hypotheses

The overall objective of this research study is to empirically analyse the effect of NPLs on bank efficiency by employing a data set covering the most recent available data of the Namibian banking sector. The specific objectives emanating from the research questions are as follows:

- To examine technical efficiency of banks in Namibia.
- To examine the effect of NPLs on technical efficiency of banks in Namibia

H_{1a}: There is efficiency among commercial banks in Namibia.
H_{1b}: NPLs decrease technical efficiency of banks.

1.4 Scope and Justification of the Study

Namibia has a very limited capacity for growing its industries into highly competitive industries, of which the financial industry is no exception. This is due to its transitioning and developing status. Developing industries can encourage efficiency through the reduction in the volume of inputs that yield a maximum output for institutions. This study is therefore pertinent, as the outcomes of the study will be valuable to academics, industry experts, bank management, shareholders, and regulators. The findings from the study can be used in expanding knowledge and gaining a new perspective on the quantified association between NPLs and banking efficiency in the Namibian banking sector. From the standpoint of economic policy, it is imperative to ascertain how several variables, in this case NPLs, which are on an increasing trend in Namibia, affect the level of efficiency of banks. This will ensure that effective actions are taken to enhance efficiency.

This study will contribute to empirical research on bank performance in three ways. Firstly, the study makes use of an innovative methodology in estimating technical efficiency of banks in Namibia by applying the DEA approach introduced by Aparicio et al. (2015). The benefit of this non-parametric methodology is that it allows for a synchronous expansion and contraction of desirable outputs and undesirable outputs (Fukuyama & Matousek, 2011). Secondly, the non-parametric efficiency scores produced by the DEA method are associated with biasedness and invalid inference possibilities. This study provides a solution by applying the first empirical analysis of the Simar and Wilson (2007) bootstrap methodology to correct for biasedness in the efficiency estimates for the Namibian banking context.

Finally, the second stage of the analysis includes more efficiency determinants, which allow for an in-depth analysis. Moreover, the study is timely, as the Namibian financial sector navigates its way out of deteriorating macroeconomic conditions and on-going impact of COVID-19 on the banking sector. The study also contributes to the existing Namibian financial industry literature by analysing quarterly data from a recent period which is stretched out (2010-2020), therefore giving insight into the evolving and current status of the banking sector. Despite the similarities in structure of the Namibian banking industry and some of the countries reviewed in the literature review such as South Africa and Botswana, it is important to note that there is no research currently, that incorporates data from recent years and NPLs as an output variable. Furthermore, the Namibian banking sector is structurally unique in that it is not saturated like other emerging markets and consists of only 8 banks. Notwithstanding that bank make up a lesser fraction of the financial system compared to non-bank financial institutions; they are integral in financial intermediation. Moreso, given the interconnectedness between them and other financial institutions. Thus, understanding their efficiency is crucial to enhancing the stability of the overall financial system.

1.5 Organization of the Study

This study comprises five chapters, which are structured as follows: Chapter 1 provides a background of the study and introduces the statement of the problem, the objectives of the study, the hypotheses, and the significance of the study. Chapter 2 focuses on the theoretical and empirical literature review underpinning NPLs and bank efficiency.

Chapter 3 presents the methodology by outlining the data types and sources, measurement of variables, and estimation techniques employed in the study. Chapter 4 is dedicated to data analysis and the discussion of the empirical findings. Chapter 5 highlights key conclusions and policy implications and recommends areas for consideration by future researchers on the topic.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter provides a coherent summary of the existing literature regarding bank efficiency and NPLs. In this regard, the section begins with an overview of the Namibian banking sector and, thereafter the theoretical framework, which covers the theories underpinning the significance of bank efficiency and NPLs. Following the theoretical framework, this chapter further explores empirical studies conducted in Namibia, in different African countries, and at a global scale relating to the subject matter.

2.2 Overview of the Namibian Banking Sector

2.2.1 Central Bank

The Central Bank of Namibia, which was established by the Bank of Namibia Act 8 of 1990, oversees the activities of all commercial banks in Namibia. The Namibian Constitution mandates the Bank of Namibia to control the supply of money and to supervise the operations of banking institutions in Namibia. The central bank, therefore, performs the following functions: serving as the banker to the Government and acting as its advisor, supporting the country's growth and development, promoting price stability, ensuring that the financial system remains stable, and serving as the lender of last resort to all commercial banks in Namibia (BoN, 2012).

Monetary policy is an important tool that the Bank of Namibia uses to oversee the operations of all commercial banks in Namibia. After independence, Namibia opted to remain under the framework of the Common Monetary Area (CMA). In this arrangement, the Namibian dollar is pegged to the South African rand on a one-to-one basis within the CMA. The repo rate, which is the rate at which the Bank of Namibia lends money to licensed commercial banks in Namibia, is an important monetary policy instrument that the central bank uses to control the domestic supply and demand of money as per the Bank of Namibia Act 1 of 2020.

Over the past two-and-a-half decades, structural and organisational reforms have been realised in the banking sector. This includes the introduction of the regulation and supervision of banks within the central bank. The key function of the Supervision

Department within the central bank is to ensure a sound and stable banking environment in the country. Further to this, the parliament of the Republic of Namibia enacted the Financial Intelligence Act (FIA) on July 20, 2007, to deal with issues around money laundering. In August 2008, the Banking Institutions Act also made it possible for the core banking institutions' system and operations to be localized. These are some of the key intervention measures which regulatory authorities in Namibia have adopted as a way of responding to the effects of internal and external shocks. According to the Financial Stability Report (2018), the Namibian banking industry is operating within the regulatory provisions on a continuous basis. Therefore, the financial soundness indicators of the Namibian banking industry continue to be at comfortable levels in relation to international standards.

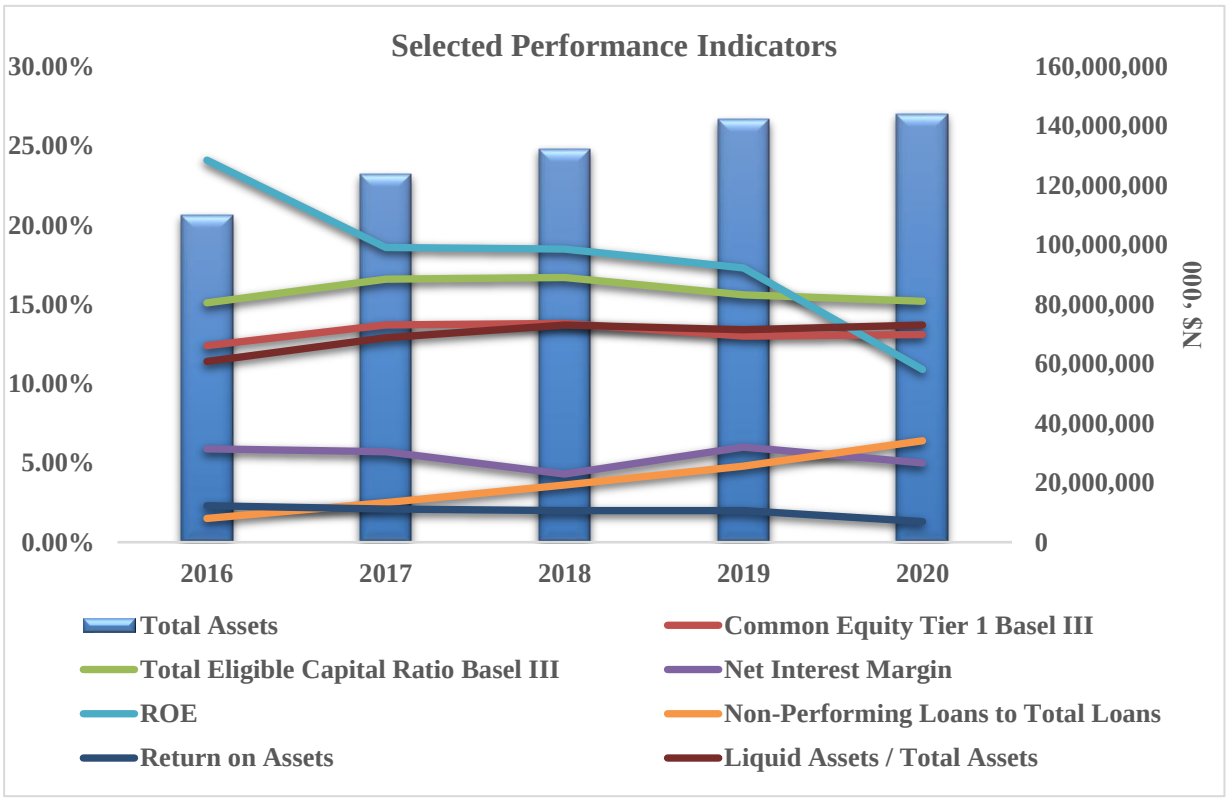
2.2.2 Commercial Banks

In Namibia, commercial banks operate under the Banking Institutions Act 2 of 1998 (Shifotoka, 2014). The role of commercial banks in the Namibian financial system cannot be underestimated. Commercial banks lend money to the public, which can be invested in different projects. Other important services and products offered by commercial banks include mortgage loans, loans, currency exchange services, deposit accounts or credit card accounts, and digital banking services. There are currently eight commercial banks in Namibia with total assets valued at N$1440 billion (for the year 2020) (BoN, 2020). These are Nedbank Namibia Limited, Banco Atlantico (branch of a foreign banking institution), First National Bank Namibia Limited, Letshego Bank Namibia Limited, Bank Windhoek Limited, Bank BIC Namibia Limited, Standard Bank Namibia Limited, and Trustco Bank Namibia Limited.

The Namibian banking sector is, however, concentrated by four of the eight banks, which are referred to as the larger banks or Domestic Systematically Important Banks (D-SIBs) (BoN, 2014). The D-SIBs comprise one local bank and three South African banking subsidiaries, which share more than 95 percent of the market in terms of deposits and the loan book (BoN, 2014). The D-SIBs have been operational in Namibia before the country became independent of colonial rule in 1990. The remaining smaller banks only set foot in the market after 2012 (BoN, 2017). It is also worth mentioning that non-bank financial institutions are said to be dominating the financial sector in Namibia accounting for 150 percent of GDP in assets, whereas commercial banks assets accounted for an estimated

70 percent of GDP in 2019 (IMF, 2019). With respect to the extension of credit to the domestic economy, the total loans and advances of banks totalled N$105.0 billion as at December 2020 (BoN, 2020). In addition to commercial banks, the financial system in Namibia also comprises two development bank institutions, pension funds, several unit trusts, insurance institutions and more than 300 micro-lending institutions.

Figure 2.1: The Namibian Banking Industry Performance Review (2016-2020)



Source: Bank of Namibia Annual Report 2020

The performance review of the Namibian banking industry focuses on total assets, bank funding, capital adequacy and NPLs with reference to the Bank of Namibia's annual reports from 2016 to 2020, however other indicators are illustrated in Figure 2.1 above.

i) Balance Sheet Structure

The balance sheet in 2020 stood at N$144.0 billion compared to N$142.2 billion in 2019, representing only a 1.3 percent growth in comparison to 7.6 percent growth recorded in 2019 (BoN, 2020). It is also worth noting that this annual growth fell below the annual inflation rate of 2.2 percent. The growth in the balance sheet is attributed to an increase in cash and balances with banking institutions, and short-term negotiable securities of

N$1.1 billion and N$723.5 million, respectively (BoN, 2020). Regarding the availability of funding to support asset growth, non-bank funding remains a presiding source of funding as it comprises 76.7 percent of the banking industry's funding. The banking industry's balance sheet size is observed to be on a general upward trend between 2016 to 2020, as observed in Figure 2.1 above.

ii) Banking Industry Funding

In 2020, the Namibian banking industry funding was dominated by non-banking funding, which stood at N$110.5 billion, forming 76.7 percent of total funding (BoN, 2020). This was a lower growth when compared to 9.4 percent recorded in 2019. The main sources of bank funding in 2020 included borrowings, debt instruments, capital and reserves, and other liabilities. On the other hand, the main source of non-bank funding includes fixed and notice deposits, foreign funding, demand deposits, savings deposits, negotiable certificates of deposit and (BoN, 2020).

