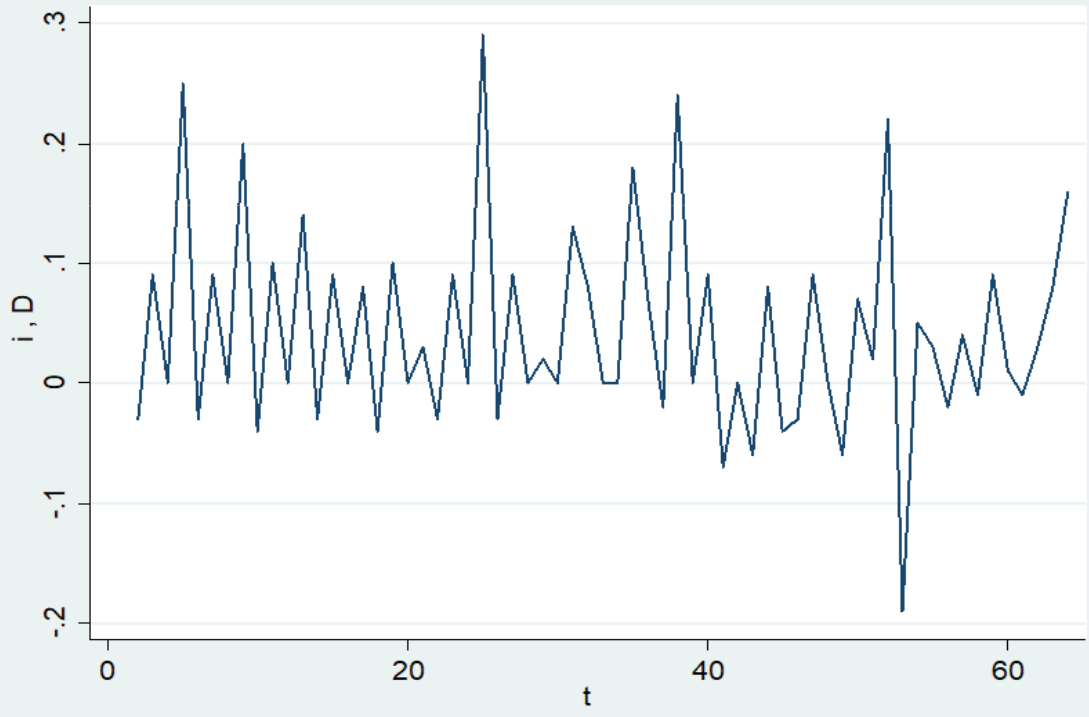
Technology Shocks and Performance of Commercial Banks in Tanzania

Dorika Jeremiah Mwamtambulo, Keregero Chirongo Moses
and Alulelius Jubilent Lema

Research Report 2023/14



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Abstract

In a constantly changing environment, technology is among the factors proven to be able to keep up with ever-changing social demands. Given its widely acclaimed acceptance, the uses of technology vary from one individual to another and from one institution to the next. In banks, technology is used in pioneering inclusivity resulting from its wider network and in increasing the bank's performance. In capturing the impact of technological change on the performance of a bank in the literature, the emphasis has only been on the effects of economic factors on the performance of the banks. This totally excluded an important factor, which is the performance itself. On that note, the current study is set on understanding the information contained within the factor of performance. It will be looking at its predictability, especially in the event of technological change and technology shocks.

Times series data collected from a total of thirteen (13) commercial banks in the country, including aggregate data from the banking sector for the period between 2000-2021 is used. The findings revealed the existence of a very short window, from the time of adopting a particular technology to actually reaping the economies of scale. According to our observations, it ranges from three months to a year. Moreover, the different technology shocks resulting from external factors are shown to influence banks' performances with a lag of three months. These shocks, however, did not exhibit volatility levels with some clustering effects. The findings proved the need for banks to formulate relevant policies and strategies for their technology adoption programmes. The goal is to ensure they are concurrent with the goal of profit maximisation and the maximisation of shareholders' wealth. The study also takes the liberty of calling out for banks to support those investments pertaining to technology development. This can arguably be a result of their prominent use of technology or as a gesture of social responsibility to both current and future generations.

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List of Abbreviations

ACB	Akiba Commercial Bank
ACF	Autocorrelation Function
AIC	Akaike Information Criterion
AR	Autoregression
ARCH	Autoregressive Condition Heteroscedasticity
	ARIMA Autoregressive Integrated Moving Average
ATM	Automated Teller Machine
BOT	Bank of Tanzania
BIC	Bayesian Information Criterion
CRDB	Cooperative and Rural Development Banks
DCB	Dar es Salaam Community Bank
E-GARCH	Exponential Generalised Auto-Regressive Conditional Heteroscedasticity
FinTech	Financial Technology
GARCH	Generalised Autoregressive Conditional Heteroscedasticity
ICB	International Commercial Bank
ICT	Information, Computer and Technology
IT	Information and Technology
LM	Lagrange Multiplier
MA	Moving Average
NMB	National Microfinance Bank
NBC	National Bank of Commerce
NIM	Net Interest Margin
OM	Operating Margin
OP	Operating Profit
PACF	Partial Autocorrelation Function
PBZ	People's Bank of Zanzibar
PPE	Profit Per Employee
POS	Point of Sale
ROA	Return on Asset
ROE	Return on Equity
SMEs	Small and Medium Enterprises
	SWIFT Society for Worldwide Interbank Financial Telecommunication
T-GARCH	Threshold Generalised Auto-Regressive Conditional Heteroscedasticity
UK	United Kingdom

Chapter One
Introduction

1.1 Background Statement

Continuous advancement in technology raises concerns for users regarding its adoption and adaptability, especially on how to integrate new technology with the available resources. The pioneer of early adaptation has listed its benefits, including that of reaping early economies of scale, as the new invention is receiving worldwide recognition (Gatignon and Robertson, 1989; Bates and Flynn, 1992; Moore, 1993; Archibugi and Iammarino, 1999; Arora and Fosfuri, 2003; Almeida and Fernandes, 2008; Persson, 2012; Huang et al., 2020). However, this option tends to expose users to losses in the event the innovation fails to capture the market. Late adopters, on the other hand, tend to reap more guaranteed economies of scale while trading off for catching-up time (Bates and Flynn, 1992; Archibugi and Iammarino, 1999).

Similarly, the adaption period of technological advancement to both early and late adopters, tends to vary, depending on the adaptation window. It tends to be long and agonising to early adopters due to its non-sophistication status, requiring a number of trials and adjustments, which in turn requires a significant amount of restructuring, remodelling and updating process. On the other hand, it tends to be short and promising to late adopters, given that it is implemented in a system that is already knowledgeable and prepared for its functionality. Nonetheless, in a competitive market, the time to adopt and adapt to new technology needs to be short (Gatignon and Robertson, 1989; Burgess et al., 1998; Reiss, 1998; Lee and Allaway, 2002; Arora and Fosfuri, 2003; Rao and Budde, 2015). The question of how short the timeframe needs to be is open for discussion, as it tends to vary from one industry to another.

In nature, technological advancements are more dynamic than static, and over the years have brought influxes of both positive and negative shocks into the country's systems, including its financial systems (Coccia, 2020). The period of the impact of these shocks tends to vary depending on the maturity, susceptibility to shocks, size and stability of the financial system (Utterback and Abernathy, 1975; Utterback and Suarez, 1993; Damanpour, 2010). Nonetheless, both technological changes and shocks affect the economies of scale of a given financial system (Anselin, Varga and Acs, 1997; Mesinga and Larry, 2008; Latzer, 2009; Abu, 2010; Persson, 2012; Idun, Aboagye and Idun, 2014; Meifang et al., 2018). Compared to technological change[1] , which is significantly planned and willingly executed by a given country's financial systems, technological shocks[2] are random and unpredictable, thus they are hard to manage (Coccia, 2020). Whether the technological change is planned or unplanned, any financial system of a country needs to prepare and adjust itself on how it will manage the technological shift (Idun, Aboagye and Idun, 2014; Kauffman, Liu and Ma, 2014).

[1]Technological change refers to an increase in output for a given level of input resulting from process of invention, innovation and diffusion (Seo, 2017). It includes an increase in efficiency of production or processing which result in increase in output without a relative increase in the level of input

[2]Technology shocks are sudden changes on technology which significantly affects the system outcomes (i.e., social, economic, and political). They are short term fluctuations (commonly termed as volatility) which bring about broad-based disruptions on the general functioning of a system.

The performance[3] of commercial banks in Tanzania can be categorised depending on the period of the country's development. Starting with the colonial period, where the function of the commercial banks was to serve the interest of the colonialist (Ndalichako, 2014). Similarly, after independence, a number of commercial banks were operating in the country, however, they were observed not to be serving the interests of the local people, as the majority remained in an impoverished state (Ndalichako, 2014; Bourguignon, 2018). After the Arusha Declaration, the performance of commercial banks in Tanzania was articulated by the performance of the National Bank of Commerce (NBC) for Tanzania Mainland and the People's Bank of Zanzibar (PBZ) for the Isles. After financial liberalisation, the commercial bank industry was populated with both foreign and private banks whose performances had significantly driven the financial system of the country, including the country's economy itself. Just two decades after the introduction of financial sector reforms, the performance of the banking industry has more than doubled, as observed on Figure 1.1

[3]Business performance relates to the ability of the business to utilise its allocated resources to achieve its stated objectives (Lebas, 1995). In the course the business, a number of key performance indicators metrics are used in its measurements. They include financial measures: profitability, productivity, sales growth and other accounting indicators; customer and employee satisfaction.

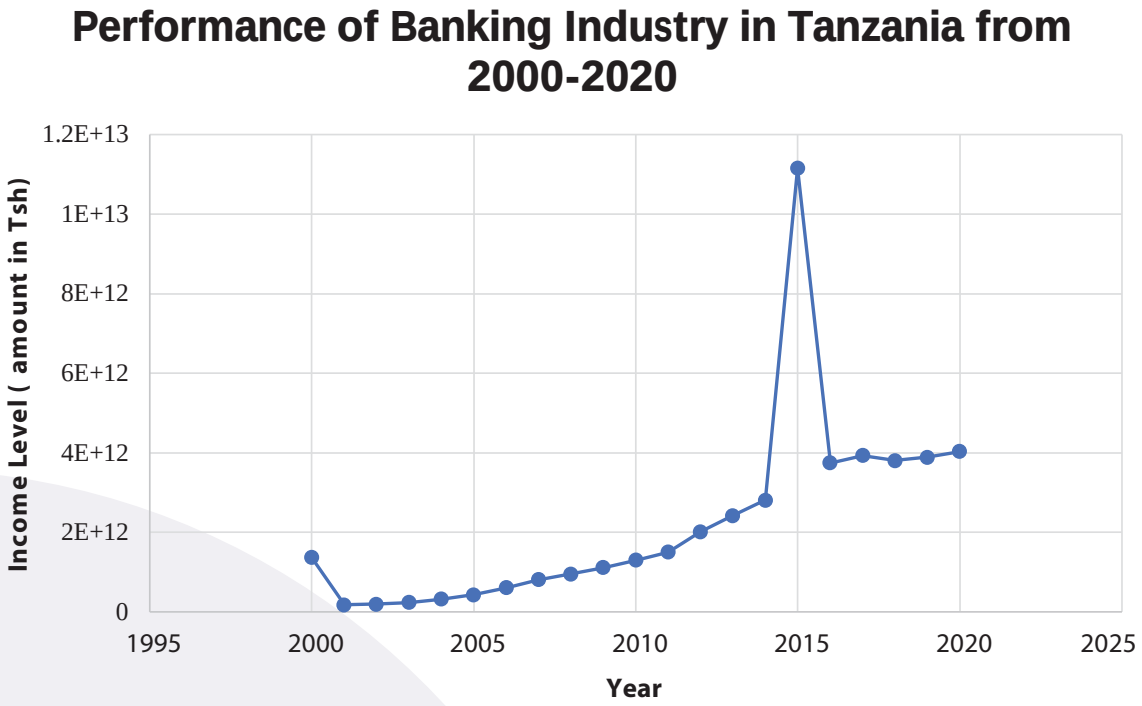

Figure 1. 1 Performance of the Tanzania Banking Industry for the Period Between 2000 and 2020

Literature has shown evidence of the existence of a positive relationship between technological change and the performance of the banking industry. This can be seen in the study of Nartey, Osei and Sarpong-Kumankoma (2019), Haabazoka (2019), Yang et al.(2018), Ndunga, Nkati and Rukangu (2016), Akhisar, Tunay and Tunay (2015), Abbas et al. (2014), who observed a positive relationship between the adoption of a particular technology or group of technologies, such as a number of Automated Teller Machines (ATMs), internet banking and mobile banking, and the performance of the banking sector. Similarly, the findings by Thuy (2021), Chege, Wang and Suntu (2019), Chai, Tan and Goh (2016), Arora and Arora (2013), Beccalli (2007), have proved the significance of adopting a part of or the whole component of Information, Computer and Technology (ICT) systems on the performance of the banks.