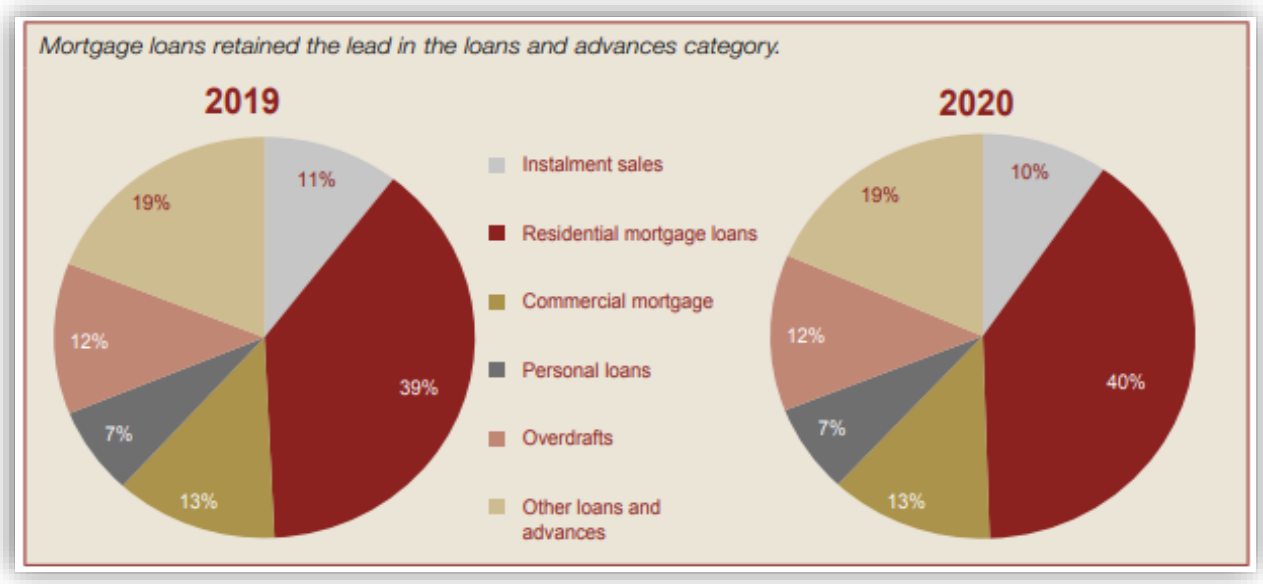
iii) Non-Performing Loans (NPLs)

The performance of NPLs between 2016 to 2020 was on an increasing trend, highlighting a deterioration in the quality of the loan book of the banking industry over the period. During 2020, the NPL ratio stood at 6.4 percent, breaching the Bank of Namibia's trigger benchmark of 6.0 percent. This was also a pick-up from 4.8 percent recorded in 2019. The increase in NPLs for 2020 was attributed to clients who were unable to live up to their repayment commitments (BoN, 2020). On the other hand, the credit product types contributing to the rise in NPLs include mortgages of N$800.2 million, overdrafts of N$386.0 million, other loans and advances of N$337.0 million, and personal loans of N$138.5 million (BoN, 2020).

The economic impact of the COVID-19 pandemic led to considerable uncertainty at macro and micro economy levels. This has created various challenges for borrowers, and consequently for banking institutions. In addition, the COVID-19 pandemic emerged at a time when Namibia was already facing an economic downturn. The pre-existing depressed economy coupled with the COVID-19 pandemic could intensify defaults and lower recoveries due to inactive markets of collateral. Global policy responses have been geared towards alleviating the pressure on borrowers by allowing for temporary capital and interest moratoriums for borrowers affected by COVID-19.

Against this backdrop, the Bank of Namibia issued the Determination on Policy Changes in response to economic and financial stability challenges (BID-33), following the manifestation of the COVID-19 pandemic. BID-33 makes provision for banking institutions to grant capital payment moratoriums, where a holiday is allowed on the principal amount for a period ranging between six and 24 months (BoN, 2020).

Figure 2.2: Composition of Total Loans and Advances



Source: Bank of Namibia Annual Report 2020

iv) Profitability and Earnings

The total banking sector income reduced by 3.1 percent year-on-year, from N$10.4 billion to N$10.0 billion. This is in comparison to a growth of 7.7 percent recorded during 2019. The contraction in total income during 2020 was mainly attributed to the prevailing low interest rate environment. The components making up total income include net interest income, which reduced by N$446.9 million to N$5.5 billion due to the depressed interest margins caused by the low interest rate environment (BoN, 2020). The low interest rate environment came as a result of the outbreak of the COVID-19 pandemic, which resulted in the Monetary Policy Committee of the Bank of Namibia reducing the policy rate up to 275 basis points during 2020 (BoN, 2020).

In terms of the operational efficiency of the banking sector, the cost-to-income ratio deteriorated during 2020. Operating expenses rose by 3.5 percent from N$5.7 billion in 2019 to N$6.0 billion in 2020 (BoN, 2020). As a result, the cost-to-income ratio

(operating expenses/total income) increased from 55.5 percent to 59.3 percent, exceeding the international benchmark of 50.0 percent. The growth in operating expenses was mainly attributed to the growth in depreciation and amortisation costs as well as administration and overhead (BoN, 2020).

2.3 Theoretical Framework

2.3.1 Performance Evaluation of Banks

Following the establishment of Structural Adjustment Programs (SAP) in the late 1980s, banking sectors across the world have been experiencing key transformations in their operational environment. Countries have relieved some controls on interest rates, adopted Basel Accord principles, lowered government involvement to some degree and welcomed international banks into their jurisdictions (Ismi, 2004). For this reason, researchers over the years, have become interested in understanding bank efficiency in relation to these developments. There are several studies and theories to explain the performance of commercial banks before and after the changes in the financial configuration of countries. In consideration of these transformations in the banking industry, this section focuses on financial performance, covering Capital Adequacy, Asset Quality, Management Efficiency, Earnings Ability and Liquidity (CAMEL) and, thereafter, economic indicators, covering efficiency.

2.3.1.1 Financial Indicators: The CAMEL Framework

The CAMEL Model was initially developed and applied in 1979 by the Federal Financial Institutions Examination Board to assess the stability and soundness of banking institutions in the USA (Nguyen et al, 2020). The CAMEL framework stands for Capital Adequacy, Asset Quality, Management Efficiency, Earnings Ability and Liquidity, and is a ratio-based model, which is applied to evaluate and rank the performance of banks. In recent times, the model has become an institutionalized approach to analyse the financial stability of commercial banks among regulators (Rose & Hudgins, 2010). In Namibia, the central bank makes use of this framework for offsite surveillance of commercial banks. Each of the pillars under the CAMEL framework are discussed in detail below.

i) Capital Adequacy

Capital adequacy of banks can be defined as the amount of own funds that banks are required to hold to support the bank's business and enable it to withstand credit, market and operational risks (Athanasoglou et al., 2005). Banks are normally exposed to different risks, and capital allows them to absorb potential loses and safeguard the interest of the bank's debtors. Banks cannot solely rely on deposits to guarantee long-term security as this makes them fragile and prone to bank runs. In this sense, banks can use their own funds to support their operations. This can also serve as a buffer especially when they are cash strapped. Capital adequacy is measured on the parameter of the Capital Adequacy Ratio (CAR), which looks at the bank's potential to overcome losses when faced with financial challenges (Athanasoglou et al., 2005). Capital adequacy ratio demonstrates the bank's internal ability to survive losses in the event of a crisis. The capital adequacy ratio is directly correlated with the resilience of banks to crisis events (Athanasoglou et al., 2005).

ii) Asset Quality

A bank's asset quality is another performance indicator and bank-specific variable that affects its efficiency. Asset quality can be defined as the different assets of a bank, which may come in various forms such as fixed and current assets, credit portfolio and other investments (Ongore & Kusa, 2013). Often, the growth (in size) of the asset base is related to the age of a bank (Athanasoglou et al., 2005). Under asset quality, bank failure is normally triggered by low levels of liquidity and poor asset quality. The risk of losses emanating from NPLs may affect the overall health and performance of the bank's portfolio as the loans that they issue, as well as the assets generated from these loans, contribute significantly towards a bank's income and profitability. It can therefore be concluded that asset quality is an important determinant of a bank's efficiency.

iii) Management Efficiency

Efficiency can be expressed through various management systems such as organizational discipline, control systems, quality of staff and other quantitative mechanisms. These quantitative mechanisms include financial ratios used in financial statements such as proxies for management efficiency, income maximization and others (Ongore and Kusa, 2013). Management efficiency comprises different financial ratios such as total asset growth, loan growth rate and earnings growth rate. In terms of measurement, management

efficiency is generally measured based on two ratios: the operating profit-to-income ratio and the expenseto-assets ratio. The operating profit-to-income ratio is said to be positively related to operational efficiency in the sense that a high operating profit-to-income is likely to lead to more efficient management in terms of income generation and operational efficiency (Ongore & Kusa, 2013).

iv) Liquidity Management

Liquidity management can be described as a bank's ability to honour its responsibility towards its short-term obligations (Marozva, 2015). Liquidity management is another useful measure of a bank's performance levels. Among a bank's assets, cash and investments are the most liquid. If the liquidity of a bank is low, then the bank will not be able to meet its current financial obligations. If liquidity is too high, then it is an indicator that the bank is not utilizing its cash in an effective manner. Therefore, an appropriate balance of liquidity is essential so that banks can generate maximum profit while providing liquidity to the depositors and meeting their obligations when they fall due. The most-used financial ratios in measuring the liquidity position of banks are the total loan-to-customer deposits ratio and the customer deposit-to-total asset ratio (Athanasoglou et al., 2005).

2.3.1.2 Economic Indicators

This section covers a discussion related to the efficiency concept as applied to banking production, the non-parametric and parametric approaches to estimation of bank efficiency, the orientations (inputs, outputs) including the intermediation and production approaches of a bank's production function, and a general theoretical discussion on NPLs and bank efficiency.

i) Efficiency Concepts

Lovell (1993) described efficiency as an evaluation centred on the experiential and optimum values of outputs, which are derived from a specified level of inputs. Similarly, Coelli and Perelman (1999) defined efficiency as the distance between the existence and degree of optimal quality of inputs and the outputs that can be achieved. Efficiency can be differentiated from another phenomenon called partial efficiency where only a single production factor is concerned, whereas full efficiency can only be achieved when all input and output factors are taken into consideration.

The groundworks for the measurement of efficiency started with the work of Debreu (1951) and Koopmans (1951). Debreu (1951) put forward the measurement of efficiency through a study on the coefficient of resource utilization. The study establishes how inefficient the allocation of resources in an economy is by determining the amount by which the same level of satisfaction to the consumers could be attained using less resources. On the other hand, Koopmans (1951) looked at the concept of technical efficiency where he defined a possible point in the commodity space to be efficient if "a rise in one of its coordinates (net output of one good) can be attained only at the cost of a reduction of another coordinate (net output of another good)."

It is crucial to understand the diverse concepts of efficiency that exist, i.e., technical, allocative, and cost efficiency. In the opinion of Farrell (1957), **technical efficiency** deals with the use of inputs (such as capital, labour, and machinery) to produce outputs parallel with a benchmark in a specified sample of Decision-Making Units (DMUs). Hence, given the same technology for all the DMUs, no wastage of inputs is reflected in generating the given output. The DMU operating at best practice is then used as a benchmark in comparing with others in the sample as it is said to be technically efficient. The scale of operations and managerial practices affect technical efficiency.

On the other hand, the concept of **allocative efficiency** satisfies two conditions. Firstly, all outputs that are produced should be at their optimum level in relation to the given inputs. Secondly, all outputs are produced until their last unit meets a marginal utilization need by customers, and simultaneously satisfies the marginal cost for producers. In essence, allocative efficiency means that there is no waste on either the consumption or the production side (Grosskopf, 1993). Allocative efficiency is denoted as a percentage score, where a score of 100 percent is reflective of an organisation that is using its inputs in the sizes which optimally minimize costs (Grosskopf, 1993). An institution that is operating at best practice in engineering terms could still be operating at an allocatively efficiency below 100 percent if it is not using inputs in optimal proportions, which minimize its costs given relative input prices.

The concept of **cost efficiency** deals with both technical and allocative efficiency. This is because an organisation is only considered to be cost efficient if it is both technically and allocatively efficient. Adongo et al. (2005) define cost efficiency as an attribute that measures the change in a bank's variable costs corrected for random error, in relation to

the estimated costs needed to produce a set of outputs as efficiently as the best practice bank in the sample (with the condition that all banks are facing the same exogenous variables). These variables include variable input prices, variable output quantities and fixed net inputs and outputs. Thus, a 100 percent cost efficiency is only achievable by an institution if it has achieved 100 percent for both allocative and technical efficiency.

2.3.2 Approaches to the Estimation of Bank Efficiency

There are two widely used techniques to measure efficiency referred to as the accounting and econometric techniques. The accounting methodology makes use of financial ratios to analyse the efficiency or financial performance of an organisation. The econometric techniques are divided into two broad categories referred to as the parametric and non-parametric approaches. The parametric approach makes use of the cost, production, and revenue functions, which are applied when estimating the production technology and for technology estimation. The parametric method commonly used is the Stochastic Frontier Approach (SFA). However, other parametric approaches exist, such as the Thick Frontier Approach and the Distribution Free Approach. The non-parametric methods essentially entail using linear programming techniques. The frequently used non-parametric method is the DEA (Berger & Humphrey, 1997).

The Stochastic Frontier Approach, which is based on regression analysis rather than linear programming, makes use of a production function, which is estimated and used to specify a technical profit or cost frontier. This cost or profit frontier is then used for comparison with the units of analysis, from which their degree of efficiency is determined. The basic assumptions from which the Stochastic Frontier Model is based are referred to as the 'inefficiency component' and the 'random component' of the residual (Greene, 2005). According to Greene (2005), an important assumption made under the Stochastic Frontier method is that the bank-specific drivers of inefficiency are accounted for in the model in the form of effects and are not correlated with the input levels. The Stochastic Frontier Approach is understood to address two main shortcomings of the DEA, among others. These two shortcomings are the presence of random noise, measurement errors and outliers, and the correlation between input and output variables. The major benefit of using the SFA is that one can compute the technical, allocative, and economic efficiency using this method (Greene, 2005).

The DEA technique, which was brought forward by Charnes et al. (1978) characterizes a mathematical programming method that estimates the relative efficiency score as a unit of assessment, which is established from the multiple used for inputs to produce various outputs. The fundamental assumption in the DEA technique, which forms part of the conventional formula, is the isotonicity property. In the isotonicity property, an increased input may reduce the efficiency, whereas increased output increases efficiency (Dyson et al., 2001). However, in the real world, circumstances may be more complex, where increased output could also reduce the efficiency, while increased input increases the efficiency. This is the reverse of the isotonic property and is referred to as an anti-isotonic property (Dyson et al., 2001). The anti-isotonic situations bring about the concept of 'undesirable' or bad factors to the input or output variables. An undesirable output variable of NPLs is also explored in this study. In the case of an anti-isotonic circumstance, the output factor will need to be minimized while the input factor is maximized (Dyson et al., 2001).

The DEA method is extensively used to analyse technical efficiency in organisations, where the results are used to rank organisations according to their performance. The beneficial feature of DEA is that it makes no assumption about the functional form of the data. However, the disadvantageous feature of the DEA method is that since it in not possible to estimate parameters for the model, it makes it unfeasible to test a hypothesis regarding the performance of the model. Additionally, given that the linear programming method is not stochastic, it accounts for noise as inefficiency, thereby making it vulnerable to outliers and specification error because it assumes that data is free from measurement errors (Akoena et al., 2013).

The main idea for evaluating the performance of a bank is to arrive at information that is relevant in informing bank managers and government policymakers on the effects of deregulation, mergers, and market structure efficiency. According to Usman et al. (2010), bank efficiency ensues when the best level of output is attained without having to make any changes to the quantity of input. Comparing the DEA method to other methods, it has two advantages in the benchmarking domain. To begin with, the method can make simultaneous comparisons using several dependant performance measures and provide a yardstick for the best practice. Furthermore, the DEA method is able to infer on the amount of resources that can be spared, or equally so, on the amount of additional output

resources that could have been produced had the organisation used methods and techniques of 'best practice' when operating.

2.3.3 General Theoretical Discussion on Non-Performing Loans and Bank Efficiency

i) Theoretical Relationship between Non-Performing Loans and Bank Efficiency

From the perspective of management accounting, the asset quality of a bank and operating performance are positively correlated. If a bank's asset quality is inadequate, i.e., the loan amount and interest payable cannot be fully collected, the bank's bad debt losses and provisions for loan losses will increase. Banks will also need to avail more human resources to the recovery of NPLs (Berger & De Young, 1997). For every loan amount that has been listed for collection, a bank will attract extra operating costs. Apart from the extra costs to monitor loan quality, these operating costs also include earning the trust of management and the public at large. Furthermore, additional cost will be incurred to preserve the bank's performance rating, and a decline in deposits could be observed due to a loss in credibility (Abd Karim et al., 2010). It is this escalation in cost that then deteriorates bank efficiency.

Conversely, Berger and DeYoung (1997) also indicate that efficiency of banking institutions could also affect NPLs in the banking industry. The bad management and bad luck hypotheses were developed to explain this relationship. The bad luck hypothesis emphasises that the occurrence of external events results in an increase in NPLs in banks. On the other hand, the bad management hypothesis reflects low efficiency as an indicator of poor managerial performance, which also influences the loan extension behaviour of banks. Berger and DeYoung (1997) claim that bad management of the banking institutions affects the loan extension process of banks, which is the core of banking business and results in them not being efficient. Additionally, the challenge of information asymmetries between lenders and borrowers further complicates the challenge. As a result, lower credit ratings for loans that are approved and a higher probability of default are observed, causing an increase in NPLs. Thus, the conclusion that banks' inefficiencies may lead to increased NPLs. The concepts of information asymmetries and bad luck hypothesis are discussed in detail below.

ii) Asymmetric Information

The theory of asymmetric information dates to the late '90s and is typically attributed to Akerlof (1970)'s "lemons problem" phenomenon, which describes the disappointing investment in a used car. The presence of asymmetric information in the car market may prevent a transaction from taking place between buyers and sellers. This is because buyers may have little knowledge of the quality of the car that sellers are offering, hence buyers will try to avoid overpaying for such a vehicle.

Similarly, asymmetric information may also have an impact on credit markets as lenders may not be well acquainted with the price at which a loan is acquired. Lenders could also be tempted to increase interest rates or set high standards for loan repayment as they may not have full knowledge of the borrowers requiring funds (Stiglitz & Weiss, 1981). Richard (2011) argues that asymmetric information derails efficiency in the market, as lack of complete or credible information by borrowers makes it very difficult for lenders to make informed decisions. Consequently, lenders cannot pre-empt certain businesses and the lack of credible and complete information may result in them making wrong decisions about business transactions. The concept of asymmetric information has affected the Namibian banking industry's NPLs in that the fees and charges are not well disclosed, therefore introducing information asymmetries in the credit administration process of banks.

iii) Bad Luck Hypothesis

The bad luck hypothesis is another important theory that can be used to relate to the relationship between NPLs and a bank's efficiency. The bad luck hypothesis generally emphasizes a negative relationship between NPLs and a bank's efficiency. This is because low level of banks' efficiency is fundamentally triggered by low-quality loans (Rossi et al., 2005). The discourse on the bad luck hypothesis was brought forward by Berger and De Young (1997) who argued that NPLs arise due to unpredicted external outcomes such as firm breakdown or economic slumps. This, therefore, imposes extremely high costs on banks which will have to evaluate the problem with such loans. Koutsomanoli-Filippaki and Mamatza-kis (2009) were some of the proponents of the bad luck hypothesis while analysing 27 European Union members from 1998 to 2006.

iv) Skimping Hypothesis

The skimping hypothesis is one of the theories that contrasts the bad luck hypothesis. The discourse on the skimping hypothesis was also brought forward by Berger and De Young (1997) who argued that the exercise of monitoring and underwriting loans can be dealt with efficiently by firms that maximize profits in the long run. Though one will have to deal with the challenge of non-forthcoming borrowers in the long term, one is able to maintain lower costs by devoting few resources to loan-recovering activities. Under the skimping hypothesis, managers are said to be forward-looking individuals; meaning that a manager will look for a way to lower short-term costs with the aim of maximizing long-term profits, which lowers the prospect of them becoming myopic. High efficiency is normally attributed to lower, short-term costs. Banks, therefore, do not immediately look to resolve poor asset quality, they would rather choose to consider this in the long term (Williams, 2004).

2.4 Empirical Literature Review

A vast amount of research has been conducted to analyse the efficiency of banking institutions all over the world. The review of literature in this study brought to light a gap in terms of empirical studies on banking efficiency that accounts for NPLs, particularly in Africa. However, several studies have been conducted outside of the African continent. In this regard, this section discusses valuable insights provided by previous bank efficiency literature across the world and highlights key methodologies and results. This section divides the empirical literature into three categories, namely studies conducted in Namibia, in Africa, and in the rest of the world.

2.4.1 Efficiency Literature in the Namibian Context

This study has identified only two studies that have been conducted on the efficiency of the banking industry in Namibia. Ikhide (2000) conducted a study on the efficiency of commercial banks in Namibia for the period 1993 to 1998, while placing specific consideration on some Namibian commercial banks, namely First National Bank, Bank Windhoek, Standard Bank, Commercial Bank of Namibia and City Savings and Investment Bank. Ikhide (2000)'s study employed operating ratios and the cost frontier approach as a methodology. The results of the operating ratios established that high profit levels existed in the banking industry during the period in question. The trans-log cost

function, on the other hand, established that there was a great deal of economies of scale in the Namibian industry.

In 2008, Ikhide (2008) expanded the earlier research by further using the econometric frontier approach to study the efficiency of commercial banks in Namibia for the same period (1993-1998). The study established that significant economies of scale exist within the Namibian banking industry. The study further revealed that most banks found it difficult to achieve efficiency due to high input costs that they incurred. The study also found that banks in Namibia could promote economies of scale when they operate optimally with less input.

Nkabila (2017) employed the DEA method to analyse the level of efficiency of commercial banks in Namibia using the period 2011-2015. The research focused on the four big banks (in terms of market share), namely First National Bank, Bank Windhoek, Standard Bank and Nedbank. The study, using the intermediation approach, considered deposits, staff costs and fixed assets as input variables, whereas non-interest income and loans were the output variables. The findings of the study indicated that two out of four of the sampled commercial banks in Namibia achieved optimal efficiency. The study further inferred the Namibian banking sector had an average efficiency of 89.4 percent in terms of the analysis period.

2.4.2 Empirical Studies from other African Countries

Kablam (2010) analysed the determinants of banking industry efficiency in Sub-Saharan Africa for the period of 1998-2002 using the SFA to determine the cost-effective frontier. The study also made use of the Generalised Method of Moments to determine the financial development index, as well as the ratio of private loans to GDP, GDP per capita, share of rural population and capitalisation, and bank-size ownerships as key variables. The study found that an efficient banking system had a positive impact on financial development in Sub-Saharan Africa, especially if banks are carrying out their intermediary roles effectively. Furthermore, the study established that a sound credit environment and effective regulation are some of the key drivers of bank efficiency in Sub- Sahara Africa.

Moffat and Valadkhani (2011) added an element of uniqueness to their study on efficiency of financial institutions in Botswana by making use of three alternative

approaches in denoting the combination of input and output variables. This was done to test the sensitivity of the efficiency results obtained and ensure reliability of the results. The study made use of the intermediation approach, the value-added approach, and the operating approach (or income-based approach) in calibrating the input and output variables. Several conclusions were drawn from the study, with the most important being that the ranking of the banks' efficiency scores remain consistent among the three different approaches of selecting input and output variables. Furthermore, the study also indicated the most efficient banks to be a mix of small and large institutions in terms of asset size, which is in line with the findings of Akoena et al. (2013).

Akoena et al. (2013) highlighted that increased bank size might not necessarily translate into higher technical or scale efficiency. This was established through an investigation of technical and scale efficiencies and returns to scale features of 16 Ghanaian banks. A DEA employing both the intermediation and production approaches was performed for insight into bank size and efficiency of these banks. The study found that small banks had higher average returns to scale compared to big banks. In addition, small banks as a group were found to be operating nearer to their lowest average cost in comparison to large banks.

Using a sample of five big banks, Erasmus (2014) investigated the efficiency of the major banks in South Africa. The study was conducted for the period between 2006 and 2012 and incorporated an analysis of efficiency during the period of the global financial crisis of 2008. The study employed the standard and alternative DEA methods. The difference between the two methods is that the standard DEA method makes use of linear averages of all variables whereas the alternative DEA method makes use of non-linear averages in measuring efficiency. The study indicated that most South African banks were efficient under both methods. The study also observed that the efficiency scores of the banks that were inefficient under the standard approach improved under the alternative approach. As a result of the banks being overall efficient, the study concluded that the global financial crisis did not affect the efficiency of most of the banks. Similarly, the study also argued that the South African banks' efficiency was one of the instrumental factors for their resilience during the global financial crisis, as the banks were efficient even before the crisis.

Abdalla (2014) analysed the efficiency of commercial banks in Sudan for the period 2009 to 2010 using the DEA, by considering a sample of 29 commercial banks in the country. The study used loans, assets and profits as outputs, and administrative expenses, deposits, and assets as inputs in view of measuring the efficiency levels of each of these banks. The overall efficiency level was found to be 84 percent, with four out of 29 banks being technically efficient and another four being purely technically efficient.

In a study on income diversification and bank efficiency in Ghana, Alhassan (2015) applied the SFA on 26 Ghanaian banks to estimate the cost and profit efficiency scores. The study thereafter applied a Tobit Regression Model to analyse the empirical influence that expansion into non-interest generating activities has on the cost and profit efficiency scores estimates. The results from the SFA uncover high levels of inefficiencies on the revenue side, as reflected in lower efficiency scores of the profit compared to the cost. Furthermore, the results suggested that larger banks have high cost and profit efficiency compared to smaller banks. A non-linear association between income diversification and efficiency was also observed in the same study.