The limitation presented in the literature is its failure to capture the effects of information contained within the performance factor itself. That is, rather than basing the discussion on the economic theory point of view, the need is on extracting the information constituting the factor itself in understanding the effects of both technological change and shocks on the performance of a bank. This poses the following questions needing to be addressed. The first question is on ways in which the banking sector is able to cope with or show some resilience towards both technological changes and shocks. The second question is on the adoption period (i.e., the period from the implementation of the new technology to actually reaping the economies of scale); and, the last question is on the significance of technological shocks on the performance of financial systems. Addressing this problem is important to financial systems, especially in planning and setting out strategic reactions towards technological change and shocks. Similarly, it is important for an individual bank in deciding which technological shocks risks can be ignored, supported, managed and insured against.

1.2 Statement of the Problem

Over the years, the significance of technology shocks has manifested itself through its influence on economic growth and development (Mesinga and Larry, 2008; Idun, Aboagye and Idun, 2014; Meifang et al., 2018). Countries, including developed nations such as the USA, Japan and South Korea, have observed an increase in productivity as a result of embedding technology in their capital, leading to the most efficient allocation and utilisation of capital investments. Similarly, embedding technology with labour has increased labour efficiency and productiveness.

Given its function as an economic lifeline support, the significance of having a healthy functioning financial system cannot be understated (Ndalichako, 2014; Bourguignon, 2018). Over the years, a number of technological changes have been adopted by the world and by the financial system in particular (Akhisar, Tunay and Tunay, 2015; Chai, Tan and Goh, 2016; Yang et al., 2018; Zhang et al., 2018). They included the introduction and adoption of computers, the internet, mobile phones and mobile phone apps, to mention a few. The expectations of technological change are on its positive influence on innovation, performance and competitiveness of the financial system see for example (Chege, Wang and Suntu, 2019; Haabazoka, 2019; Nartey, Osei and Sarpong-kumankoma, 2019; Phan et al., 2019; Thuy, 2021). However, the remaining question is how the financial sectors have embraced technological change as reflected by their performance. This study is set to examine the influence of technological change in financial systems, with a special interest in the information contained in the performance factor, while paying special attention to the Tanzania banking system.

The selection of the banking system is based on its dynamism in adopting new technologies, and this goes as far back as its inception. However, significant changes in Tanzania's banking sector go as far back as the 1990s, when a shift was made away from using a paper-based model to a digitalised system, through the adoption of computers and other digital peripherals. The introduction of the internet allowed for the interconnectedness of branches across the country and the world, and more so it has brought bank customers closer to banking services through internet banking. Similarly, the introduction of ATMs and mobile services has further reduced the service gap between customers and banks.

In light of the above discussion, the following objectives will be addressed by the study:

1.3 Research Objectives

1.3.1 General Objective

The general objective of the study is to examine the impact of technology shocks on the performance of commercial banks in Tanzania

1.3.2 Specific Objectives

The above general objective will be addressed with the following specific objectives:

1. Determine the technology adoption period for commercial banks in Tanzania.
2. Examine the influence of technological shocks on the performance of commercial banks in Tanzania.

1.4 Significance of the Study

The study intended to provide relevant information to the country's financial system, on the adaptability of technological change and the management of technology shocks. The inevitability status of technological change calls for prior preparation by the country's financial system, especially banks. The study provides a guideline on how banks can strategize their technology adoption to ensure it is beneficial to their investors and users. The accounted window on the adoption of technology embarks on new prospects for banks in planning and making decisions. It further provides room for discussion on how to reduce the adoption window and manage the adoption process.

Moreover, knowledge of the influence of technological shock on performance will increase banks' preparedness in combating technology-related risk. The results will help in the formulation of policies relevant to the adoption of a particular technology. The findings will also seek the formulation of policies in the country that go hand-in-hand with the growth of its financial system. More so, the findings can be used as a binding tool between banks and the government in the formulation of policies that ensure the proper functioning of the financial system.

Chapter Two
Literature Review

2.1 Background of the Banking Sector in Tanzania

The history of banking systems in Tanzania has some colonial influence, as they were set primarily to serve the interests of the colonialists, rather than those of Tanzanians (Ndalichako, 2014; Yona and Inanga, 2014a, 2014b). The initial official banking system to be put in place was established during German rule. During this period, two banks were in operation, namely: (i) Deutsche Ostafrikanische Bank, established in 1905; and (ii) Handelsbank für Ostafrika in 1911. After World War I, Tanganyika was placed under the custodianship of the British, who replaced the two German banks with three new banks namely: Grindlays Bank, Standard Bank and Barclays Bank. After independence in 1961, The National Bank of Commerce, The National Cooperative Banks and The People's Bank of Zanzibar were also introduced. Following the Arusha Declaration of 1967, only three banks remained in operation. They included The National Bank of Commerce (NBC), Cooperative and Rural Development Bank (CRDB) and People's Bank of Zanzibar (PBZ).

The first financial reforms were introduced in the country in 1991, to combat the problem of high non-performing loans on the bank's portfolios (Ndalichako, 2014; Yona and Inanga, 2014c, 2014a). These reforms also provided room for the participation of both private and foreign banks in Tanzania's banking sector. As of 2020, a total of 35 commercial banks, 5 community banks, 4 microfinance banks and 2 development banks are operating in the country (BOT, 2020). The performance of the banks and other financial institutions including insurance, mutual and pension funds, have helped in stabilising the financial systems of the country. Moreover, in recent years as a result of development in technology, the banking industry has set out to design new financial products that embrace changing technology to improve their performance and their sustainability. Given the large use of technology in the financial systems, it is becoming relevant to examine the influence of technological change on the performance of Tanzania's commercial banks.

2.2 Empirical Literature Review

Over the years, banks have become the major component of the financial system, with its role as the chief intermediary between savers and borrowers (Boakye and Amankwah, 2012; Arora and Arora, 2013; Sayani and Miniaoui, 2013; Mohammed et al., 2020). Banks accept deposits from the general public and channel them out to borrowers in need of such funds, at a price (Abu-Bader and Abu-Qarn, 2008; Asmundson, 2011; Bodie, Kane and Marcus, 2014; Mwamtambulo and Ntulo, 2018). In doing so, banks create new payment systems and are endowed with the responsibility of creating new money, while ensuring the proper allocation of financial resources for economic development (Braun and Raddatz, 2010; Arora and Arora, 2013; Ndalichako, 2014). In carrying out these responsibilities, banks have come to rely significantly on information in making optimal economic decisions.

The growth of technology in many capacities has enshrined banks with the prospect of serving these goals. Over the years, banks have been observed to be significantly investing in technology related to their services. This includes the process of designing and re-designing both hardware and software, investing in Information Technology (IT) and training personnel on new technology (Beccalli, 2007; Chipeta and Muthinja, 2012; Arora and Arora, 2013; Abbas et al., 2014; Chai, Tan and Goh, 2016; Haabazoka, 2019; Thuy, 2021). This can also be seen in the introduction and the use of diverse technologies by banks. They include ATMs, internet banking, mobile banking and telephone banking.

However, the adoption of technology and its innovation has not only helped banks in making optimal economic decisions but has also proven to affect their performance. This fact has been evidenced by different authors in the literature. Using a total of 225 banks, Webster (1997) examined the effect of technological change on the performance of banks, measured by the Return on Assets (ROA) and Return on Equity (ROE). He observed that the technological change of a bank significantly affects its overall performance, and this tends to increase with an increase in the bank's size. In the findings of Nartey, Osei and Sarpong-Kumankona (2019) poor technology was not only influencing the performance of banks, but also their general productivity. Using data from 120 banks from 24 African countries for the period between 2007-2012 Nartey, Osei and Sarpong-Kumankona (2019) argued that inadequate technological progress has a significant influence on the productivity of both private and foreign banks, as compared to state banks. The argument derived by this study is on the need of each country to improve its state-of-the-art technology, as means to improve productivity in the banks.

In examining the influence of technological innovation, in this case, ATMs, mobile banks and internet banking, on the performance of 19 commercial banks in Zambia, Haabazoka (2019) observed these factors to be significant. The findings revealed a strong positive relationship between mobile banking usage and the performance of commercial banks. Similar observations are observed by Yang et al. (2018), Chai, Tan and Goh (2016), and Akhisar, Tunay and Tunay (2015). Using five banks in China for the period between 2003 and 2013, Yang et al.(2018) reported on the effectiveness of electronic banking systems on the performance of the five banks measured, in terms of ROA, ROE and Operating Margin (OM). However, in their study, electronic banking was observed to have little influence on the Net Interest Margin (NIM) and the efficiency of the banks.

In examining the effects of technology adoption resulting from the global trends and practices by banks on their performance, Chai, Tan and Goh (2016) observed that the quick rise in demand for efficient and reliable technology by the bank, was a response to their influence on their performance. Akhisar, Tunay and Tunay (2015), on their part, aimed at investigating the effects of electronic-based banking services on the performance of banks situated in both developing and developed nations, in 2005 and 2013. Using a dynamic panel model in the analysis, they observed that the ratio of the number of ATMs to the number of branches was significant in affecting the performance of the banks. Although they observed an insignificant influence on the factor of electronic banking services on the performance of banks. They also argued on the need for introducing technology-based applications, including internet banking, mobile banking, telephone banking, ATMs and Point of Sales (POS), to ensure the provision of a competitive edge for banks in the delivery of financial products to customers.

More evidence is provided by Scott, Reenen and Zachariadis (2017) who examined the impact of the adoption of the Society for Worldwide Interbank Financial Telecommunication (SWIFT) on the performance of banks. Since SWIFT is a network-based infrastructure with a set of standards aiming at ensuring worldwide interbank telecommunication, the researcher expected its influence to be significant on the profitability of the banks. Using data from 6,848 banks in 29 countries in Europe and America, they observed a positive long-run influence of the adoption of SWIFT on the profitability of the banks. This significant relationship was more pronounced in smaller small banks as compared to large ones. These findings are backed up by those of Mustapha (2018), who observed a positive relationship between the adoption of electronic payment technology and the performance of the banks. Their findings also reveal that the current performance of a bank is less related to its past performance, and argued for the need for banks to concentrate on their current performance in making economic decisions.

In their findings, Chipeta and Muthinja (2012), observed that financial innovation, including branchless banking models: mobile banking, agency banking, internet banking and ATMs, significantly influence the performance of commercial banks in Kenya. In their argument, Chipeta and Muthinja (2012) provided that financial innovation in banks is necessary for the profitability of the banks and should act as an incentive to motivate shareholders to invest more in technology. In the study of Chaarani and Abiad (2018)[4] , only the shareholder investment in ATMs was observed to increase the performance of Lebanese banks, for the period from 2010-2017. The study also provides some evidence on the irrelevance of technological innovation, such as mobile bank investment, on the performance of banks, raising the argument on the need for banks to adopt those technologies which are compatible with their goal of maximising shareholders' wealth through profit maximisation.

In testing the quick access to information and its relevance to the performance of banks, the study of Abbas et al.(2014), provides such evidence. The study by Abbas et al.(2014), aimed at examining the influence of the quick availability of information and their user-friendly characteristics on the performance of Allied Bank employees. Using unstructured interviews with the bank's employees, their observations showed that a bank which implements appropriate technology while ensuring proper training to its employees significantly outperforms its counterparties. Abbas et al. (2014), argued that there is a need for all prerequisites to be adhered to by the banks, before starting to adopt and implement a particular technology.

The evidence presented by Beccalli (2007), of 737 European commercial banks[5] for the period 1995-2000, observed investment in IT services by banks to an external provider, has a positive effect on the profit and efficiency of commercial banks. However, the actual acquisition of the hardware or software by the banks was observed not to have a significant relationship to the performance of commercial banks. These findings, however, are contradicted by those of Phan et al.(2019), who observed a negative relationship between the performance of 41 Indonesian banks and the growth of Financial Technology (FinTech). They argue that the growth of FinTech, rather than increasing the performance of banks in Indonesia, undermines their performance, leading to a reduction in banks' profitability. This raised the debate on which optimal way a bank can invest in technology development.

[4]The only technological innovation analysed in the study included internet banking, mobile banking, ATMs and investment in software.

[5]The commercial banks were derived from France, Germany, Italy, Spain and United Kingdom.

Thuy (2021), on the other hand, examined the effects of the whole component of ICT (Information & Communications Technology) on the performance of 20 commercial banks in Vietnam, for the period 2007-2019. Using the ICT index of each commercial bank, he observes that the commercial banks' readiness to adopt and develop IT had a significant influence on performance while controlling the factor of the size of the bank. Similarly, Arora and Arora (2013), examine the influence of IT on the profitability of 27 Indian public sector banks, between 2004 and 2009, their findings presented a positive outcome in relation to the investment in IT and the profitability of the banks, measured by Operating Profit (OP) and Profit Per Employee (PPE). Based on their findings, Arora and Arora (2013), argued the need for banks to invest heavily in IT, as it serves to enhance their performance and thus profitability.

Technological change is not only observed to be associated with the performance of banks. Other findings have shown the significance of technological change going beyond the banking industry. In the study of Chege, Wang and Suntu (2019), using data from 240 entrepreneurs, they observed that proper and timely adoption of technology enhances the performance of Small and Medium Enterprises (SMEs). Similarly, Yang et al. (2018), presented the significance of technology, including that of reducing operational costs by allowing for the reduction of the size of the workforce, equipment and space. Adoption of technology is further expected to increase access to clients and services, thus allowing the creation of new distributional channels, which lead to an increase in brand value. The great setback presented by Yang et al. (2018), is the possibility of increased competition between adopting parties, which may lead to a reduction in profit. This however, was refuted by Ndunga, Nkati and Rukangu (2016), who observed that the introduction of mobile money transfers, the registration of micro finance institutions, and the entry of internet money services, had led to the reduction of competition between banks and banks and between banks and other financial institutions.

An account also has been provided on the performance of commercial banks in Tanzania. In the study of Kaaya and Pastory (2013), and Meshack and Mwaura (2016), factors of credit and operational risk management activities are significant in influencing the performance of commercial banks in Tanzania. Similarly, in the studies of Gwahula and Man (2013), and Kingu, Macha and Gwahula (2018), an increase in non-performance loans on the commercial bank portfolio was observed to significantly affect the performance of commercial banks. In the study of Kipesha and Moshi (2014), the capital structure of a commercial bank played a significant role in affecting the performance of the commercial bank in Tanzania. On the other hand, the study of Ally (2022), also showed the significance of macroeconomic factors in contributing towards the performance of commercial banks. The influence of technology adoption on commercial banks in Tanzania was evidenced by Gwahula (2013), who observed a positive relationship between technological change and the performance of commercial banks in Tanzania.

The literature account provided for the argument on the effects of factors of technology on the performance of commercial banks around the world, and Tanzania in particular. In the examination of the studies conducted in Tanzania related to the performance of commercial banks, an identified gap can be presented on the need to examine the impact of technological change on the performance of commercial banks, the performance being the main subject of the equation. This study fills this gap by examining the information content of the factor of performance on the influencing factor of technology.

Chapter Three
Methodology

3.1 Data

The study used Time Series data collected from secondary sources, including individual banks' quarterly and annual reports. The banking sector aggregate data was derived from the Bank of Tanzania (BOT). The relevant period covered by the study is from the period 2000s to 2021. The interest of the period is on ensuring the incorporation of the impact of the country's financial reforms in the banking system, which includes the liberalisation of financial systems and the re-introduction of both private and foreign banks. Moreover, the majority of technological changes adopted by the financial system are mostly from the late 20th century and the majority are in the 21st century. Through a tracing process, the relevant period during which the country embraced new technological changes was identified, including the accounting of different technological shocks around the world. Table 3.1 provides the names of the banks and the period under review.

Table 3. 1: Summary of the Banks and Period Coverage

Sno	*Bank Name*	*Series Frequency*	*Period Under Review*
1.	Bank of India	Quarterly	2014-2021
2.	CRDB Bank Plc	Quarterly	2006-2021
3.	DCB Commercial Bank	Quarterly	2016-2021
4.	EXIM Bank	Quarterly	2013-2021
5.	Equity Bank	Quarterly	2012-2021
6.	MWALIMU Commercial Bank	Quarterly	2016-2021
7.	NMB Bank Plc	Quarterly	2008-2021
8.	NBC (1997) Limited	Quarterly	2013-2021
9.	International Commercial Bank (ICB)	Quarterly	2013-2021
10.	Diamond Trust Bank	Annually	2000-2021
11.	People's Bank of Zanzibar	Annually	2000-2021
12.	AKIBA Commercial Bank	Annually	2000-2021
13.	I&M Bank	Annually	2002-2021
14.	Bank of Tanzania	Annually	2000-2020

Note: Bank of Tanzania (BOT)series is the aggregate data of the banking sector derived from the Directorate of Financial Sector Supervisions of the BOT

The time series variable of interest constitutes the commercial banks' interest and non-interest income for the period. In the case of the banking sector, an aggregate variable is used. The selection of the income variable over factors such as ROA and ROE is based on sensitivity to even small technological changes and thus can offer more information in relation to changes in technology. Since the values are measured in terms of Tanzania Shillings, a natural logarithm of the factor is considered for the analysis.

3.2 Times Series Properties

In examining whether the time series is stationary or non-stationary, a line graph is plotted for the observed value over the period. The series is assumed stationary when the distribution of its value remains the same as time progresses. Figures 3.1 to 3.4 present the line graph of some series before and after the first differencing, that is first-order Integration I (1), at which they were observed to be stationary.

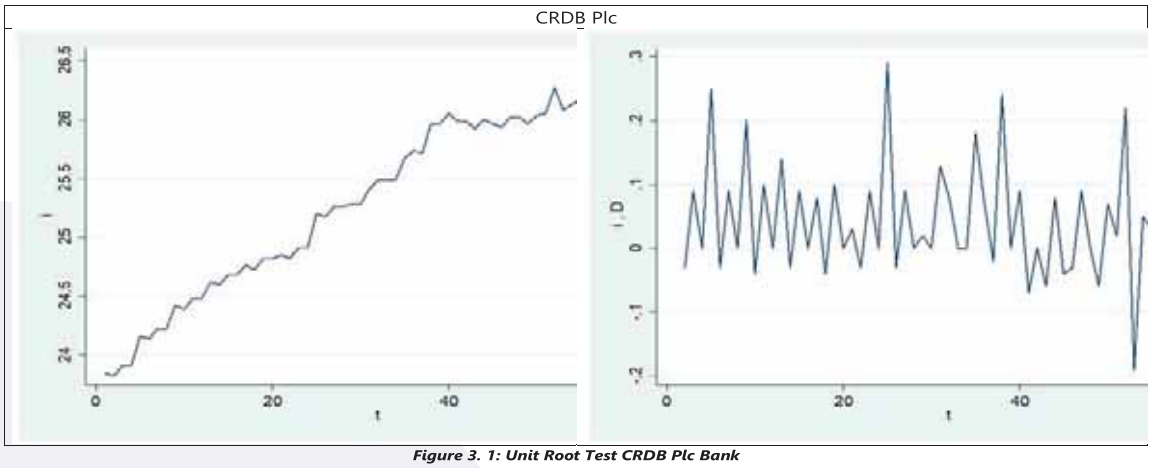

Figure 3. 1: Unit Root Test CRDB Plc Bank

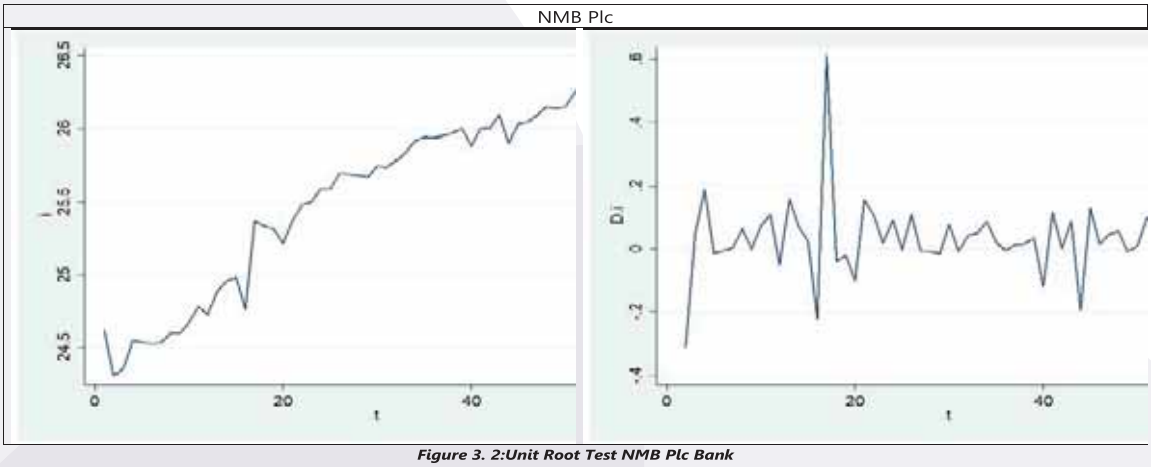

Figure 3. 2:Unit Root Test NMB Plc Bank

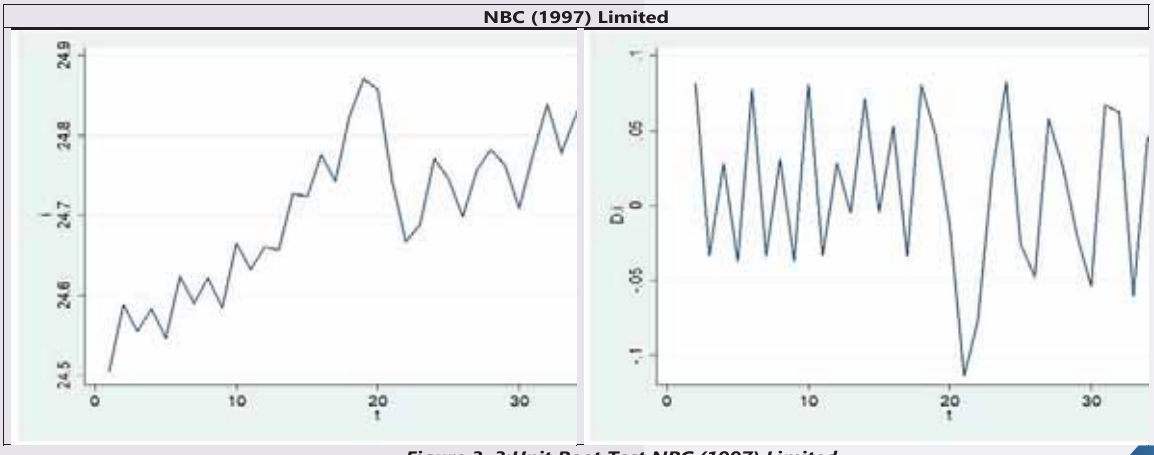

Figure 3. 3:Unit Root Test NBC (1997) Limited

Furthermore, the Augmented Dickey-Fuller test was applied to confirm whether there is an existence of a unit root in the data, or if the data was coming from a process exhibiting reversion to its mean (i.e., stationary). In the event the times series was not stationary at level, first-order differencing was implemented. The Augmented Dickey-Fuller results are presented below, with the inclusion of MacKinnon's approximate p-value for Z(t).

Table 3. 2: Augmented Dickey-Fuller Test

Series	Intercept and Trend	P-Value
i_{EQUITY}	(0.7712) ***	0.0000
Di_{CRDB}	(0.1470) **	0.0270
i_{ICB}	(1.3153) ***	0.0000
i_{DCB}	(1.2105) ***	0.0000
i_{INDIA}	(0.2918) ***	0.0000
i_{EXIM}	(1.0285) ***	0.0000
Di_{NBC}	(I.3974) ***	0.000
Di_{NMB}	(1.3524) ***	0.0000
$i_{MWALIMU}$	(1.2104) ***	0.0000
Di_{PBZ}	(1.4353) ***	0.0000
$i_{DIAMOND}$	(1.2098) ***	0.0008
Di_{AKIBA}	(1.3801) ***	0.0000
$Di_{I\&M}$	(1.0325) ***	0.0147
i_{BOT}	(0.8844) ***	0.0001

Note ***, ** present 1% and 5% significant levels respectively

3.3 Data Analysis

3.3.1 Model Specification

Autoregressive Integrated Moving Average (ARIMA) model is used to fit our time series data. The ARIMA model follows the following process:

Generalised AR(p) Model:

$$Y_t = \alpha + \sum_{p=1}^{P} \emptyset_p Y_{t-p} + \epsilon_t$$

Where $|\emptyset| < 1$

Generalised MA(q) Model:

$$Y_t = \gamma \epsilon_t + \sum_{q=1}^{Q} \theta_q \epsilon_{t-q}$$

The Generalised ARIMA (p, d, q) will be provided as follows:

$$Y_t = \alpha + \sum_{p=1}^{P} Y_{t-p} + \gamma \epsilon_t + \sum_{q=1}^{Q} \epsilon_{t-q}$$

In building the ARIMA model, Box-Jenkins (1976), approach is used. It included the process of model identification, estimation and diagnostic checking. Model identification, which includes the process of parameterisation, was captured by ACF and PACF, which were used for capturing the dynamic features of the data (Hayashi, 2000; Brooks, 2008). Whereas a spike in the PACF plot shows the presence of the AR(p) process, the spike in the ACF denotes the existence of the MA(q) process. Both Akaike Information Criterion (AIC) and Bayesian Information Criteria (BIC), coupled with the maximum likelihood valued and volatility measures, are used to determine the model that better fits the data.

Moreover, both technological change and shocks are expected to bring in a series of volatile performances to banks, which tend to phase out with time. While positive shocks bring in positive, highly volatile positive returns, negative shocks, on the other hand, tend to bring in negative returns. Given this property, the Autoregressive Condition Heteroscedasticity (ARCH) and Generalised Auto-Regressive Conditional Heteroskedasticity (GARCH) family models are appropriate and thus, were employed to measure the timeframe on the influence of technological change on the performance of commercial banks in Tanzania.