Several other studies have been conducted on the efficiency of banks in Ghana, for instance Alhassan and Ohene-Asare (2016) and Alhassan and Biekpe (2016). Alhassan and Ohene-Asare (2016) assessed the relationship between competition and bank efficiency in Ghana. Using the DEA method, the Boone indicator as a proxy for competition and a panel regression model, the study established some improvements in cost efficiency and competition within the Ghanaian banking industry for the reviewed period (2004-2011), in comparison to prior periods. The estimations also suggested that competition puts forth a positive influence on cost efficiency.

Alhassan and Biekpe (2016), through their study on explaining bank productivity in Ghana, found that growth in productivity could be ascribed to the catch-up effect of changes in efficiency and productivity growth. Results of the panel regression analysis in the same study found concentration, size, income diversification and risk to be the factors that explain productivity differences among banks in Ghana.

Alhassan and Tetteh (2017) investigated the effect of including non-interest income in the assessment of bank efficiency. The study applied a two-stage bootstrapping method, where in the first stage efficiency scores were obtained with the inclusion of non-interest

income and thereafter without. In the second stage, a truncated bootstrapped regression was computed to examine the effect of the appropriate variables on the bootstrapped efficiency scores. The study found that non-interest income was an important variable in ensuring that the efficiency scores were not under-estimated. Furthermore, the second stage suggested that bank efficiency increases as the size of banks increases, with this being mainly attributed to economies of scale, although this was only up to an optimal point after which inefficiency sets in.

2.4.3 Empirical Studies from across the World

The empirical literature on efficiency of banking institutions has received considerable attention across the world over the past two decades. Matthews et al. (2009) examined the productivity growth of banks in China, while incorporating NPLs as an undesirable output variable, over 10 years with the period ending 2006. The study employed a bootstrap approach to estimate the Malmquist index of productivity growth, while also using the most fitting confidence intervals. The results indicated that on average, the productivity growth of state-owned banks was minimal or negative in comparison to that of joint-stock banks, which was noted to be higher. The study also observed that, on average, the productivity of banks in China improved modestly over the study period.

Abd Karim et al. (2010) analysed the relationship between NPLs and bank efficiency in Malaysia and Singapore using the Stochastic Cost Frontier (SCF) approach to measure cost efficiency. The efficiency scores that were obtained were thereafter used in a Tobit regression to determine the degree of the relationship between NPLs and bank efficiency. The results indicated that banks in Singapore exhibit higher scores when compared to Malaysia. Further to this, the Tobit regression indicated that high NPLs reduce cost efficiency. The results are in line with the bad management hypothesis, which was proposed by Berger and DeYoung (1992).

Garza-García (2012) used the DEA method to analyse the main determinants of efficiency in the Mexican banking industry. A Tobit Regression Model was also conducted thereafter to establish the main determinants of bank efficiency. The result of the DEA revealed that the Mexican banking sector faced inefficiencies on average, in terms of technical efficiency, pure technical efficiency and scale efficiency during 2001-2009. According to the Tobit regression results, the variables of foreign ownership, growth in

Gross Domestic Product (GDP) and loan intensity were observed to increase bank efficiency.

Hamid et al. (2017) measured the efficiency of the Malaysian banking sector in the presence of NPLs. The study consisted of 21 commercial banks of which eight were domestic and 13 were foreign banks. In addition, the study employed a Directional Distance Function (DDF), which is an extension of the DEA method. The results indicated that the technical efficiency score for domestic banks was marginally higher than those of the foreign banks.

Ramli et al. (2018) investigated the effect of NPLs on bank efficiency in Malaysia using the slack-based method and a Tobit Regression Model. The study found that NPLs cause negative impact on commercial banks, which was statistically significant. The results of the slack-based measure point out that the technical efficiency score of foreign banks was higher than that of domestic banks.

Qayyum and Riaz (2018) established that private, smaller, well-capitalized banks are more efficient. The researchers conducted a study on the efficiency of 24 emerging economies, while incorporating NPLs, for the period of 1999–2013. Using the DDF in conjunction with the DEA, the study concluded that after the inclusion of credit quality, the distributions of efficiency scores were observed to be different. However, these scores varied on a systematic basis, with the accumulation of NPLs across the different regions that formed part of the study. An important observation that was drawn from the study was that the financial crisis of 2007–2008 affected more severely the regions that had higher ratios of NPLs. A follow-on non-parametric regression also was conducted, of which the results indicated that banks that are smaller in terms of asset size, better capitalized and privately owned were more efficient.

In Turkey, Partovi and Matousek (2019) evaluated the relationship between NPLs and efficiency by analysing the technical and allocative efficiencies of Turkish banks from 2002 to 2017. The study employed a modified version of the DEA approach, which uses a directional distance model. The model accounted for NPLs as an undesirable output variable. In addition, the study examined the determinants of efficiency by making use of a quantile regression on panel data. The results obtained were in line with the “bad

management" hypothesis. Furthermore, the study found that the ownership structure of banks in the Turkish market had a significant influence on the level of efficiency.

A comparative analysis of the banks in India was conducted by Tamatam et al. (2019) using the outputs of the DEA model. The study compared the performance of banks in terms of their size and ownership structure using Malmquist indices, by determining the 10-year trend of productivity in the Indian banking industry. The findings of the study indicated that only 24 percent of the 38 banks that formed part of the study were overall technically efficient. Scale inefficiency was also observed to have contributed more than pure technical inefficiency to the overall average inefficiency of 5 percent.

2.5 Summary

The literature that was reviewed above demonstrated the significance of bank efficiency and NPLs as an area of research. As observed from the bank efficiency studies on the various banking industries in Africa, it appears that there is a gap in the efficiency literature, with regard to the relationship between NPLs and efficiency of banks. The most widely explored topic is general efficiency of banking sectors and in some instances its relationship with other variables such as size, capital structure and corporate governance. Notably, there are also different methodological approaches used in the studies with DEA being the dominant method. Other methods employed included the SCF approach, Malmquist index of productivity growth and the slack-based measure method. However, there seems to be no study conducted in Namibia which particularly considered the subject in question. Hence, this study intends to fill the gap and add to empirical literature for Namibia.

Studies that incorporated NPLs in their estimation of bank efficiency include, among others: Partovi and Matousek (2019), conducted on banks in Turkey; Abd Karim et. al. (2010), conducted on banks in Singapore and Malaysia; and Qayyum and Riaz (2018), conducted on 24 emerging economies as reviewed. While most of the studies reviewed employed a two-stage DEA approach of which some accounted for undesirable outputs following the introduction by Chung et al. (1997), the studies all focused on single countries. Qayyum and Riaz (2018) highlighted this as a significant limitation, primarily because it does not allow for cross-country and regional comparisons of bank efficiency

scores, which could be an important aspect in shedding light on differential impacts on countries of mutual macroeconomic shocks. e.g., global financial crises.

Table 2. 1: Taxonomy of Bank Efficiency Studies

NO.	AUTHOR(S)	COUNTRIES	SAMPLE SIZE	SAMPLE PERIOD	METHOD-OLOGY	INPUTS	OUTPUTS	EFFICIENCY TYPE	APPLICATION CATEGORY	NPL IMPACT RESULTS
1.	Abd Karim et al. (2010)	Malaysia and Singapore	Not stated	1995 to 2000	SFA	Sum of expenses on wages and salaries, Land, Buildings, Equipment and Interest on deposits.	Total loans, total deposits, and investments	CE	Bank Efficiency and NPLs	Higher non-performing loan reduces cost efficiency
2.	Abdalla (2014)	Sudan	29	2009-2010	DEA	Administrative expenses, Deposits, Assets	Profit, loans, and assets	PTE, SE	Efficiency of commercial banks	N/A
3.	Akoena et al. (2012)	Ghana	16	2000-2006	DEA	deposits, Other liabilities, Shareholders' equity, Staff costs, Fixed assets, non-interest expenses	Loans and overdrafts, Investments in securities, Deposits with other banks, non-interest income	Composite efficiencies (product of technical and scale	Investigation of technical and scale efficiencies and returns to scale	N/A
4.	Alhassan and Biekpe (2016)	Ghana	18	2003-2011	DEA-MPI	Personnel expenses, Fixed assets, Deposits	Loans and advances, Fees and commissions	PG	Explaining bank productivity	N/A
5.	Alhassan and Ohene-Asare (2016)	Ghana	26	2004-2011	DEA	Fixed assets, Deposits, Staff expenses	Investment, Loans, Fees	TE; CE	Relationship between competition and bank efficiency in Ghana	N/A
6.	Alhassan and Tetteh (2017)	Ghana	26	2003-2011	DEA	Fixed assets, Deposits, Staff expenses	Investment, Net Loans, Fees	PTE	Effect of including non-interest income in the assessment of bank efficiency, efficiency determinants	N/A
7.	Alhassan (2015)	Ghana	26	2003 to 2011	SFA	Fixed assets, Deposits, Staff expenses	Loans and advances, Investments	TE	Relationship between income diversification and bank efficiency	N/A
8.	Erasmus (2014)	South Africa	5	2006-2012	Standard and Alternative DEA	Deposits, Other liabilities, Shareholders' equity, Staff costs, non-interest expenses, Fixed Assets	Loans and overdrafts, non-interest Income	TE	Bank efficiency	N/A
9.	Garza-García (2012)	Mexico	18	2001-2009	DEA	Total costs, Total deposits	Total loans and other earning assets	TE, PTE, SE	Determinants of bank efficiency	N/A
10.	Hamid et al. (2017)	Malaysia	21	2008-2015	Directional Distance Function	Personnel expenses, Fixed Assets, and Total deposits	Interest income, Total earning assets, non-performing loans	TE	Bank efficiency and NPLs	Significant change in efficiency scores
11.	Ikhide (2008)	Namibia	5	1993-1998	SEFA	Labour, Capital, and Deposits	Total loans and advances	CE	Measure operational efficiency of Namibian banks	N/A
12.	Kablam (2010)	29 Sub-Saharan Africa countries	137	1998-2002	SFA	Labour, Physical capital, and financial capital	Deposits, Loans and Securities	CE	Banking efficiency and financial development	N/A
13.	Matthews et al. (2009)	China	14	1997 - 2006	DEA-MPI	Number of employees, Fixed assets	Total deposits, Total loans, other earning assets, Non-interest income	MPI	NPLs and Productivity	Negative impact

14.	Moffat and Valadkhani (2011)	Botswana	10	2001-2006	DEA	Deposits, Labour (salaries), Capital-related operating expenses	Loans, Investment	TE	Efficiency of financial institutions	N/A
15.	Nkabila (2017)	Namibia	4	2011-2015	DEA	Deposits, Staff costs (including benefits), Fixed assets (Property& Equipment)	Non-interest income, Loans	TE	Assess the level of efficiency of banks in Namibia	N/A
16.	Partovi and Matousek (2019)	Turkey	44	2002 to 2017	DEA	Capital and Deposits	Total loans and receivables, Total securities, Total off-balance sheet activities, Total non-interest income, NPLs	TE; AE	Relationship between NPLs and efficiency	Negative impact
17.	Qayyum and Riaz (2018)	24 emerging economies	918	1999–2013	DEA	Personnel expenses, Other administrative expenses, User cost of fixed assets, Total Deposits, Personnel expenses, Other administrative expenses, User cost of fixed assets	Total deposits, total loans, other earning assets, NPLs	TE	Incorporating credit quality in bank efficiency measurements	Varied systematically with accumulation of NPLs across regions
18.	Ramli et al. (2018)	Malaysia	21	2008-2015	Slack-Based Measure	Total deposits, Interest expenses, Overhead costs	Total loans, non-interest income, Other earning assets, Non-performing loans	TE	Effect of NPLs on technical efficiency	Negative significant impact
19.	Tamatam et al. (2019)	India	38	2008–2017	DEA-MPI	Total assets and Total deposits	Advances, Interest income, Total income and Operating profit	TE, PTE, SE	Efficiency analysis	N/A

Note: SEFA=Standard Econometric Frontier Approach; DEA= Data Envelopment Analysis; MPI= Malmquist Productivity index; SFA= Stochastic Frontier Analysis; TE=Technical Efficiency; PTE= Pure Technical Efficiency; SE=Scale Efficiency; CE=Cost Efficiency; AE=Allocative Efficiency; PG=Productivity Growth; NPLs= Non-performing Loans. Source: Candidate's compilation from empirical literature.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter outlines the method and tools that were applied in analysing the efficiency of commercial banks in Namibia. The chapter gives a detailed specification of both the theoretical and empirical model. The chapter addresses the following items: the research approach and design, the sample and data collection strategy that was employed, and the justification of the variables that were used in the study. The study employed the DEA in the first stage, which is used to measure the efficiency of a set DMUs between factor input and output variables. In the second and final stage, a truncated bootstrap regression equation will be applied in order to analyse the impact of NPLs in the model.