It followed the following process:

$$y_t = x_t' b + \epsilon_t$$
$$\epsilon_t | \varphi_{t-1} \sim \mathcal{N}(0, \sigma_t^2)$$
$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \epsilon_{t-i}^2$$

and satisfies the conditions

$$\omega > 0, \alpha_i \geq 0, i = 1,2, \ldots., q)$$

The GARCH (p, q) process is:

$$y_t = x_t' b + \epsilon_t$$
$$\epsilon_t | \varphi_{t-1} \sim \mathcal{N}(0, \sigma_t^2)$$
$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \epsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2$$

and satisfy the conditions

$$\omega > 0, \alpha_i \geq 0, \omega + \alpha_i \geq 0 \; for \; i = 1,2, \ldots., q$$

On the other hand, both Threshold-GARCH (T-GARCH) and Exponential-GARCH (E-GARCH) are to be employed to capture the significance of both positive and negative technological shocks on the performance of commercial banks.

The following T-GARCH process was employed

$$y_t = x_t' b + \epsilon_t$$
$$\epsilon_t | \varphi_{t-1} \sim \mathcal{N}(0, \sigma_t^2)$$
$$\sigma_t = \omega + \sum_{i=1}^{q} \alpha_i \epsilon_{t-i} + \sum_{i=1}^{p} \beta_i \sigma_{t-i}$$

The following E-GARCH process was employed:

$$y_t = x_t' b + \epsilon_t$$
$$\epsilon_t | \varphi_{t-1} \sim \mathcal{N}(0, \sigma_t^2)$$
$$log\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \epsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i log\sigma_{t-i}^2$$

The existence or non-existence of the ARCH effects is confirmed by Engle's (1982) ARCH-LM (Lagrange Multiplier) test. The results of the test are presented in Table 3.3.

Table 3. 3: ARCH Effect Test Results

Series	Chi-Square	Df	Prob>Chi-Square
CRDB Bank Plc	0.023	1	0.8800
ICB	1.888	1	0.1695
EXIM Bank	0.018	1	0.8944
EQUITY Bank	0.529	1	0.4672
NBC (1997) Ltd	0.593	1	0.4411
NMB Bank Plc	5.868	1	0.0154
MWALIMU	5.750	1	0.0165
DCB	0.996	1	0.3183
BANK OF INDIA	0.505	1	0.4774
PBZ Bank	0.3459	1	0.8880
DIAMOND TRUST	0.0090	1	0.9253
ACB	0.160	1	0.6893
I&M Bank	0.073	1	0.7869
BOT	0.0300	1	0.8631

Note: The ARCH/GARCH effects are observed for a p-value of less than 5%

3.3.2 Diagnostic Check

The residual diagnostics approach by Box and Jenkins (1976), is adopted in the study. The diagnostic was on finding some evidence of the existence of linear dependence within the residuals. Both the ACF, PACF or Breusch-Godfrey LM test were used in this accord. In the event there exists linear dependence between the residual, the suggestion is inadequate for the model specified (Brooks, 2008).

Chapter Four
Findings and Discussion

4.1 Performance of Commercial Banks in Tanzania

An analysis of the performance of commercial banks in Tanzania during the period under observation was done. It includes the examination of the rate of change in the income on which the interest was on the downward and upward momentum of the factor of income. It also included the examination of significant positive and negative shocks on the bank's performance. The discussion of the findings is presented as follows.

4.1.1 CRDB Plc Tanzania

The performance of the bank for the period from 2006 and 2021 is presented in Figure 4.1

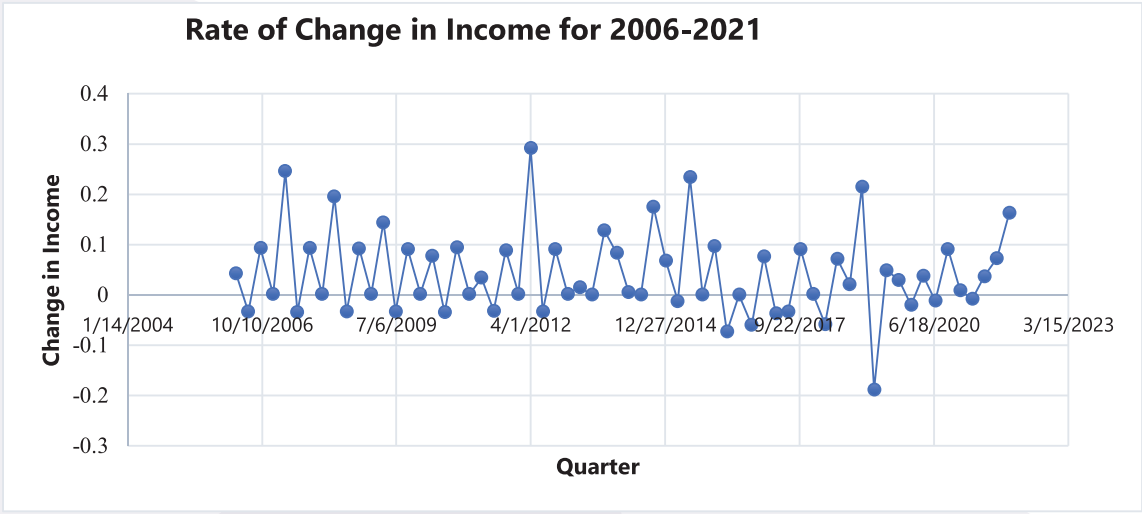

Figure 4. 1: Rate of Change of Income for CRDB Plc 2006-2021

The figure shows how volatile the performance of the bank was for the period from 2006-2021. A period of high performance was significantly followed by a period of high performance. Similarly, the period of low performance was also followed by a period of low performance. This can be seen during the second quarter of 2007, the second quarter of 2012, the second quarter of 2015 and the first quarter of 2019, where a significant plunge in income levels is observed. This, however, was able to be recovered in the subsequent quarter. Between the period of 2006-2021, a persistent upward momentum is observed, with a short period of downturn momentum showing the ability of the bank to recover from poor performance with better strategies, including planning and shocks it brings about to the bank system.

4.1.2 NBC (1997) Tanzania Limited

The performance of NBC (1997) Tanzania Limited for the period from 2013 and 2021 is presented in Figure 4.2

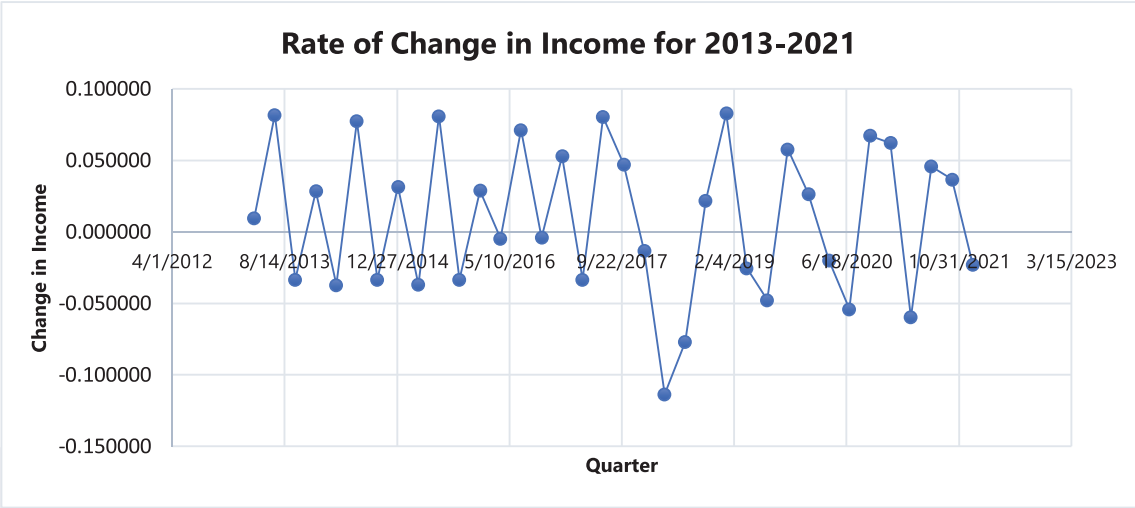

Figure 4. 2: Rate of Change of Income for NBC (1997) Tanzania Limited 2013-2021

The bank's performance can be explained in two phases: Phase I from 2013-2016 and Phase II from 2017-2021. In Phase I, both the downward and upward momentum trends were persistent during the period. While the upward momentum had the highest peak, the downward momentum had a lower peak. However, both the downward and upward momentums were short-lived. In Phase II, the upward momentum was significantly high and also took a long time to phase out. A significant downturn momentum peak can be observed from the second quarter of 2016 to the second quarter of 2018. However, the bank was able to recover within the next two quarters. Similarly, the effect of COVID-19 can be observed with a downward plunge in bank performance in 2019. Nonetheless, a persistent upward trend can be observed over the period, reflecting the bank's ability to strategize on its performance.

4.1.3 NMB Plc Bank

NMB Plc Bank's performance for the period from 2013 and 2021 is presented in Figure 4.3

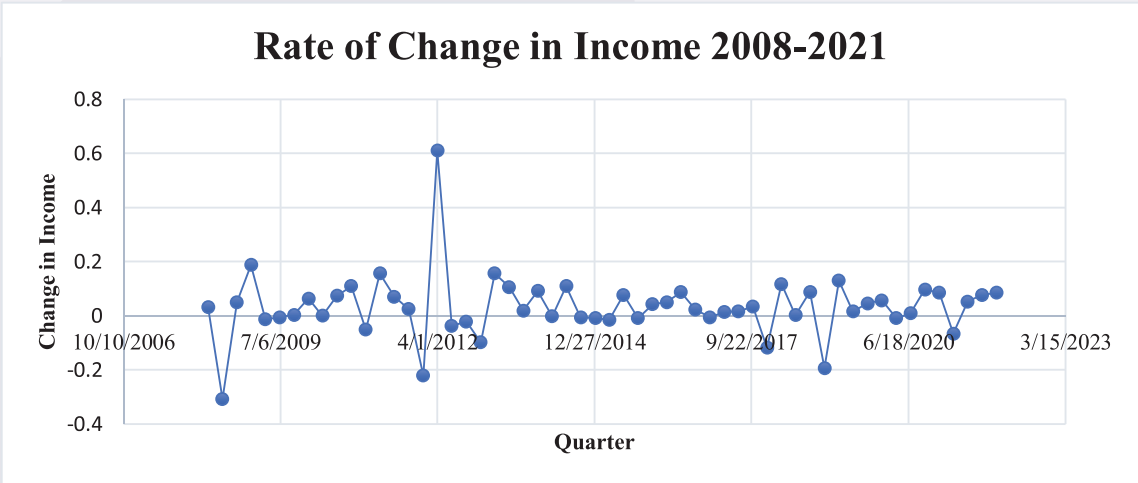

Figure 4. 3: Rate of Change of Income for NMB Plc 2008-2021

The rate of change in income for the bank over the period has been fluctuating significantly over the period under observation. A series of downward movements in the performance of the bank followed by a series of downward performances. However, a series of positive performances were significantly followed by a series of bad performances, resulting in a short-lived positive performance by the bank. The bank experienced a positive shock during the first quarter of 2012, whose effects only lasted a single quarter. Downward peaks were also observed during the second quarter of 2008, the fourth quarter of 2011 and the fourth quarter of 2018. In general, on average, the bank's performance has been consistent, with a short-lived period of relevant shocks, showing the bank's resilience towards market shocks.

4.1.4 ICB Bank

Figure 4.4 shows the performance ICB-Tanzania for the period from 2013 and 2021.

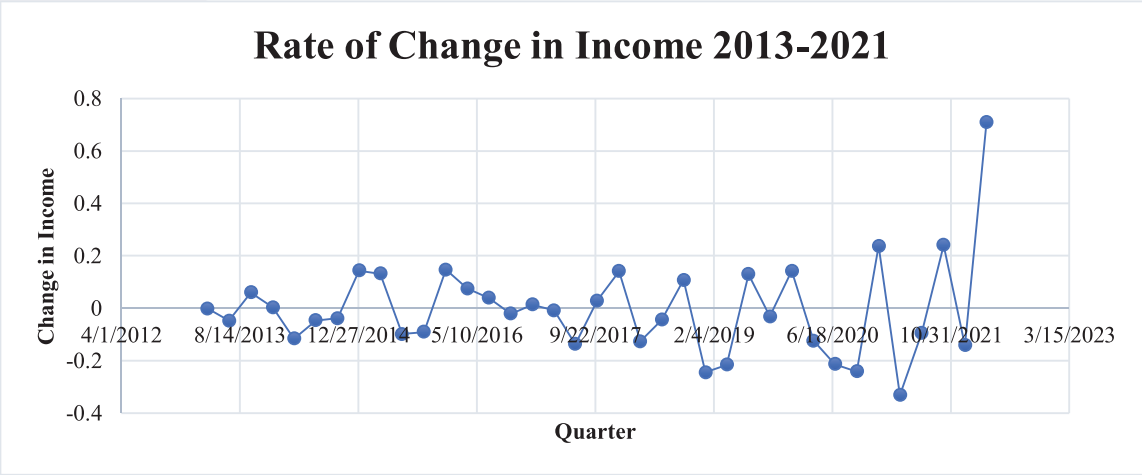

Figure 4. 4: Rate of Change of Income for ICB Bank 2013-2021

For the period from 2013-2016, on average the upward momentum was significantly higher, reflected by a significantly long period of positive outcomes. Moreover, the downward momentum was short-lived, reflecting the banks' ability to recover from a decline in their income. Starting from 2017, we can observe significant positive peaks in changes in income. However, they were more short-lived, as shown by the decline in income. Moreover, both the upward and downward momentums had their share in affecting income, with the downward momentum being more persistent during the (COVID-19) pandemic.

4.1.5 DCB Bank

The performance of Dar es Salaam Commercial Bank for the period from 2016 and 2021 is presented in Figure 4.5

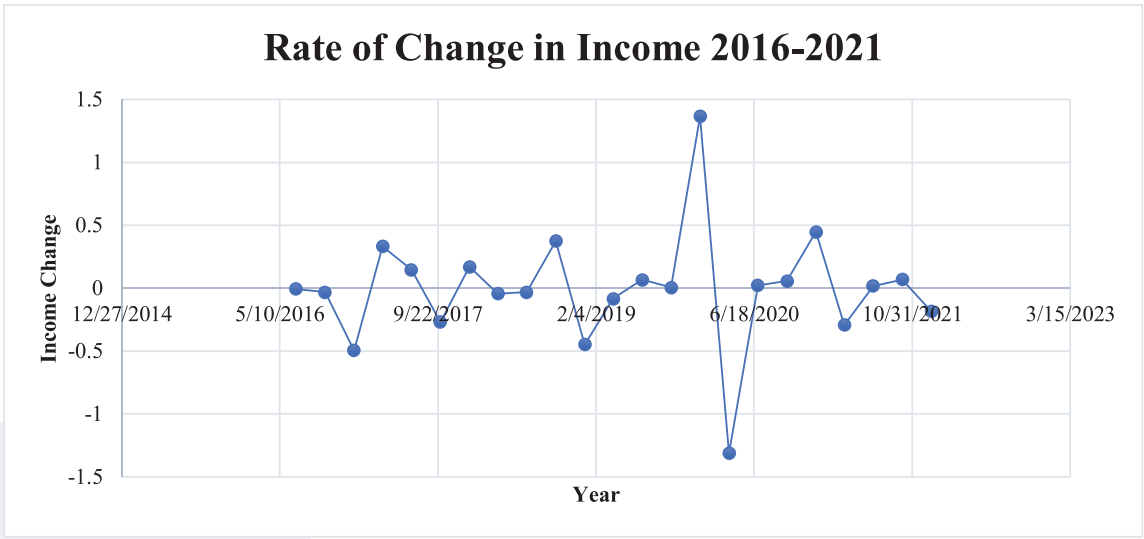

Figure 4. 5: Rate of Change of Income for DCB Bank 2016-2021

On average, the bank's performance has been stable over the period 2016-2021. We can observe some downward plunges in the last quarter of 2016, which recovered in the first quarter of 2017. Similarly, a downward momentum is observed in the second and third quarters of 2017, the fourth quarter of 2018 and the first quarter of 2021. However, the bank experienced a nose dive in its performance in the first quarter of 2020, which can be explained by the impact of the COVID-19 pandemic. This, however, was able to be recovered in the next three quarters of 2020. A significant upward momentum can be observed in the bank's performance over the years, showing the bank's ability to withstand the shocks brought about by the market.

4.1.6 Mwalimu Commercial Bank

Figure 4.6 shows the performance of Mwalimu Commercial Bank for the period from 2016 to 2021.

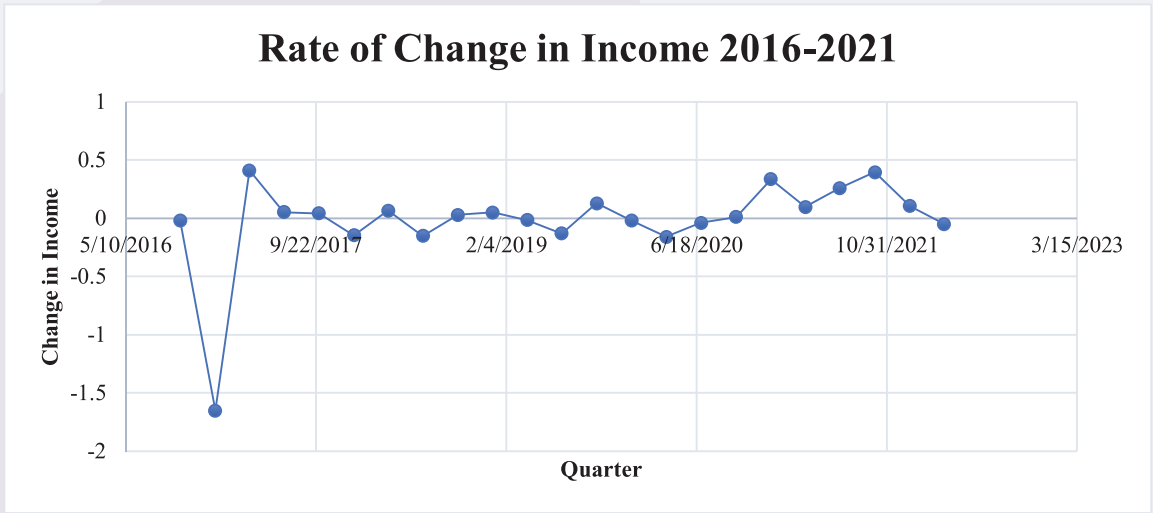

Figure 4. 6: Rate of Change of Income for Mwalimu Commercial Bank 2006-2021

The performance of Mwalimu Commercial Bank over the years has been stable throughout 2017 and 2019, with minor downward plunges. A significant shift in the trend can be observed starting from 2020, when an upward momentum has been taking shape and is observed to be taking hold of the banking performance for the next five quarters, before taking a downward plunge in the last quarter of 2021.

4.1.7 Bank of India

Figure 4.7 shows the performance of the Bank of India for the period from 2014 and 2021.

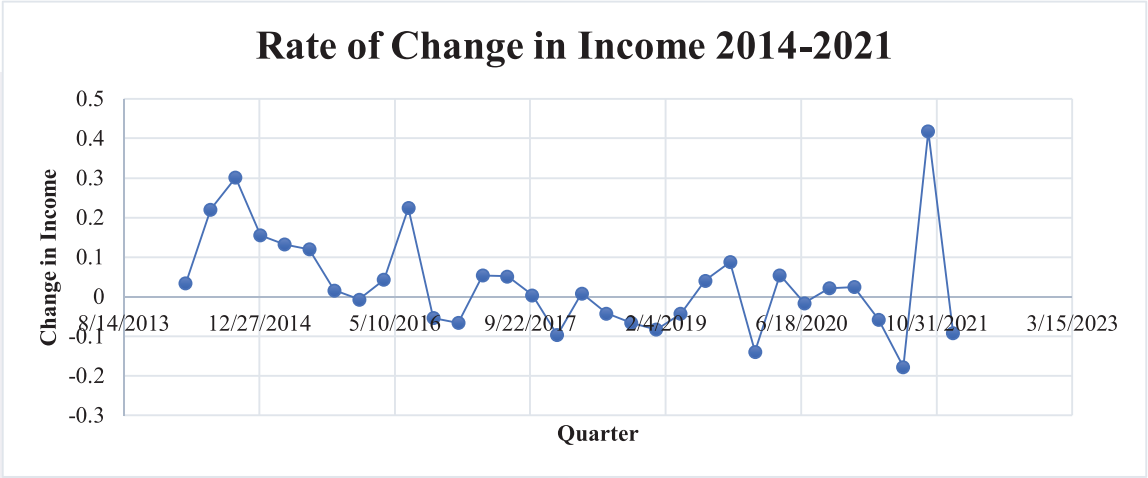

Figure 4. 7: Rate of Change of Income for Bank of India 2014-2021

During the period from 2014 to 2021, the bank experienced a series of upward and downward momentum. The bank has experienced a strong upward momentum from the first quarter of 2014, which started to die down in the fourth quarter of 2014, where a downward momentum was observed to take hold of the bank's performance. This, however, did not cause a significant loss in income. Starting from the third quarter of 2016 to the second quarter of 2021, the bank experienced a series of downturn momentums, which were significantly persistent throughout the period. It explains the bank's difficulty in bringing about new sources of income. Similarly, the impact of COVID-19 proved to be among the factors affecting performance.

4.1.8 Exim Bank

The performance of Exim bank for the period from 2013-2021 is presented in Figure 4.8

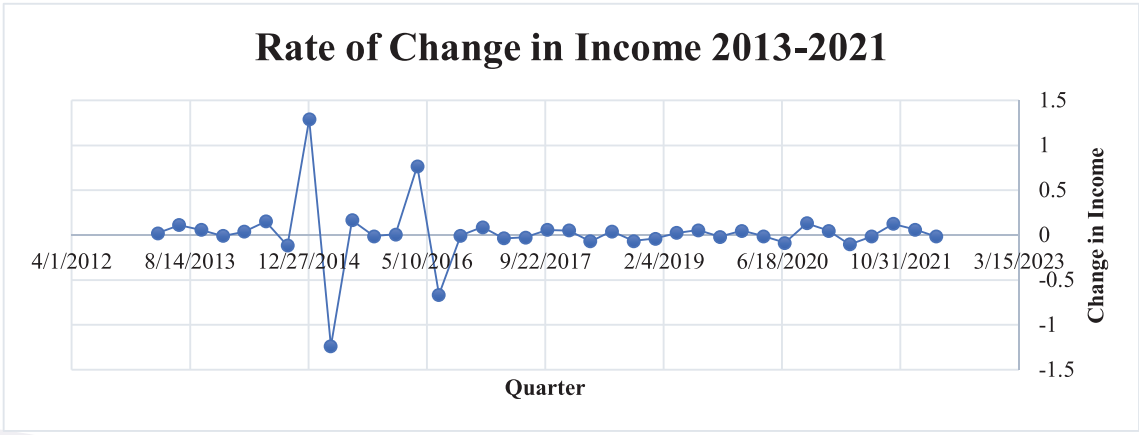

Figure 4. 8: Rate of Change of Income for Exim Bank 2013-2021

The bank's performance has been consistently stable, with a short period of downward momentum. The downturn momentum can be observed during the first quarter of 2015 and the second quarter of 2016. From 2017 through 2021, the bank has been able to maintain the same performance levels, thus avoiding significant dives in performance, especially during worst-case scenarios, such as the outbreak of the COVID-19 pandemic.

4.1.9 Equity Commercial Bank

Equity Commercial Bank's performance for the year 2012-2021 is presented in Figure 4.9

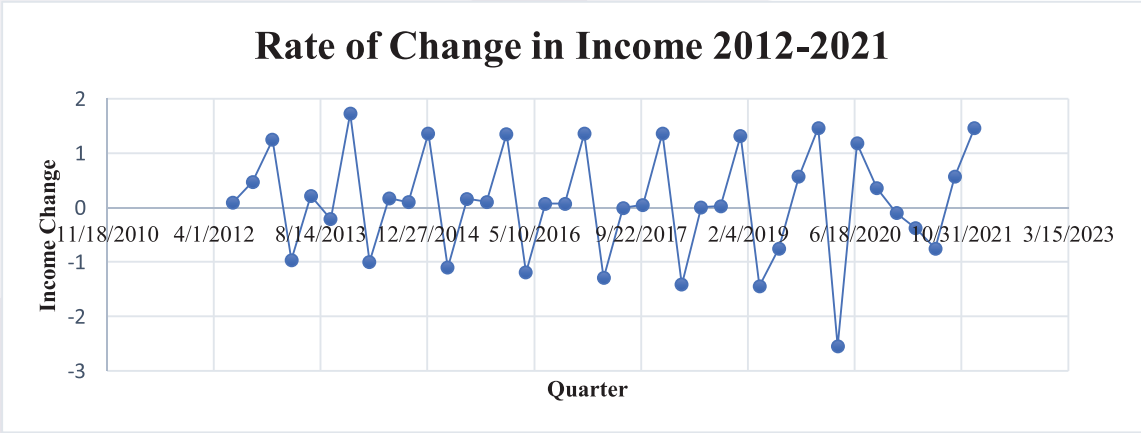

Figure 4. 9: Rate of Change of Income for Equity Commercial Bank 2012-2021

An important seasonal trend in the bank's performance can be observed from 2012 and 2021. The first quarter represents the lowest season of the bank in terms of performance, as significant downturns can be observed. Starting in the second quarter, the bank is observed to increase its performance, reaching a peak in the fourth quarter, at which point the cycle repeats itself. The bank's strategies can account for the performance of the bank, including the type of customers it serves and the operations in place during the period.