3.2 Research Approach and Design

As observed in the literature that was reviewed, the relationship between NPLs and the estimated efficiency scores is appropriately analysed using a quantitative method. A quantitative research study produces statistics through the analysis of large-scale survey data, by making use of methods such as interviews or questionnaire to collect the data, among other ways (Dawson, 2002). Since this study has also incorporated variables of a numeric nature to analyse the data set, the study therefore made use of the quantitative approach.

3.3 Sample and Data Collection

This study analyses bank-level quarterly data between period 2010 and 2020 that is collected from the Bank of Namibia. As of 2020, there were eight banks that were licensed by the Bank of Namibia and in operation. The study uses quarterly data from the most recent period which is stretched out (2010-2020), therefore giving insight into the evolving and current status of the Namibian banking sector.

3.4 Analytical Framework

This study employed a two-stage DEA. The first step involved the application of the DEA method to estimate efficiency scores of commercial banks. In the second stage and final stage,

the efficiency scores were then used as dependent variables in a multiple linear regression analysis.

3.4.1 Stage 1: Estimating Efficiency

There are several parametric and nonparametric methods advanced in the efficiency measurement literature. This study made use of the DEA method, which is a non-parametric method. The DEA technique results in a frontier consisting of all the efficient units with scores equal to 1. Inefficiency is depicted by scores of less than 1. Among others, the benefit of using DEA is that the input and output variables can be selected without the burden of adding relative importance to each of them or making any assumptions about the distribution of the efficiencies (Charnes et al., 1978).

There are two traditional DEA Models -- the CCR Model developed by Charnes et al. (1978) (CCR) and the BCC Model developed by Banker et al. (1984). These models are based on constant and variable return to scale assumptions, respectively. This study focused on the CCR model in analysing the Technical Efficiency of banks in Namibia. Regardless of the focus on the CCR Model, the study generated both constant and variable return to scale results for comparison purposes, which are referred to as DEA_{CRS} and DEA_{VRS}, respectively. Furthermore, the scale economies were derived by dividing the efficiency scores derived from dividing the CRS (Constant Return to Scale) estimation by the efficiency scores under VRS (Variable Return to Scale). The mathematical representation of the input oriented DEA_{CRS} Model is illustrated in equation 1 (Ozcan, 2008):

Maximise $\theta_0 = \sum_{\Gamma=1}^{s} u_r y_r \,/\, \sum_{i=1}^{m} v_i x_{i0}$

Subject to $\left[\sum_{\Gamma=1}^{s} u_r y_{rj} \,/\, \sum_{i=1}^{m} v_i x_{ij}\right] \leq 1$ (3.1)

$u_r, y_{rj} \geq 0 \; for \; all \; r \; and \; i.$

Where θ_0 is the efficiency score of a DMU ("0") of focus; i the inputs; r the output; u_r and v_i the weights allocated to outputs and inputs; x_{ij} represents the number of inputs *i*, used by the *j*th bank, and y_{rj} is the output, *r*, generated by the *j*th bank.

There is a high degree of intuition required when it comes to running a regression of efficiency scores estimated by the DEA and their explanatory variables. Simar and Wilson (2007) demonstrate that the common two-stage estimation has severe flaws that compromise the credibility of the results, and the statistical inference derived from these results. To address this shortcoming, Simar and Wilson (2007) have established a bootstrap-based, two-stage method. This method comes in two variants and proposes two Stata algorithms, which both lead to the same regression results. This study made use of the first algorithm (which uses externally generated efficiency scores) of the Simar and Wilson (2007) bootstrap bias correction model to account for possible biases using the notations adopted from Halkos and Tzeremes (2013) as follows:

$$\widehat{BIAS}_B(\hat{\theta}_{DEA}(x_{\dot{0}}, y_0)) = B^{-1} \sum_{b=1}^{B} \hat{\theta}^*_{DEA,b}(x_0, y_0) - \hat{\theta}^*_{DEA}(x_0, y_0) \quad (3.2)$$

where $\hat{\theta}^*_{DEA}(x_0, y_0)$ are the bootstrapped scores and B represents the bootstrap repetitions. The error correction estimator can be denoted as follows:

$$\begin{aligned} \hat{\hat{\theta}}(x_{\dot{0}}, y_0) &= \hat{\theta}_{DEA}(x_{\dot{0}}, y_0) - \widehat{BIAS}_B(\hat{\theta}_{DEA}(x_{\dot{0}}, y_0) \\ &= 2\hat{\theta}_{DEA}(x_{\dot{0}}, y_0) - B^{-1} \sum_{b=1}^{B} \hat{\theta}^*_{DEA,b}(x_0, y_0) \end{aligned} \quad (3.3)$$

3.4.1.1 Input and Output Variable Selection

Unlike the manufacturing industry, which has explicit input and output variables, the financial industry demonstrates several operating processes when selecting input and output variables. This in some instances is affected by the availability of data. The choice of variables employed in efficiency research can significantly affect the results. In addition, the joint production and pricing allocated to typically "packaged" services make the measurement of input and output variables cumbersome (Triplett, 2007).

Favero and Papi (1995) expressed five methods of deciding on input and output variables as follows: the production approach, asset approach, intermediation approach, valued-added approach, and user-cost approach. Discussions about the most suitable definition and measurement for inputs and outputs continue to exist. In banking literature, consensus has not yet been reached as to which approach is best (Fethi & Pasiouras, 2010). However, there are

two known approaches that are commonly applied in literature with regard to the measurement of inputs and outputs of a bank, i.e., the production approach and the intermediation approach (Humphrey, 1985).

The **production approach** reflects banks as using acquired inputs (land, labour and capital) to produce the outputs of deposits and various categories of bank assets. In a study to investigate which bank could produce services using the lowest cost, Benston (1965) was one of the first researchers to make use of the production approach. Banking literature deals with and quantifies loans and deposits as outputs in terms of the number of accounts. The production approach only takes into account operating costs and excludes interest expense paid on deposits because the method considers deposits as outputs. D'Souza and Lai (2003) identified the weakness of the production approach to be the fact that it is unable to account for the mitigation of financial risk that commercial banks are exposed to while doing loan transactions.

In contrast, the **intermediation approach**, brought forward by Sealey and Lindley (1977), considers banks to be financial intermediaries that use collected funds for intermediation of loans and other assets. In this approach, the volume of deposits, loans and other variables are considered as inputs and outputs of a bank. Outputs are calibrated in monetary value terms and total costs comprise all operating and interest expenses. Johnes et al. (2009), in their study on efficiency in Islamic and conventional banks, quantified inputs of banks as the fixed assets, deposits and short-term funding, general and administrative expenses, and equity. Whereas, the outputs of banks comprised the total loans and other earning assets. In another study by Chang et al. (2011), which measured the branch efficiency of a Taiwanese bank, personnel expenses, interest fees and incidental expenses were regarded as input variables, whereas the output variables included operating profit, net profit, total deposit, total loans, NPL ratio, and interest gain. The above-mentioned studies, and all others in literature, in essence reflect that the DEA method for performance of banks does not dictate any underlying assumption of a functional form in connection with the inputs or outputs of the banks. Given the varying set of inputs and outputs of different banks, the DEA constructs its own functional form, therefore avoiding the risk of misspecification of the frontier (Ofori-Sasu, 2019). In the intermediation approach, the DEA does not assume that all DMUs (banks) are using the same technology.

Several researchers such as Brissimis et al. (2010) and Van Heerden and Van der Westhuizen (2008) deem the intermediation approach to be more advanced compared to the production approach. These researchers put forward the following three arguments: Firstly, they claim that

because the intermediation approach incorporates interest expenses, this allows for more than half of a bank's total cost to already be accounted for. Secondly, the methodology allows for a solution to the data availability problem. Thirdly, regarding cost minimization, the approach minimizes total costs and not just the production costs. This study makes use of the intermediation approach to outline the inputs and outputs applied in the analysis.

This study has assumed the intermediation approach in selecting the input and output variables for the construction of the efficiency frontier. The intermediation approach is grounded on the assumption that the main objective of a commercial bank is to create output, identified as loans and investment, while using capital, liabilities (that include deposits) and labour as inputs. In this study, the choice of input variables are **fixed assets, total deposits,** and **staff costs**. The chosen output variables are **NPL**s (as an undesirable output), **gross loans and advances** and **investments**. The variables that this study made use of can be described and explained as follows:

i) Fixed Assets

These are long-term assets acquired with the purpose of long-term use. Fixed assets cannot be easily or quickly converted into cash. In terms of banking business, fixed assets include land, buildings and equipment (such as ATMs). Fixed assets are applied as an input variable in order to capture the banking sector's property value and to determine the magnitude by which investment in assets has a bearing on the efficiency scores of the banks (Nkabila, 2017).

ii) Total Deposits

Bank deposits refers to the money that customers place with banking institutions for safekeeping and investment, among other reasons. There are different kinds of deposit accounts, which customers make use of, as part of the products offered by a bank. These include money market accounts, checking accounts and savings accounts. Deposits in this study refers to the amount of money paid into the banking institutions accounts by customers (both individuals and retail) and did not take into account inter-bank transactions (Nkabila, 2017).

iii) Staff Costs

Will banking institutions with a larger wage bill be more efficient than those with a smaller wage bill? The inclusion of staff costs is regarded as a necessary input as employees play an

important role in the transition of input variables into outputs. In this regard, staff costs include all benefits offered to employees.

iv) Non-Performing Loans

A loan extended by the bank to its customers is considered non-performing if no agreed repayment and interest payment has been made for more than 90 days. When customers do not honour their agreed repayment arrangements for 90 days or more, the bank will need to set aside additional capital. This reduces its capacity to provide new loans, hence introducing inefficiency. One of the main purposes of the study is to determine to what extent this is the case for the Namibian banking industry.

v) Gross Loans and Advances (Loans)

Banks lend money to customers, who then have an obligation to pay back the loans at a predetermined interest rate. There are various loan products that banks offer, such as motor vehicle loans, credit cards and mortgages. The variable was selected to incorporate the volumes of loans accumulated by banks as an output generated from the production of input variables. The perfect situation for banks is having customers honour their obligation by redeeming their loans. However, this is not always the case. Deviation of bank customers from paying back their loans indicates inefficiency within the system, hence the inclusion of NPLs as a separate variable.

vi) Investments

Investments, which represent the investments made using money collected from deposits, are often used as an important variable for financial intermediation in the banking industry. Therefore, these benefits that have been incurred, and invested assets, are used as efficiency outputs. (Abd Karim et al., 2010) (Alhassan & Ohene-Asare ,2016).

3.4.1.2 Dealing with NPLs as an Undesirable Output in the DEA Model

Despite that the literature on efficiency analysis with DEA technique has provided a vast research base, treatment of specific outputs has not yet been thoroughly researched. However, literature does put forward some approaches to simultaneously dealing with undesirable and desirable outputs.

According to Halkos and Petrou (2019), there are four ways in which undesirable outputs can be dealt with, which include ignoring them from the production function and carrying out the necessary transformations to account for these undesirable outputs in the model. The methods of performing transformations have thus far proven to have their own disadvantages, for example, directly adding a specified constant to the undesirable output or moving undesirable outputs to the inputs side of the model may neglect the relative significance between desirable and undesirable outputs, thus making the efficiency scores less credible.

This study makes use of the notion of the Sharpe ratio to deal with the coexistence challenge among desirable and undesirable outputs in the DEA Model as applied by Pan et. al (2010). To take into account the relative importance between desirable and undesirable outputs, one of the desirable outputs, in this case investments, is divided by the undesirable output (NPLs) so that a new modified output variable is formed. This transforms NPLs into a new desirable output, such that it is in this form: amounts of desirable output (investments) per unit of undesirable output (NPLs).

3.4.2 Stage 2: Technical Efficiency and NPLs

To measure the effect of non-performing loans on the bank's efficiency, a multiple regression model incorporating several determinant variables, regressed on the efficiency scores will be used in the study. Below is the equation illustrating the model:

$$\hat{\theta}_{i,t} = \beta_0 + \beta_1 NPLs_{i,t} + \beta_2 SZ_{i,t} + \beta_3 ROA_{i,t} + \beta_4 LEV_{i,t} + \beta_6 OVA_{i,t} + \varepsilon_{i,t} \quad (3.4)$$

Where $\hat{\theta}$ denotes the estimated technical efficiency scores in stage 1, NPLs is non-performing loans, SZ is the bank size measured in terms of total assets, ROA is return on assets, LEV is the ratio of total bank debt to total assets, OVA is Overhead over total Assets, β represents the coefficients and ε the error term. i and t denote bank and time (year), respectively.