4.1.10 PBZ Commercial Bank

Figure 4.10 shows the performance of PBZ for the period from 2000-2021.

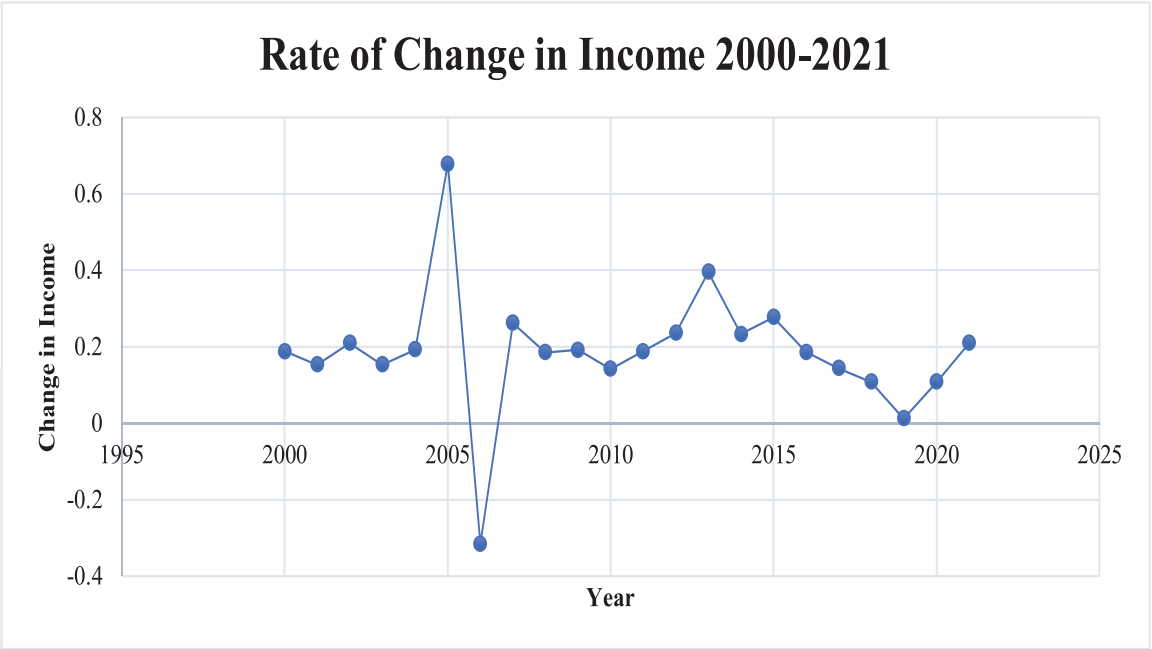

Figure 4. 10: Rate of Change of Income for PBZ 2000-2021

A promising performance is observed for PBZ during the period from 2000-2020. A consistent upward trend is observed, with few significantly short-lived downturns. Similarly, significant upward momentum is observed to be followed by downturn momentum. This trend is observed to be broken at the beginning of the year 2015, when a persistent downturn was observed, reaching a peak in 2019, where we observed an upward momentum taking its turns in driving the performance.

4.1.11 Diamond Trust Bank

Figure 4.11 presents the performance of Diamond Trust Bank for the period from 2020-2021.

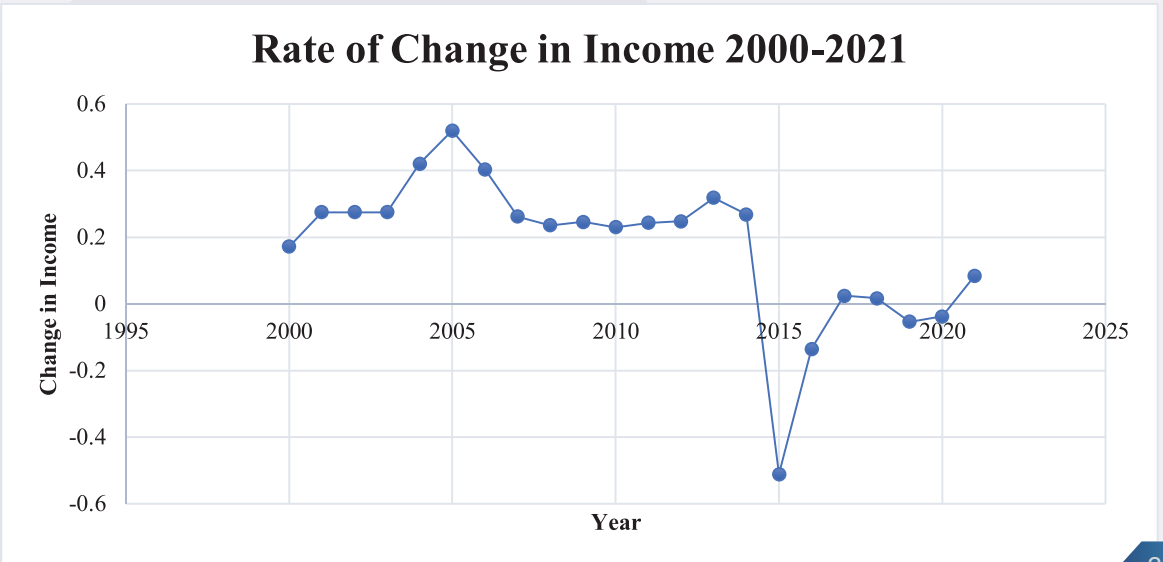

Figure 4. 11: Rate of Change of Income for Diamond Commercial Bank 2000-2021

The bank's overall performance has been promising throughout the observation period. Significant upward momentum has been consistent during the period, with only a single plunge in 2015 and during the COVID-19 pandemic. However, the bank has shown some resilience, indicated by the recovery rate, as the downturns were short-lived.

4.1.12 I&M Bank

Figure 4.12 presents the performance of I&M bank for the period from 2000-2021.

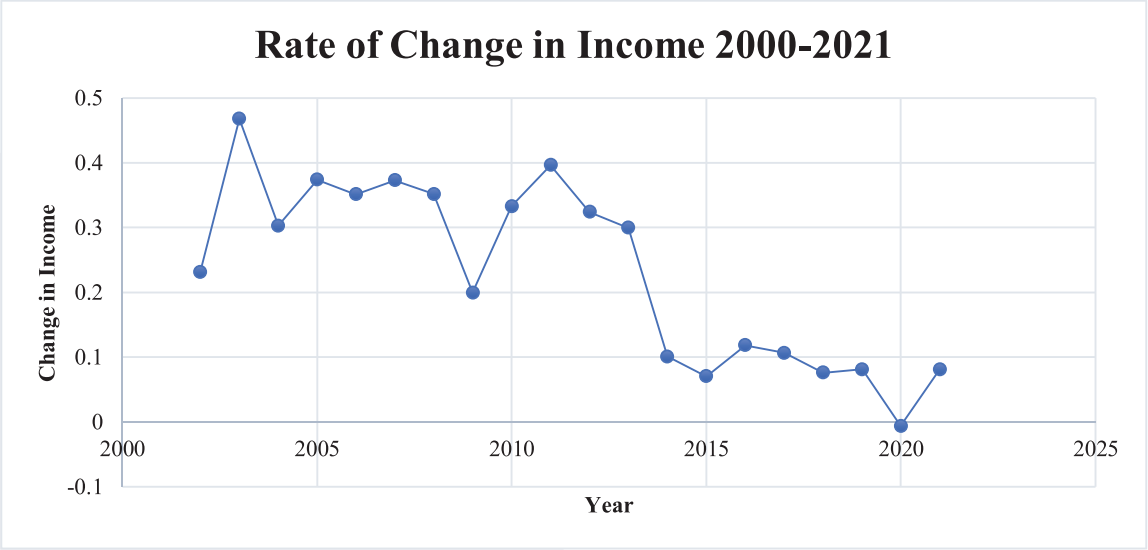

Figure 4. 12: Rate of Change of Income for IM Bank 2002-2021

A downward trend in the performance of the bank was observed during the period from 2000-2020. Although the bank was able to recover in 2010 from the negative shocks of 2009, the recovery time was short-lived, as the bank's performance continued to decline with no sign of recovery. However, some renewed hope in the performance can be observed from 2021.

4.1.13 AKIBA Commercial Bank

The performance of AKIBA commercial bank is presented in figure 4.13

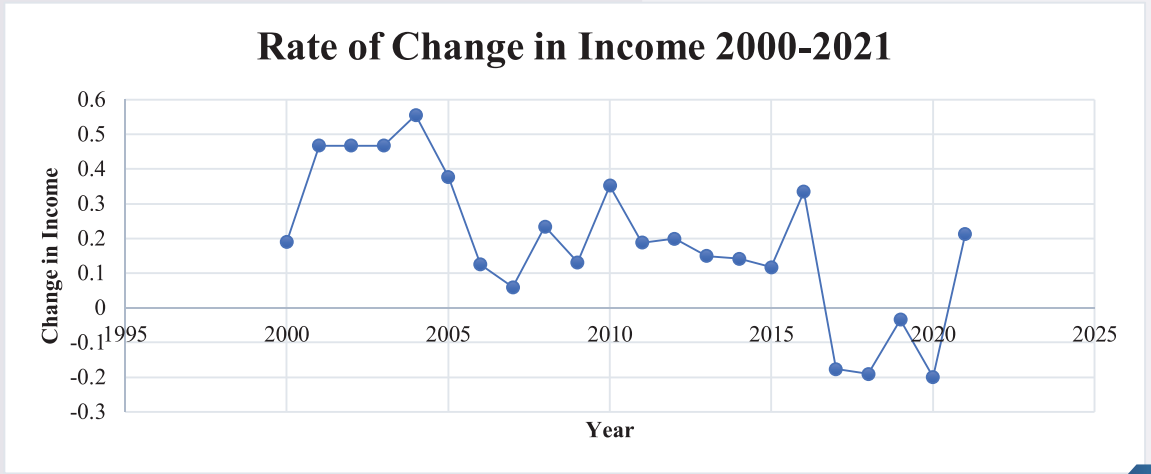

Figure 4. 13: Rate of Change of Income for AKIBA Commercial Bank 2000-2021

The bank's performance during the period has been characterized by positive performance, with a decline in its value. The bank obtained a high positive outcome in 2004, which also marked a decline point in the performance. Poor performance can also be seen in the period from 2017-2020, where the lowest outcome was observed. Moreover, poor performance can also be associated with the COVID-19 pandemic. A positive outcome in the year 2021, shows some promising performance in the coming years.

4.1.14 Banking Industry Performance

The performance of the banking industry in Tanzania between the period of 2000 and 2020 is presented in Figure 4.14

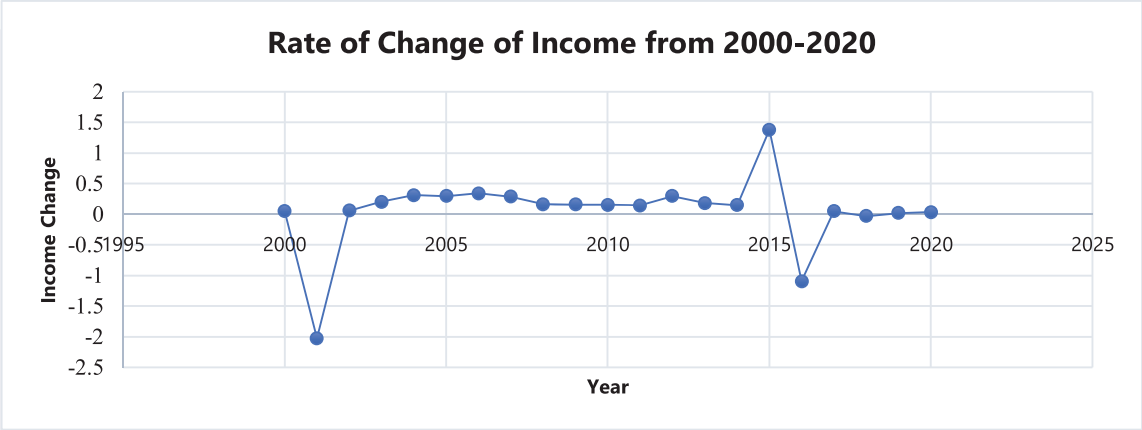

Figure 4. 14: Rate of Change of Income the Banking Industry 2000-2020

The general performance of the banking industry in Tanzania has been stable over the period between 2002 and 2014, and it seems to continue starting from 2017-2020. This performance explains how resilient the banking industry is towards market shocks. A significant shock within the industry is observed from 2001 to 2016 when there is a significant plunged. The banking industry, however, was able to recover from this downturn within one year. A peculiar phenomenon is observed in 2015, where the highest peak was observed, followed by a plunge in the next year.

4.2 Results for ARIMA Model

Table 4.1 below presents the results of the ARIMA (d, p, q) model fitting for our times series data.

Table 4. 1: ARIMA Model Results

	Coefficients	AIC	BIC
DCB			
Constant	22.7330***		
AR (1)	0.1468	19.2659	24.9433
AR (2)	(0.1557)		
MA (1)	(0.2953)		
BANK OF INDIA			
Constant	21.7058***		
AR (1)	0.9396***	(19.0246)	(17.5588)
MA (1)	0.1145		
EXIM BANK			
Constant	24.5126***		
AR (1)	0.9060***	18.8403	30.1167
MA (1)	(0.7134)		
ICB			
Constant	21.5771***		
AR (1)	0.8415***	(23.8396)	(22.2196)
MA (1)	(0.1670)		
EQUITY BANK			
Constant	23.3064***		
AR (1)	0.3036	93.9128	100.567
MA (4)	0.6112***		
CRDB			
Constant	0.0428***	(145.3177)	(143.1743)
AR (1)	(0.9044) ***		
DIAMOND TRUST			
Constant	23.0494***		
AR (1)	0.9714***	(5.7790)	(3.3794)
MA (1)	0.5957**		
ACB			
Constant	0.1536***		
AR (1)	0.6245**	(5.8170)	(3.1458)
I&M Bank			
Constant	0.2346**		
AR (1)	0.9220***	(19.9167)	(16.3552)
MA (1)	(0.4519)		
NBC			
Constant	0.0085***		
AR (1)	(0.8016) ***		
AR (2)	(0.3864) **	(110.8457)	(101.5136)
AR (3)	(0.5394) ***		
MA (1)	0.7067		

Note ***, ** present 1% and 5% significant levels respectively

Both ARIMA (1,0,1) and ARIMA (1,1,1) are observed to best suit our time series data set. In the CRDB Bank Plc and Diamond Trust Bank series, both the Autoregressive (AR) and Moving Average (MA) are significant in the model, showing both autoregressive and moving average effects to be present. In the case of Akiba Commercial Bank, Bank of India, Exim Bank, International Commercial Bank, I&M Bank and People's Bank of Zanzibar, only the autoregressive component is significant, exhibiting evidence of some persistence of past performance to the current performance. On the other hand, the Equity Bank series showed some significance in its MA component, while the DCB series had little information as both the AR and MA components were not significant. This provided the argument on the existence of other economic factors influencing the performance of the bank, apart from the information contained in the actual performance itself. In the NBC Bank series, three past values of the performance of the bank are observed to be significant in predicting the current performance, while its MA component remained to be insignificant. BIC and AIC values are presented to validate the model specification and served as the criteria for selecting this particular model as the best fit for our time series data.

4.3 Results for GARCH Model

The ARCH effects observed by the Engle (1982) ARCH-LM test in section 3.3.2 allowed for the carrying out of the ARCH/GARCH process for NMB and MWALIMU Commercial Banks. The findings are presented in Table 4.2.

Table 4. 2:ARCH/GARCH Process Results

	Coefficient	AIC	BIC
NMB			
Constant	0.0229***		
AR (1)	(0.3980)	(92.3003)	(82.3554)
ARCH (1)	0.7247***		
Constant	0.0030		
GARCH (1)	0.1887		
MWALIMU Commercial Bank			
Constant	21.0920***		
AR (1)	0.9507***	5.6752	10.2172
ARCH (1)	0.9706**		
Constant	0.0190		

Note ***, ** present 1% and 5% significant levels respectively

The ARCH process is termed to be significant in both series, with little to no evidence of the effects of the GARCH process. Both series are observed to follow the assumption stated in 3.3.1 above, to ensure the stationarity of the time series.

That is

$\omega>0, a_i \geq 0, \omega+a_i \geq 0$ *for* $i=1,2,\ldots,q)$ .The relevancy of each model in predicting the data is also given by the AIC and BIC values.

4.4 Technological Change and Performance of Commercial Banks

The results from the ARIMA analysis provided the following information in relation to each bank.

4.4.1 CRDB Bank Plc

The current performance of CRDB Bank Plc is observed to be affected by its past quarter's performance, current innovation put in place and innovation put in place in the previous quarter. The negative fluctuations of past performance are dominant or persistent, causing changes that have occurred in the past to continue affecting current performance (Kotze, 2020). This, however, is in a smaller amount than the technological change adopted from the immediate past year, as shown by a positive of the MA component on the series. However, the persistence of the adopted technological change lags is observed to fade away in the current quarter. In light of this, technology innovation currently put in place by CRDB, will affect both the current and the next quarter's performance. This helps in generalising that the period of technology adoption by CRDB Bank Plc is six months or two quarters.

4.4.2 NBC (1997) Bank Limited

According to the current findings, the performance of NBC Limited is affected by both its past performance and the technological change exerted by the current innovation put in place. However, in the case of NBC Limited, the full reaction to the technological change does not occur immediately, rather it affects the performance gradually. This can be explained by three significant lags in the model. However, the persistence is observed to gradually decrease over time, given the value of the lags coefficient (Brown, 1952). Thus, a current introduction of new technology within NBC Bank is absorbed into the current quarter, and such effects will continue to persist for the next three quarters. In general, technological change or innovation introduced by NBC Bank will affect the performance for the next four quarters (i.e., one year).

4.4.3 Diamond Trust Bank

Similar to the observations made on CRDB Bank Plc, the past fluctuations relating to technology or innovation shock will continue to influence current performance as evidenced by the MA component. Compared to CRDB Bank, the fluctuation is positive and phases out within two quarters, providing an estimate of two years for the effect of a change in technology or innovation, on the performance of the bank to phase out.

4.4.4 Equity Bank

Both past performance and currently introduced technology in the bank are observed to have no significant effect on the current performance of the bank. However, the technological change that has been implemented in the past fourth quarter is observed to affect the performance of the Equity Bank. In this accord, in adopting any technology, Equity Bank will be required to wait for an average of one year to begin reaping the economies of scale on such technology. It is important to note that such effects are specific to that quarter, with little to no transfer to the next quarter. Given these findings, it can be argued that the waiting time for technological change on the performance of Equity Bank is one year.

4.4.5 Other Banks

In the case of Akiba Commercial Bank, Bank of India, Exim Bank, International Commercial Bank and People's Bank of Zanzibar, the significance of any innovation on performance is determined by its past performance and the current technology or innovation put in place. It can be expected that a new technology put in place will have an immediate impact on the performance of the bank, and such performance will have an effect on the performance of the following quarter. This is, however, at varying degrees. In the case of Bank of India, Exim Bank, I&M Bank and International Commercial Bank, the previous year's performance is far more dominant than the current performance, and such dominance has a positive influence on the current performance. However, these effects phase out with time, as the technological change coming from the immediate past is observed to not significantly affect current performance. This can be observed by insignificant coefficients of the MA(q) process. Moreover, previous year performances are observed to be less persistent for People's Bank of Zanzibar's and Akiba Commercial Bank's current performance. We can place the technology adoption period time for these banks to be three months (i.e., a single quarter) for Bank of India, Exim Bank and International Commercial Bank, and one year for Akiba Commercial Bank and People's Bank of Zanzibar.

4.4.6 DCB Commercial Bank

The ARIMA model specification for DCB Commercial Bank is observed to be insignificant in explaining the variations in the current performance of the bank. This means the past performance of DCB Commercial Bank carries no information in relation to the current performance, the argument of examining other economic factors inside and outside the bank, expected to influence the bank's performance

4.4.7 Banking Sector in Tanzania

In Tanzania's banking sector as a whole, technology or innovation currently adopted in the country's financial sector is expected to have a positive effect on current performance. Moreover, positive fluctuations are significantly consistent, although they are observed not to be significantly related to the technology innovation implemented in the past year. Thus, we can generally estimate that on average, the technology adoption period time for the banking sector to be twelve months (i.e., one year).

4.5 Technology Shocks and Performance of Commercial Banks

The ARCH/GARCH results presented the effects of the volatility of our residual on the time series, which is the time-varying phenomenon of our series. In our case, ARCH/GARCH examines the effects of technology shocks on the performance of banks. Since such volatility is conditioned to occur as a result of external factors, the time of their impact is of significance (Hayashi, 2000; Greene, 2002; Brooks, 2008). Our analysis showed that both NMB and MWALIMU Commercial Banks are affected by random changes in technology (i.e., technology shock) exerted outside the bank. These shocks are observed to occur with a lag of one quarter. The finding also reveals such volatility phases out with time, due to an insignificant observation of the GARCH process

Chapter Five
Conclusion and Policy Recommendation

5.1 Conclusion

The effects of technological change are not only impacting the manufacturing and service sectors, but have further extended to influence financial sectors, and in this case the banking sector. The goal of any bank is to act as an intermediary, by serving those with excess funds by accepting deposits and lending to those in need of such funds, in the form of loans, for profit. Other functions of banks include facilitating payments to their clients. This function requires its services to be readily available to the consumer, to ensure customer satisfaction, value creation and sustainability. In serving the sustainability need, banks are required to increase their performance. As the bank's performance is strictly tied to the provision of its financial products to its customers, the necessity of the adoption of technology becomes requisite.

The problem with technological change is that it is not static, but rather dynamic. It changes with time and according to the needs of society. What was deemed to be a technology necessity, for example, one hundred years ago, can be irrelevant or outdated today. The passing of time affects the significance of technology. Moreover, discoveries in new technological discoveries call for the need to monitor technological changes, to ensure one keeps up with those changes. Furthermore, one of the advantages of implementing technology is its inclusivity property. One is allowed to use a particular technology by accepting the terms and conditions of using such technology. This inclusivity property provides users (in this case businesses) of such technology an environment to meet potential customers. For banks, the use of technology presents an opportunity to offer their financial services to a wider and more inclusive clientele. Due to technology relevancy in supporting banks' operations, it is important for banks, at this juncture, to plan how they will adopt such technological changes, including technology shocks, to improve performance.

In this study, the goal was to determine the period during which banks need to plan, in relation to the adoption of technology and how to embrace the shocks resulting from technological changes. Time series data from thirteen (13) commercial banks in Tanzania for the period 2000 and 2021, including aggregate data for the banking sector, is used. Using the Box-Jenkins approach, an appropriate ARIMA (p, d, q) is used to estimate/fit a particular time series. The selection of the model is based on the value of AIC and BIC and complemented with maximum likelihood and volatility values. The existence or non-existence of the ARCH/GARCH effects is tested using the ARCH-LM test. The residual diagnostic test is implemented to validate our model. It included the plotting of ACF and PACF and the Breusch-Godfrey LM test in testing for autocorrelation within the residuals.

Our findings showed both technological change and technology shocks have a significant influence on the performance of commercial banks. The effects of technological change on performance are observed to be strong and persistent in banks such as CRDB Bank Plc and Diamond Trust Bank.

These fluctuations are observed to be significant, leading to the significance of previous year shocks, allowing the estimation of the technology period to be six months (two quarters). Similarly, in the case of Akiba Commercial Bank, Bank of India, Exim Bank, International Commercial Bank and People's Bank of Zanzibar, fluctuations are observed to be significant, however, they have little effect on previous shocks. This estimates an adoption window of three months for the Bank of India, Exim Bank and International Commercial Bank, and one year for Akiba Commercial Bank and People's Bank of Zanzibar.

For banks such as NBC (1997) Tanzania Limited and Equity Bank, the effects of technological change are exhibited differently from other banks. Effects on performance have gradually declined in the case of NBC (1997) Tanzania Limited while having a waiting period of 12 months in the case of Equity Bank. While the effect of technological change at NBC (1997) is long, that of Equity Bank is short and bound to a single quarter. We can estimate a waiting period of 12 months for Equity Bank, with a window of three months to reap the economies of scale. In the case of NBC Bank, the opportunity window is one year. The findings showed the insignificance of information contained in the past performance of DCB, proving the argument for the existence of other economic factors influencing the bank's performance.

The past performance of the banking sector in Tanzania is observed to have a significant impact on the current performance of banks. This persistence resulting from past fluctuations is observed to phase out with time. The adoption window of the banking sector is estimated, on average, to be twelve months (1 year). On the other hand, the significance of technology shocks on the performance of NMB Bank Plc and MWALIMU Commercial Bank is observed to have a lag of three months, conditional on the arrival of information.

On this note, the use of technology in offering financial services by Banks has become among the functions of the bank. Given its dynamism, the banking sector should not be left out in creating better interventions, including investing in appropriate technology that will serve its own needs. Given that the window to reap the economies of scale from technological change and shocks is short (less than a year), technology adoption by banks, especially commercial banks in Tanzania, must be done strategically to ensure it is aligned with the company's performance and the goal of maximising the wealth of owners. Thus, both technology adoption and development should be among the responsibilities of a bank, as a sense of social responsibility, given that they are among the largest beneficiaries, and also taking into consideration its association with improving banking performance.

5.2 Policy Recommendation

The information observed in the findings provides us with enough justification to offer the following recommendations:

1. In overseeing the adoption of a particular technology need, banks must ensure a proper plan is in place to make room for the swift adoption of technology. Since the adoption period to the reaping of economies of scale is short, banks should ensure a prompt adoption system of new technology. This will include the need for the creation of a technology adoption manual.