3.4.2.1 Measurement and Description of Independent Variables

There is well-established empirical literature that explains DEA efficiency scores by investigating the determinants of technical efficiency (e.g., Alhassan & Tetteh (2017), Abd Karim et al. (2010) and Ramli et al. (2018)). The literature divides the determinants into two broad categories, namely financial and economic determinants. Of the various determinants

that have been analysed in the literature, the following variables have been adopted for investigation in this study:

a) Non-Performing Loans

This study will make use of the absolute figures of NPLs as a variable. That is, the total loan book that is 90 days or more past due. As highlighted in the literature review, management accounting leans towards the notion that a bank's asset quality and performance have a positive relationship. This goes to say that if the performance of the bank's loan book is inadequate (e.g., there is an increase in NPLs), the bank's expenses increase due to an increase in bad debts and other accompanying expenses such administrative costs for delinquent loan collection. This increase in NPLs and expenses, in turn, weakens bank efficiency. Mester (1992) and Matthews et. al (2009), among many other researchers, also demonstrated that the exclusion of NPLs in the computation of bank efficiency results in flawed bank efficiency measures. In addition, Qayyum and Riaz (2018), Altunbas et al. (2000), Partovi and Matousek (2019), Abd Karim et. al. (2010), Matthews et al. (2009), Ramli et al. (2018), and Fan and Shaffer (2004) have empirically confirmed the negative relationship between NPLs and bank efficiency. This is predominantly true because a large proportion of NPLs could be a sign that banks make use of less resources than usual in their credit evaluation and loan monitoring process, therefore highlighting increased credit risk, which needs to be managed. Berger and DeYoung (1997) highlighted that better management of credit risk is an indication of an efficient bank.

H_1: NPLs have a negative effect on bank efficiency.

b) Bank Size (Total Assets)

Bank size is commonly determined by using a bank's total value of assets. The effect of bank size on efficiency is not consistent across different researchers. Literature on the economies of scale concluded that the size of a bank and bank efficiency have a positive relationship. However, an exception was concluded for extremely large banks, where the size could result in negative bank efficiency. The reasoning behind the positive relationship between size and efficiency is because it is expected that larger banks will develop their technological, technical, financial and even human capacity, resulting in enhanced efficiency (Lieu et al., 2005).

Mercan et al. (2003), Williams and Nguyen (2005), Reddy and Nirmala (2013), and Vu and Nahm (2013) found a direct correlation between size and efficiency of a bank, whereas Isik and

Hassan (2002), Akin et al. (2009) and Sufian and Habibullah (2010) found a negative relationship between bank size and bank efficiency. Sufian and Haibullah (2010) argued that as the size of banks increases, an inclination towards the misallocation of resources occurs, thus introducing the bank to inefficiency even with the benefit of economies of scale. Several studies such as Mester (1992), Clark (1996), and Karray and Chichti (2013) also found that an increase in the size of banks above specified thresholds culminates to diseconomies of scale, which results in inefficiency. In such a case, widened interest margins would be observed.

H_2: Growth in bank size increases bank efficiency.

c) Return on Assets (ROA)

Return on assets is one of the most used methods of calculating the profitability of banks. The primary objective of any business is to yield a financial return. This study has made use of the ratio of net income to total assets in calculating the return on assets. Instinctively, the relationship between profitability and bank efficiency is expected to be positive because inefficiency introduces costs, which will impact negatively on the profitability of a firm. Therefore, banks have a better chance of improving their profitability when they remain efficient. Košak and Zajc (2006) found a positive relationship between ROA and efficiency. On the contrary, Palečková (2015), Kosmidou (2008), Pasiouras et al. (2006) and Akhigbe and Stevenson (2010) conclude the opposite. Palečková (2015) empirically found an inverse relationship between ROA and efficiency. Akhigbe and Stevenson (2010) and Stiroh and Rumble (2006) argue that diversification of income does not necessarily result in increased profits.

H_3: Profitability has a positive impact on efficiency.

d) Leverage

The conventional operating model of banking business requires banks to raise debt in order to finance their assets. The most applied financial leverage ratios are the debt ratio, the debt-to-equity ratio and interest-coverage ratio. Similar to Alhassan and Tetteh (2017), this study has made use of the debt ratio in calculating financial leverage, which is given by total liabilities to total assets. In Namibia, the leverage ratio stood at 75.4 percent as at December 2020 (BoN, 2020), highlighting that a major fraction of the assets of banks are financed using deposits, which made up about 83 percent of the total banking industry liabilities during the same period.

Theoretical literature provides contrasting views on the relationship between leverage and bank performance. Literature that is centred around signalling and the agency costs stemming from the conflicts of interest encountered by managers and shareholders, argue in favour of a positive relationship. On the other hand, the literature analysing the agency costs stemming from the digressing interests between shareholders and borrowers argue in favour of a negative relationship. A positive association between leverage and efficiency would mean that a bank has better access to credit facilities, which can improve the performance of a bank through greater leverage and higher competitiveness (Weill, 2008).

In terms of theory, the impact of the linkage between leverage and bank efficiency is distinctively grounded in the binding nature of debt, i.e., financing that is majorly reliant on debt increases the pressure exerted on managers to perform because it reduces the moral hazard behaviour (Jensen, 1986). As a result, banks with higher leverage would be expected to enhance their performance. However, higher leverage also results in more agency costs due to the digressing interests of shareholders and debtholders. This challenge, brought about by moral hazard, implies that leverage may negatively impact on performance (Jensen, 1986). In line with this school of thought, therefore, this study expects high leverage to result in less efficiency.

H_4: High bank leverage reduces bank efficiency.

e) Overhead Costs / Total Assets

Overhead costs, which are also referred to as non-interest expenses, are other operating expenses that the bank incurs. These expenses are separate from interest expense, which are incurred in respect of loans and deposits received. Good management of a bank's expenses is expected to yield positive results on a bank's level of efficiency. Empirical literature has made various efforts to evaluate the impact of non-traditional banking means on bank efficiency (Alhassan, 2015; Nguyen, 2018; Gulati & Kumar, 2011). In the same vein, this study believes that a lower proportion of non-traditional banking business signifies a lower extent of income diversification, which has an impact on the level of bank efficiency. However, in general a declining operating cost ratio over time indicates a decrease in the costs incurred by a bank, which could be an indication that a bank is being more efficient in the use of their resources. Therefore, the study expects that an increase in overhead costs ratio will result in a decrease of efficiency.

H_5: High overhead costs lead to lower bank efficiency.

Table 3. 1: Summary of Regression Variables

Symbol	Definition	Expected sign
	Dependent variable	
TE	Technical efficiency	-
	Independent variable	
NPLs	Non-performing loans	-
	Control variables	
SZ	Bank size	+
ROA	Return on assets	+
LEV	Leverage	-
OVA	Overhead cost	-

Source: Author's computations from research data.

3.5 Summary

This chapter presented the two stages of the methodology that was used in Chapter 4 to assess bank efficiency and NPLs in the Namibian banking sector. The study employed the DEA in the first stage, which is used to measure the efficiency of a set DMUs between factor input and output variables. In the second and final stage, a truncated bootstrap regression equation was applied in order to analyse the impact of NPLs in the model. The Chapter introduced and discussed the relevant frameworks and variables used in the study. The results of the analysis done using the methodology that was described in this Chapter are presented in the next chapter.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents an analysis and discussion of the results pertaining to the effect of NPLs on technical efficiency of the eight commercial banks in Namibia. In line with the methodology outlined in Chapter 3, the analysis is done in two stages. Stage 1 illustrates performance in terms of the average efficiency scores for the quarterly data between 2010 and 2020. Stage 2 discusses the truncated bootstrap regression results with an emphasis on the impact of NPLs in the model.

4.2 Descriptive Statistics

4.2.1 Input and Output Variables

Table 4.1 shows the descriptive statistics of the input and output variables employed in the DEA Model to measure the efficiency scores.

Table 4.1: Input and Output Variables

	Mean	Median	Std Dev	Minimum	Maximum
Output					
Loans	14 074 667	12 684 328	10 333 873	9 022	35 086 173
NPLs	389 217	198 805	467 085	0.000	2 110 103
Investments	722 429	422 227	809 111	0.000	3 504 876
Input					
Fixed Assets	290 878	205 929	271 486	2470	968 618
Total Deposits	15 258 175	15 695 628	10 704 226	936	38 077 967
Staff Cost	102 868	96 583	76 278	0.000	284 509

Note: NPLs = non-performing loans; All values in Namibia Dollars. Source: Author's estimates from research data.

From Table 4.1, it is observable that there was considerable variation in the data during the study period of 2010-2020. This is evident in the maximum and minimum values across all the variables under review. This can further be observed in the dispersion of the variables measured by the standard deviation, which is observed to be relatively high in relation to the maximum and minimum of each variable. Looking at the input variables in the table, it is worth noting that deposits form about 97 percent on average of the input structure of the banks. Deposits are portions of the banks' total debt payable within a year. Furthermore, from Table 4.1, the standard deviation of deposit funding suggests that the overall deposits as a source of funding

among the commercial banks in Namibia have a high variability during the study period. This may be brought about by the fact that there was variation in data between the four larger banks compared to the four smaller banks and may not necessarily be an indication that the long-term lending rates offered by banks are high as result of the volatility. From Table 4.1, the highest total deposits (N$ 38 077 967) and staff cost (N$284 509) were both recorded in 2020. The lowest figures of zero were mainly observed due to the case where the smaller banks were in their inception stages during the study period. It is also interesting to note that the Namibian banking sector has exhibited the highest figures during 2020, highlighting growth of the sector over the years (see *Overview of the Namibian Banking Sector* in the Literature review).

Looking at the output side of the model, it can be observed that loans, comprising 93 percent, form a significant part of the outputs of the banks in comparison to investments and NPLs. This comparison indicates that the main activities of banks, insofar as the generation of income is considered, are focused more on the extension of credit. It could be concluded that commercial banks' efforts are concentrated more on traditional avenues as opposed to other non-traditional-generating avenues such as trading income and transaction-based fee income.

4.3 Evolution of Efficiency Scores

As highlighted in the previous chapter, among the principles of the DEA Model is that the model is based on relative efficiency. In other words, the institution with the highest efficiency will be used as the benchmark for other institutions within the sample and would be regarded as efficient. Table 4.2 shows summary statistics of the quarterly geometric means of the cross-sectional DEA_{CRS} (Technical Efficiency) and DEA_{VRS} (Pure Technical Efficiency) scores. Table 4.2 further displays efficiency scores from two different specification of the output variables, i.e., with and without NPLs as an output variable. The decision for the measurement of the DEA_{CRS} is because banks are assumed to operate at an optimal scale whereas measuring DEA_{VRS} was due to its reliability for observing banks functioning under an imperfect competitive setting, in this case in Namibia.

From the results in Table 4.2, the study observes that efficiency scores for DEA_{CRS} and DEA_{VRS} do not show similar results of efficiency among banks in Namibia. Efficiency results revealed better scores under the VRS in comparison to the CRS method. In this regard, banks were observed to be more efficient under the VRS method. This is because banks are deemed to have greater scale advantage, and furthermore the VRS method is less stringent and envelopes the

frontier more tightly, compared to the CRS method. The banks that were inefficient, which was majorly the case throughout the data set, suggest that their respective input variables, i.e., their deposits and costs were not being optimally utilized.

Table 4.2: Summary Statistics of Efficiency Scores

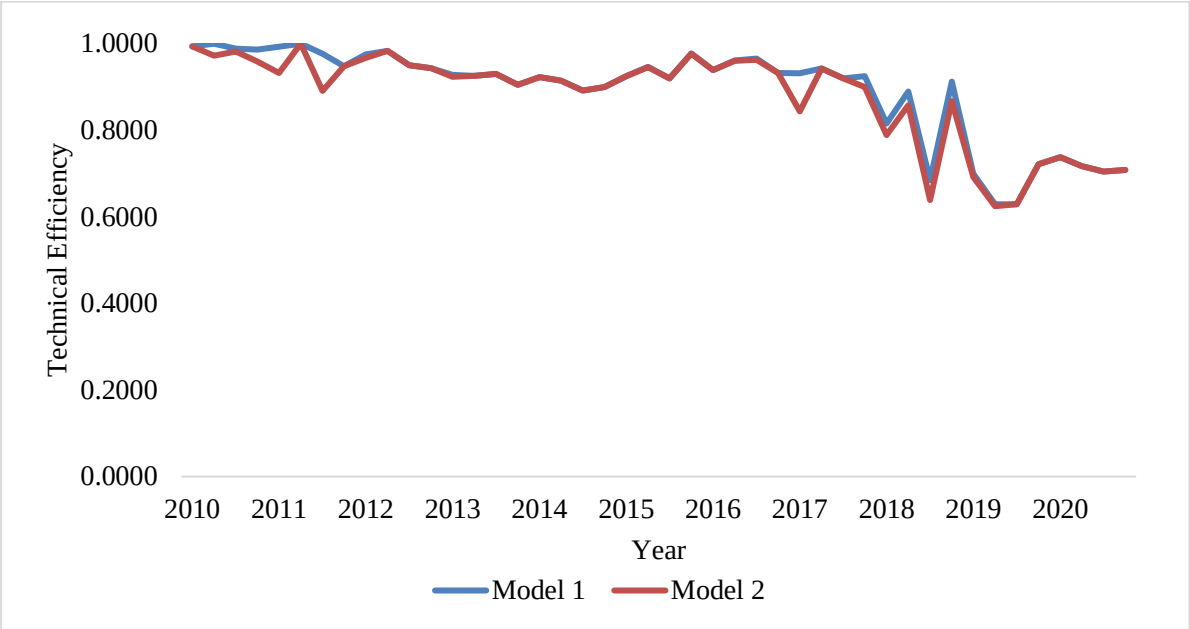
	Model 1 With undesirable output			***Model 2 Without undesirable output***		
	DEA_{CRS}	DEA_{VRS}	SE	DEA_{CRS}	DEA_{VRS}	SE
Mean	0.8908	0.9430	0.9420	0.8794	0.9355	0.9374
Maximum	1.0000	1.0000	1.0000	1.0000	1.0000	1.0256
Minimum	0.6291	0.7634	0.7284	0.6247	0.7428	0.7284
Std dev	0.1087	0.0554	0.0775	0.1083	0.0567	0.0783
N	352	352	352	352	352	352

Note: DEA_{CRS} = Technical Efficiency; DEA_{VRS} = Pure Technical Efficiency; SE = Scale Efficiency. Source: Author's estimates from research data.

From the first model (Model 1) in Table 4.2, the estimated efficiency scores under the CRS method ranged between 62.91 and 100.00 percent, whereas under the VRS, the scores ranged between 76.34 and 100.00 percent during the period 2010-2020. The corresponding figures in the second model, ranged between 62.47 and 100.00 percent and 74.28 and 100.00 percent, for DEA_{CRS} and DEA_{VRS}, respectively. Overall, the average scores for DEA_{CRS}, DEA_{VRS} and SE were 89.08, 94.30 and 94.20 percent for Model 1, whereas the corresponding scores for Model 2 were 87.94, 93.55 and 93.74, respectively. This indicates that, during the study period, the banking industry operated at an average 10.92 percent and 12.06 percent technical inefficiency from Models 1 and 2, respectively.

Scale Efficiency (SE) refers to an input bundle where the size of operations is optimal such that any changes to its size will cause the unit to be inefficient or less efficient. It illustrates the best possible achievable output for that specific input combination. In the above case, the study noted that the Namibian banking industry operated at an overall average scale efficiency of 94.20 percent. It is also notable that the scale efficiency between 2012-2018 was 100 percent, just before the inclusion of the smaller banks into the sample. This suggests that the emergence of smaller banks has introduced scale inefficiency within the banking system. This is expected as smaller banks strive to increase their competitive advantage.

Figure 4.1: Trend of Technical Efficiency Scores



Note: Model 1 = Geometric average of technical efficiency scores with undesirable output; Model 2 = Geometric average of technical efficiency scores without undesirable output. Source: Author's estimates from research data.

An analysis of the trend as presented in Figure 4.1 emphasises an average inefficiency below 40 percent for each quarter of the review period. Only two periods recorded 100 percent efficiency throughout the study period 2010-2020, i.e., the second quarters of 2010 and 2011, which are the peak periods of the data set. Interestingly, these periods are just after the 2008 financial crisis. The study also noted that there was low variability in the technical efficiency of the Namibian banking industry throughout the review period, where the trend was constant with a slight drop after 2016. As mentioned earlier, this highlights the impact that the entrance of new banks in the industry has had over the research period. Nonetheless, the study acknowledges that there could be other contributing factors to the drop, such as the fact that Namibia's economy was in recession in 2016 and has since been struggling to recover.

The technical efficiency without incorporating NPLs in the output variables, as depicted in Model 2, is shown to be slightly lower on average. The average technical efficiency drops to 87.94 percent from 89.08 percent in Model 1, respectively. This result was in congruence with the results of Hamid, et al. (2017) and Qayyum and Riaz (2018) and could be a confirmation of Foos et al. (2010) and Paul et al. (2016)'s conclusion that banks with slow-growth lending activities such as the Namibian banking sector tend to have better performance compared to those with high growth. That is, NPLs, when not too high, do not impact efficiency negatively. This is further evident in the margins between Model 1 and 2 in Figure 4.1, which were not excessive.

4.4 Descriptive Statistics of Explanatory Variables

It can be observed from a comparison of the mean, minimum and maximum log of total NPLs in Table 4.3 that NPLs varied during the study period, with a mean of 11.4, and a maximum of 14.56 and a minimum of zero. This is further evident in that NPLs denoted the highest standard deviation of 3.50 among other explanatory variables. Other studies reviewed depicted only the NPL ratios, where countries such as China had recorded an NPL ratio of over 50 percent in 1997 (Matthews et al., 2009). In Malaysia, the ratio of NPLs remained below 15 percent during the period 1998-2007, according to the study of Abd Karim et al. (2010). This highlights the difference in size of the Namibian banking sector, which has never recorded an NPL ratio of more than 10 percent compared to other markets.

On average, commercial banks in Namibia had a relatively large asset base as evidenced by the mean size of 16.12 compared to the maximum size of 17.64 and the minimum of 11.21. The average asset base of banks in Namibia, which were only eight, was relatively high in comparison to a sample of 26 banks in Ghana, which had an average of 19.64 as studied by Alhassan and Tetteh (2017). Table 4.3 also shows that on average 81 percent of the Namibian banking industry's total assets were financed by its liabilities as represented by the mean leverage ratio. Notably, the maximum leverage was over 90 percent for the study period. Alhassan and Tetteh (2017)'s study showed that for banks in Ghana, the average leverage stood at almost 85 percent.

Table 4.3: Descriptive Statistics of Explanatory Variables

	Mean	*Median*	*Std Dev*	*Minimum*	*Maximum*
NPLs	11.3998	12.2699	3.5007	0.0000	14.5622
SZ	16.1206	16.7753	1.7586	11.2116	17.6359
LEV	0.8143	0.8904	0.1921	0.0223	0.9250
ROA	0.0010	0.0010	0.0013	-0.0086	0.0067
OVA	0.0175	0.0107	0.0200	-0.0009	0.1122

Note: NPLs = log of non-performing loans, SZ = log of total assets; ROA = return on assets; LEV = total liabilities to total assets; OVA = Overhead costs to total Assets. Source: Author's estimates from research data.

The average return on assets (0.1 percent) of the banks was observed to be relatively low, suggesting that banks in Namibia are not effectively utilising their assets to generate earnings. This could be as a result of high concentration in loans, signifying less diversification of income means. According to the study conducted by Matthews et al. (2009), the ROA for banks in China was at 0.67 percent, whereas for Alhassan and Tetteh (2017) the average ROA was at 2.18 percent for banks in Ghana.

The trend in the banks' overhead cost to total assets during the study period was relatively low as highlighted by the mean and standard deviation of 1.75 and 2 percent, respectively. Similar to the study of Ramli et al. (2018), the overhead costs comprise of the smallest stock values in the data set.

4.5 Multicollinearity Results: Variance Inflation Factors (VIF)

In regression analysis, multicollinearity occurs in the model when some of the explanatory variables are correlated with other explanatory variables. Extreme or high multicollinearity becomes a challenge in the model because it can intensify the variance of the regression coefficients, causing them to be nonsignificant. This study made use of the Variance Inflation Factors (VIF) in the model to scrutinize the presence of multicollinearity. In this regard, Table 4.4 shows the result of VIF between the independent variables for the model. The VIF endorses the use of the variables in the data set, in respect to the rule-of-thumb of below 10. The average VIF of all the independent variables stood at 3.66 as depicted in Table 4.4 below.

Table 4.4: Variance Inflation Factors (VIF)

	VIF	1/VIF
TA	6.42	0.16
NPLs	4.97	0.20
LEV	3.34	0.30
OVA	2.44	0.41
ROA	1.12	0.90
Mean VIF	3.66	0.39

Source: Author's estimates from research data

4.6 Determinants of Efficiency: Two-sided Truncated Bootstrapping

In the second stage of the study, a bootstrapped truncated regression was employed to examine the effect of the selected independent variables on estimated efficiency scores. This study made use of the first algorithm of the Simar and Wilson (2007) bootstrap bias correction model, which uses estimated efficiency scores that are not bias corrected and performs bootstrap repetitions to account for possible biases. The dependent variable in Model 1 and Model 2 is the DEA_{CRS} with and without the undesirable variable, regressed against NPLs, SZ, ROA, LEV (total liabilities to total assets), and OVA, the ratio of overhead costs to total assets as independent variables. In order to improve the results, the natural logarithmic function was applied on NPLs and SZ (total assets). The coefficients obtained in the model indicate the direction of impact of

the relationship and its strength. The bootstrap regression results based on the relationship between the explanatory variables and bank efficiency are presented in Table 4.5. A positive coefficient suggests that the efficiency of banks increases when the independent variable(s) increase. Whereas, a negative coefficient signifies an inverse relationship, meaning if the independent variable(s) increase the technical efficiency declines, or vice versa. The results of the regression are depicted in Table 4.5 below.

Table 4.5: Truncated Bootstrapping Regression Results.

	Dependent variable: DEA_{CRS} (Model 1)			**Dependent variable: DEA_{CRS} (Model 2)**		
	Coef.	**z**	**P>|z|**	**Coef.**	**z**	**P>|z|**
NPLs	-0.0515* (0.0265)	-1.94	0.052	-0.0178 (0.0211)	-0.84	0.399
SZ	0.0993** (0.0487)	2.04	0.042	0.1311** (0.0531)	2.47	0.013
LEV	0.9727 (0.5915)	1.64	0.100	-0.2221 (0.4027)	-0.55	0.581
OVA	-7.0407*** (2.2581)	-3.12	0.002	-8.7998*** (2.8927)	-3.04	0.002
ROA	101.8877 (73.9650)	1.38	0.168	133.4002* (78.2584)	1.7	0.088
constant	-.9266 (0.6189)	-1.5	0.134	0.7984 (0.6035)	-1.32	0.186
Wald X^2	29.56			24.36		
Prob>X^2	0.000			0.0002		
Number bootstr. Reps	1000			1000		
Banks	8			8		
Observations	352			352		

*Note: NPLs = ln of non-performing loans; SZ = ln of total assets; ROA = return on assets; LEV = total liabilities to total assets; OVA= Overhead costs to total Assets. ***, ** and * denote significance at 1, 5 and 10 percent, respectively. Bootstrapped standard errors in parentheses. Source: Author's estimates from research data.*

The results in Table 4.5 show a negative effect of NPLs on bank efficiency for Model 1 (at 10 percent significance), which indicates that an increase in NPLs decreases bank efficiency. This observed relationship confirms the assertions by Berger and DeYoung (1997) that increased NPLs introduce extra operating costs from non-value-adding activities, such as handling the collection of overdue loans. The results further support the bad management hypothesis as proposed by Berger and DeYoung (1997), which advocates that a lack of efficiency in the management of banking institutions will result in bad loan quality. This result is consistent with the studies by Altunbas et al. (2000), Fan and Shaffer (2004), and Ramli et al. (2018).

The results also show that bank's asset size as depicted by total assets is positively related to bank efficiency in Models 1 and 5 (at 5 percent significance). In line with Ramli et al. (2018) , who conducted a similar study in Malaysia, this result demonstrates that banks benefit from economies of scale by becoming more efficient. This also suggests that the effect of NPLs on efficiency is more prominent in banks with a large asset base compared to those with a smaller asset base. This existing relationship implies that an amount of the banks' inefficiency could be as a result of inadequacy in size. While this is in line with the literature on the economies of scale, an exception was concluded in literature for extremely large banks, where the size could result in negative bank efficiency. Mercan et al. (2003), Williams and Nguyen (2005), Reddy and Nirmala (2013), and Vu and Nahm (2013) found a direct correlation between size and efficiency of a bank.

Table 4.5 further indicates a negative and significant (1 percent) relationship between bank efficiency and the ratio of overhead costs to total assets (OVA) for Models 1 and 2. This suggests that an increase in overhead costs decreases bank efficiency, or vice versa. This also suggests that commercial banks in Namibia will improve their efficiency by reducing their overhead costs. A declining operating cost ratio over time indicates a decrease in the costs incurred by a bank, which could be an indication that a bank is being more efficient in the use of their resources. While Alhassan and Tetteh (2017) demonstrated that non-income interest activities positively impact bank efficiency by diversifying the sources of income this result cautions that increasing the focus on non-interest-generating activities should be done with cost-management aspects in mind. This is because increased costs reduce efficiency. This study only found one study by Ramli et al. (2018) which included overhead costs as an explanatory variable. This study however found that overhead costs were not significant in their model.

Finally, ROA depicted a positive coefficient, which was statistically significant (at 10 percent) in Model 2. This result implies that profitability has a positive impact on the level of efficiency of banks in Namibia, which means the more profitable banks are, the higher their efficiency. The results from this study were in line with the findings of scholars such Partovi and Matousek (2019), and Košak and Zajc (2006).

CHAPTER 5: CONCLUSION AND POLICY IMPLICATIONS

5.1 Introduction

This chapter concludes the study on Bank Efficiency and NPLs in Namibia. Five sections are presented in this chapter, as follows: the summary and conclusions drawn from the empirical findings as discussed in Chapter Four are presented, thereafter, limitations of the study, policy implications based on the conclusions, and finally, the chapter concludes with general recommendations of possible areas of further study in respect of the topic of Bank Efficiency and NPLs in Namibia.

5.2 Summary of the Study

This study examined the technical efficiency of the Namibian banking industry with specific emphasis on the effect of the inclusion of NPLs over a period between 2010 to 2020. Apart from the fact that a study of this nature has not been conducted before in Namibia, this specific study was motivated by the fact that it is believed to be timely, as the Namibian financial sector navigates its way out of a deteriorating macroeconomic environment and the ongoing impact of COVID-19 on the banking sector. The study assists relevant stakeholders in gaining a better understanding and a new perspective on the difference and the quantified association between NPLs and banking efficiency, among other variables investigated, in the Namibian banking sector.

The analysis of this study was a two-stage process. The first stage involved the use of the CCR model developed by Charnes et al. (1978), which is a type of DEA Model to estimate efficiency scores of commercial banks in Namibia. This method has been used by scholars like Abd Karim et al. (2010), Matthews et al. (2009) and Alhassan and Tetteh (2017). The efficiency scores estimated were then used to determine the efficiency performance of each of the banks and consequently the performance of the banking industry over the period under study. The technical efficiency estimation results indicate an average technical efficiency score of 89.08 percent for the period 2010-2020. This indicated that the banking industry operated at an average 10.92 percent inefficiency during this review period.

In the second stage, the efficiency scores obtained in the first stage were used as a dependent variable in the Simar and Wilson's (2007) truncated double bootstrapping regression approach to investigate the relationship between NPLs and banking efficiency. For this regression, the

determinant variables used were NPLs, bank size, ROA, leverage, and overhead over total assets. The truncated double bootstrapping regression results indicated that an increase in bank efficiency decreases NPLs, or vice versa. This result is consistent with the studies by Altunbas et al. (2000), Fan and Shaffer (2004), and Ramli et al. (2018), among others. Furthermore, the study confirmed the assertions by Berger and DeYoung (1997) where they highlighted that increased NPLs introduce extra operating costs from non-value-adding activities, such as handling the collection of overdue loans. The results further support the bad management hypothesis as proposed by Berger and DeYoung (1997).

5.3 Conclusions

Empirical literature pertaining to the impact of the changing macroeconomic environment on the banking sector in Namibia is intermittent. Although, historically, the asset quality of the Namibian banking industry has been stable, the recent increase in NPLs, coupled with the deteriorating macro-economic environment, necessitated a thorough investigation of the effect of NPLs on technical efficiency in Namibia. The study contributes to the only two studies conducted in Namibia (Ikhide (2008) and Nkabila (2017)), on the topic of bank efficiency. The objective of this study was twofold. Firstly, the study examined technical efficiency of banks in Namibia. Secondly, the study examined the effect of NPLs on technical efficiency of banks in Namibia. The objectives were met by using the DEA approach to compute technical efficiency scores on quarterly data for the period between 2010-2020. The choice for quarterly data and a longer period of analysis was to comprehensively capture the analysed variations in Namibian banks' efficiency, and their response to different financial cycles. This study also measured the effect of NPLs on technical efficiency using truncated double bootstrapping regression approach.

The empirical results regarding technical efficiency from this study indicated that the average score for technical efficiency was 89.08 percent for the study period. This indicates that the banking industry operated at an average 10.92 percent inefficiency during the period of review. Only two periods recorded 100 percent efficiency throughout the period 2010-2020, i.e., Quarter 2 of both 2010 and 2011. The study also noted that there was low variability in the technical efficiency of the Namibian banking industry throughout the review period, where the trend was constant with a slight drop after 2017, which is the period at which the new (smaller) banks entered the data set. The technical efficiency without incorporating NPLs in the output

variables was slightly lower in the estimated efficiency scores similar to the results of Hamid, et al. (2017) and Qayyum and Riaz (2018). This suggests that the exclusion of NPLs reduces the efficiency scores of the banks, though not significantly, for the Namibian banking sector case.

An overview of the results of the truncated bootstrap regression showed a negative significant relationship between bank efficiency and NPLs. The result indicated that an increase in bank efficiency decreases NPLs. This result was consistent with the studies by Altunbas et al. (2000), Fan and Shaffer (2004), and Ramli et al. (2018). Furthermore, the study confirmed the assertions by Berger and DeYoung (1997). A positive significant relationship was observed between bank efficiency and bank size and overhead costs.

5.4 Limitations

This study is not without limitations. Firstly, the study makes use of a single model of inputs and outputs and does not cross-compare results using different models, which could have significantly improved the reliability of the results. Secondly, the review of literature on the relationship between bank efficiency and NPLs is well assessed using a quantitative method thereby implying numerical variables to analyse data sets. Other variables that may influence this relationship were not considered as the study focused on the available data.

5.5 Policy Implications

The findings of this study can be used by the various stakeholders in the Namibian banking industry as the study included all eight banks. Overall, the study concluded that management of NPLs plays an important role in aiding banks to improve their efficiency by operating closer to the efficiency frontier. From a strategic standpoint, the study suggests that the Namibian banking industry should invest in systems that are technologically efficient in order to enhance efficiency, seeing that the study observed an overall average 10.92 percent inefficiency for the study period.

Presently, the Namibian banking industry faces concerns, such as the fast-changing needs of customers coupled with rapidly growing global technology adoption, increasing competition and profitability pressures, and uncertainties regarding future regulatory requirements. As such, efficiency management becomes of utmost importance in the banking industry. Up-to-date analysis of performance of the bank relative to its competitors ensures growth in efficiency.

Adding to the already existing internal research capabilities of banks, this timely study about the efficiency of the Namibian banking industry allows managers to dig deeper into the causes of inefficiencies and build internal capabilities to emulate the best performers (Tamatam et al., 2019). Furthermore, in view of the empirical results from this study, it is imperative that policymakers implement policies that continue to promote competition within the banking industry as competition is an important conduit for ensuring higher efficiency among commercial banks.

The study finds that non-performing loans do play a significant role in the efficiency of commercial banks in Namibia. Therefore, banks will benefit from improving their monitoring and screening process of loans, while also ensuring cost-effective measures are in place.

5.6 Recommendations for Future Studies

As noted in the literature review, there are limited studies on efficiency in the Namibian financial industry. This study looked at the effect of five important financial variables on efficiency. Future studies could investigate the relationship between efficiency and other notable financial and economic determinants. Furthermore, some assumptions have been made relating to the causes of the negative relationship between NPLs and efficiency. An efficiency study could also be extended to other equally important sectors that contribute to growth of the Namibian economy. A study on the productivity of the Namibian banking sector is also another important theme that can be studied considering the efficiency results. In this regard, a Malmquist DEA approach could be applied to study this topic and determine whether results of efficiency and productivity speak to each other.

This study could also be improved by applying the SFA and the Directional Distance techniques for similar analysis and as an alternative method for accounting for NPLs as an undesirable output variable. Cross-checking and validating the DEA results would also be valuable. Moreover, analyses could also expand to the area of cost and profit efficiency measurements and thus provide decision makers with a more dependable, analytical toolkit.

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APPENDICES

Table 4.6: Geometric Mean of Technical Efficiency

Model 1: With undesirable output					Model 2: Without undesirable output			
Year	Quarter	DEACRS	DEAVRS	SE	Quarter	DEACRS	DEAVRS	SE
2010	Q1	0.9940	0.9940	1.0000	Q1	0.9940	0.9940	1.0000
2010	Q2	1.0000	1.0000	1.0000	Q2	0.9725	0.9750	0.9974
2010	Q3	0.9888	0.9888	1.0000	Q3	0.9823	0.9823	1.0000
2010	Q4	0.9863	0.9863	1.0000	Q4	0.9591	0.9713	0.9875
2011	Q1	0.9930	0.9930	1.0000	Q1	0.9323	0.9848	0.9467
2011	Q2	1.0000	1.0000	1.0000	Q2	1.0000	0.9750	1.0256
2011	Q3	0.9768	0.9768	1.0000	Q3	0.8914	0.9768	0.9126
2011	Q4	0.9480	0.9658	0.9816	Q4	0.9480	0.9538	0.9940
2012	Q1	0.9750	0.9750	1.0000	Q1	0.9669	0.9669	1.0000
2012	Q2	0.9833	0.9938	0.9894	Q2	0.9833	0.9938	0.9894
2012	Q3	0.9500	0.9850	0.9645	Q3	0.9500	0.9850	0.9645
2012	Q4	0.9438	0.9820	0.9610	Q4	0.9438	0.9820	0.9610
2013	Q1	0.9283	0.9640	0.9629	Q1	0.9233	0.9640	0.9577
2013	Q2	0.9260	0.9685	0.9561	Q2	0.9260	0.9685	0.9561
2013	Q3	0.9305	0.9698	0.9595	Q3	0.9305	0.9698	0.9595
2013	Q4	0.9050	0.9333	0.9697	Q4	0.9050	0.9333	0.9697
2014	Q1	0.9230	0.9230	1.0000	Q1	0.9230	0.9230	1.0000
2014	Q2	0.9145	0.9145	1.0000	Q2	0.9145	0.9145	1.0000
2014	Q3	0.8920	0.8920	1.0000	Q3	0.8920	0.8920	1.0000
2014	Q4	0.9000	0.9000	1.0000	Q4	0.9000	0.9000	1.0000
2015	Q1	0.9250	0.9625	0.9610	Q1	0.9250	0.9625	0.9610
2015	Q2	0.9465	1.0000	0.9465	Q2	0.9458	1.0000	0.9458
2015	Q3	0.9195	1.0000	0.9195	Q3	0.9195	1.0000	0.9195
2015	Q4	0.9773	1.0000	0.9773	Q4	0.9765	1.0000	0.9765
2016	Q1	0.9390	1.0000	0.9390	Q1	0.9390	1.0000	0.9390
2016	Q2	0.9615	1.0000	0.9615	Q2	0.9605	1.0000	0.9605
2016	Q3	0.9660	1.0000	0.9660	Q3	0.9625	0.9625	1.0000
2016	Q4	0.9323	0.9623	0.9688	Q4	0.9323	0.9623	0.9688
2017	Q1	0.9315	0.9618	0.9685	Q1	0.8435	0.8703	0.9692
2017	Q2	0.9425	0.9425	1.0000	Q2	0.9425	0.9425	1.0000
2017	Q3	0.9195	0.9195	1.0000	Q3	0.9195	0.9195	1.0000
2017	Q4	0.9248	0.9248	1.0000	Q4	0.9000	0.9050	0.9945
2018	Q1	0.8158	0.8933	0.9132	Q1	0.7890	0.8736	0.9031
2018	Q2	0.8894	0.9164	0.9705	Q2	0.8575	0.8901	0.9633
2018	Q3	0.6844	0.7634	0.8965	Q3	0.6391	0.7428	0.8605
2018	Q4	0.9126	0.9416	0.9692	Q4	0.8676	0.9301	0.9328
2019	Q1	0.6998	0.8105	0.8634	Q1	0.6919	0.8105	0.8536
2019	Q2	0.6291	0.8588	0.7326	Q2	0.6247	0.8561	0.7297
2019	Q3	0.6291	0.8638	0.7284	Q3	0.6291	0.8638	0.7284
2019	Q4	0.7218	0.8979	0.8038	Q4	0.7218	0.8979	0.8038
2020	Q1	0.7383	0.8918	0.8279	Q1	0.7383	0.8918	0.8279
2020	Q2	0.7169	0.8871	0.8081	Q2	0.7169	0.8871	0.8081
2020	Q3	0.7050	0.8849	0.7967	Q3	0.7050	0.8849	0.7967
2020	Q4	0.7086	0.9055	0.7826	Q4	0.7086	0.9055	0.7826
Average		0.8908	0.9430	0.9420	**Average**	0.8794	0.9355	0.9374
Max		1.0000	1.0000	1.0000	**Max**	1.0000	1.0000	1.0256
Min		0.6291	0.7634	0.7284	**Min**	0.6247	0.7428	0.7284