2. As technology shocks are observed to influence banks' performances, banks need to be on the lookout for new technology. This will include investing in the development of new technology or collaborating with FinTech-type businesses. The process will include the assessment of current technology to ensure more up-to-date and functioning technology is implemented.

3. The dominance of technological change over technology shocks showed the resilience of the majority of commercial banks in Tanzania. However, the susceptibility of two commercial banks to technology shocks offers new evidence of the vulnerability of the banking industry, requiring the formulation of some sound policies on the adoption of technology in the country.

4. Moreover, it is inevitable for the estimated technology adoption period to remain fixed for a long period, due to the frequency of change in technology, including the urge to adopt new technology, arising from the 'fear of being the left-out syndrome. This calls for strong measures to be put in place in case of technology upgrading or implementing new technology. It is important for banks to also ensure there are research and development activities responsible for assessing the viability and compatibility of a particular technology, with the bank's functions.

5. It is important also for banks to invest in technological advancement in the country, resulting from them being among the biggest beneficiaries of such services. This can help guarantee the availability and supply of technology to current and future generations.

Pending the availability of quarterly data from the whole banking sector, including its aggregate data, this study can be replicated to determine a shift in the technology adoption window within banks and the country's banking system as a whole. This future study can also examine the influence of factors such as the size and age of the bank on its technology adoption window.

References

Abbas, J. *et al.* (2014) 'Impact of technology on performance of employees (a case study on Allied Bank', *World Applied Sciences Journal*, 29(2), pp. 271–276. doi: 10.5829/idosi.wasj.2014.29.02.1897.

Abu-Bader, S. and Abu-Qarn, A. S. (2008) 'Financial Development and Economic', *Journal of Policy Modeling*, 30(5), pp. 887–898. doi: 10.1016/j.jpolmod.2007.02.001.

Abu, S. T. (2010) 'Technological innovations and 3G mobile phone diffusion: Lessons learned from Japan', *Telematics and Informatics*, 27(4), pp. 418–432. doi: 10.1016/j.tele.2010.03.001.

Akhisar, I., Tunay, K. B. and Tunay, N. (2015) 'The Effects of Innovations on Bank Performance: The Case of Electronic Banking Services', *Procedia: Social and Behavioral Sciences*, 195, pp. 369–375. doi: 10.1016/j.sbspro.2015.06.336.

Ally, A. R. (2022) 'Influence of macro-economic factors on financial performance of commercial banks in Tanzania', *International Journal of Economics and Finance*, 14(7), pp. 1–17. doi: 10.5539/ijef.v14n7p1.

Almeida, R. and Fernandes, A. M. (2008) 'Openness and Technological Innovations in Developing Countries: Evidence from Firm- Level Surveys', *The Journal of Development Studies*, 44(5), pp. 37–41. doi: 10.1080/00220380802009217.

Anselin, L., Varga, A. and Acs, Z. J. (1997) 'Local Geographic Spillovers between University Research and High Technology Innovations', *Journal of Urban Economics*, 42, pp. 422–448.

Archibugi, D. and Iammarino, S. (1999) 'The policy implications of the globalisation of innovation', *Research Policy*, 28, pp. 317–336.

Arora, A. and Fosfuri, A. (2003) 'Licensing the market for technology', *Journal of Economic Behaviour and Organization*, 52, pp. 277–295. doi: 10.1016/S0167-2681(03)00002-7.

Arora, H. and Arora, P. (2013) 'Effect of investments in information technology on bank performance: empirical evidence from Indian public sector banks', *International Journal of Business Information Systems*, 13(4), pp. 400–417.

Asmundson, I. (2011) *What are Financial Services? How Consumers and Businesses Acquire Financial Goods such as Loans and Insurance*, *Finance and Development*. Available at: https://www.imf.org/external/pubs/ft/fandd/2011/03/pdf/basics.pdf (Accessed: 25 May 2021).

Bates, K. A. and Flynn, E. J. (1992) 'Innovation History and Competitive Advantage: A Resource-Based View Analysis of Manufacturing Technology Innovations'.

Beccalli, E. (2007) 'Does IT investment improve bank performance? Evidence from Europe', *Journal of Banking and Finance*, 31, pp. 2205–2230. doi:

10.1016/j.jbankfin.2006.10.022.

Boakye, C. and Amankwah, N. O. A. (2012) 'Determinants of the Demand for Financial Products in Ghana'. Available at: https://www.findevgateway.org/sites/default/files/publications/file/mfg-en-paper-determinants-of-the-demand-for-financial-products-in-ghana-2012.pdf.

Bodie, Z., Kane, A. and Marcus, A. J. (2014) *Investments*. 10th Editi. New York: The McGraw Hill Education.

BOT (2020) *Financial Sector Supervision Annual Report 2020*. Dar es Salaam.

Bourguignon, F. (2018) 'Political and economic development of Tanzania: a brief survey', in *Tanzania Institutional Diagnostic*. London: Economic Development & Institutions. Available at: http://edi.opml.co.uk.

Box, G. E. P. and Jenkins, G. M. (1976) *Time Series Analysis: Forecasting and Control*. San-Francisco: Holden-Day.

Braun, M. and Raddatz, C. (2010) 'Banking on politics: When former high-ranking politicians become bank directors', *World Bank Economic Review*, 24(2), pp. 234–279. doi: 10.1093/wber/lhq007.

Brooks, C. (2008) *Introductory Econometrics for Finance*. Cambridge: Cambridge University Press. doi: 10.1017/CBO9781107415324.004.

Brown, T. M. (1952) 'Habit persistence and lags in consumer behaviour', *Econometrica*, 20(3), pp. 355–371. Available at: http://www.jstor.org/stable/1907409.

Burgess, T. F. *et al.* (1998) 'Competitive priorities , process innovations and time-based competition in the manufacturing sectors of industrialising economies The case of Turkey', *Benchmarking for Quality Management and Technology*, 5(4), pp. 304–316.

Chaarani, H. E. L. and Abiad, Z. E. L. (2018) 'The Impact of Technological Innovation on Bank Performance', *Journal of Internet Banking and Commerce*, 23(3).

Chai, B. B., Tan, P. S. and Goh, T. S. (2016) 'Banking Services that Influence the Bank Performance', *Procedia: Social and Behavioral Sciences*, 224, pp. 401–407. doi: 10.1016/j.sbspro.2016.05.405.

Chege, S. M., Wang, D. and Suntu, S. L. (2019) 'Impact of information technology innovation on firm performance in Kenya', *Information Technology for Development*, pp. 1–30. doi: 10.1080/02681102.2019.1573717.

Chipeta, C. and Muthinja, M. M. (2012) 'Financial innovations and bank performance in Kenya : Evidence from branchless banking models', *South African Journal of Economic and Management Sciences*, 21(1), pp. 1–11. doi: 10.4102/ sajems.v21i1.1681.

Coccia, M. (2020) 'Technology Analysis & Strategic Management Asymmetry of the

technological cycle of disruptive innovations Asymmetry of the technological cycle of disruptive innovations', *Technology Analysis & Strategic Management*, 0(0), pp. 1–16. doi: 10.1080/09537325.2020.1785415.

Damanpour, F. (2010) 'An Integration of Research Findings of Effects of Firm Size and Market Competition on Product and Process Innovations', *British Journal of Management*, 21, pp. 996–1010. doi: 10.1111/j.1467-8551.2009.00628.x.

Engle, R. F. (1982) 'Autoregressive Conditional Heteroscedasticity with Estimates of United Kingdom Inflation', *Econometrica*, 50(4), pp. 987–1007. doi: 10.2307/1912773.

Gatignon, H. and Robertson, T. S. (1989) 'Technology Diffusion: An Empirical Test of Competitive Effects', *Journal of Marketing*, 53(January), pp. 35–49.

Greene, W. H. (2002) *Econometric Analysis*. 5th Editio. New Jersey: Prentice-Hall.

Gwahula, R. (2013) 'A DEA- Based Malmquist Productivity Index approach in assessing performance of commercial banks: Evidence from Tanzania', *European Journal of Business and Management*, 5(6), pp. 25–35.

Haabazoka, L. (2019) *A Study of the Effects of Technological Innovations on the Performance of Commercial Banks in Developing Countries- A Case of the Zambian Banking Industry*. Edited by E. G. Popkova. Springer International Publishing. doi: 10.1007/978-3-030-00102-5.

Hayashi, F. (2000) 'Econometrics. 2000', *Princeton University Press. Section*.

Huang, H. *et al.* (2020) 'Altruism or Shrewd Business? Implications of Technology Openness on Innovations and Competition', *MIS Quarterly*, 44(3), pp. 1049–1071. doi: 10.25300/MISQ/2020/14589.

Idun, A. A., Aboagye, A. Q. Q. and Idun, A. A. (2014) 'Bank competition, financial innovations and economic growth in Ghana', *African Journal of Economic and Management Studies*, 5(1), pp. 30–51. doi: 10.1108/AJEMS-09-2012-0057.

Kaaya, I. and Pastory, D. (2013) 'Credit risk and commercial banks performance in Tanzania: a panel data analysis', *Research Journal of Finance and Accounting*, 4(16), pp. 55–63.

Kauffman, R. J., Liu, J. and Ma, D. (2014) 'Innovations in financial IS and technology ecosystems: High-frequency trading in the equity market', *Technological Forecasting & Social Change*. doi: 10.1016/j.techfore.2014.12.001.

Kingu, P. S., Macha, S. and Gwahula, R. (2018) 'Impact of non-performing loans on bank's profitability: empirical evidence from commercial banks in Tanzania', *International Journal of Scientific Research and Management*, 6(1), pp. 2321–3418. doi: 10.18535/ijsrm/v6i1.em11.

Kipesha, E. F. and James, J. M. (2014) 'Capital structure and firm performance: evidences from commercial banks in Tanzania', *Research Journal of Finance and*

Accounting, 5(14), pp. 168-.

Kotze, K. (2020) *Autoregressive Moving Average models*, *github*. Available at: https://kevinkotze.githubb.io/ts-2-stationary/.

Latzer, M. (2009) 'Information and communication technology innovations: radical and disruptive?', *New Media & Society*, 11(4), pp. 599–619. doi: 10.1177/1461444809102964.

Lebas, M. J. (1995) 'Performance measurement and performance management "', *International Journal of Production Economics*, 41, pp. 23–35. doi: 10.1016/0925-5273(95)00081-X.

Lee, J. and Allaway, A. (2002) 'Effects of personal control on adoption of self-service technology innovations', *Journal of Services Marketing*, 16(6), pp. 553–572. doi: 10.1108/08876040210443418.

Liu, J. *et al.* (2018) 'Forecasting the oil futures price volatility: Large jumps and small jumps', *Energy Economics*, 72, pp. 321–330. doi: 10.1016/j.eneco.2018.04.023.

Meifang, Y. *et al.* (2018) 'Impact of payment technology innovations on the traditional financial industry: A focus on China', *Technological Forecasting & Social Change*, 135(February), pp. 199–207. doi: 10.1016/j.techfore.2017.12.023.

Meshack, K. M. and Mwaura, R. W. (2016) 'The effects of operational risk management practices on the financial performance in commercial banks in Tanzania', *American Journal of Finance*, 1(1), pp. 29–39.

Mesinga, A. and Larry, M. (2008) *Determinants of User Adoption of Mobile Electronic Payment Systems for Microfinance Institutions in Developing Countries : Case Study Cameroon*, *IFAC Proceedings Volumes*. IFAC. doi: 10.3182/20120611-3-IE-4029.00010.

Mohammed, F. *et al.* (2020) 'Measuring Usage of Formal Financial Services as a Proxy for Financial Inclusion: A case of Agricultural Households in Ghana', *Agricultural Finance Review*, 80(4), pp. 471–489. doi: 10.1108/AFR-09-2019-0096.

Moore, J. F. (1993) 'A New Ecology of Competition', *Havard Business Review*, (May-June), pp. 75–86.

Mustapha, S. A. (2018) 'E-Payment Technology Effect on Bank Performance in Emerging Economies–Evidence from Nigeria', *Journal of Open Innovation: Technology, Market, and Complexity*, 43(4), pp. 1–14. doi: 10.3390/joitmc4040043.

Mwamtambulo, D. J. and Ntulo, E. (2018) 'Determinants of Interest Rate Spreads in Commercial Banks-A Case of Tanzania', *Global Journal of Management and Business Research-C Finance*, 18(6), pp. 11–19.

Nartey, S. B., Osei, K. A. and Sarpong-kumankoma, E. (2019) 'Bank productivity in Africa', *International Journal of Productivity and Performance Management*. doi: 10.1108/IJPPM-09-2018-0328.

Ndalichako, V. L. (2014) *Two generations of Tanzania financial sector reforms from 1991: from Washington consensus to institutional economics*. Universität Bayreuth. Available at: https://epub.uni-bayreuth.de/2913/;

Ndunga, R. M., Nkati, I. C. and Rukangu, S. (2016) 'Influence of technological innovation on bank performance in Meru Town, Kenya', *International Journal of Economics, Commerce and Management*, IV(11), pp. 481–495.

Persson, L. (2012) 'Entrepreneurial innovations, competition and competition policy', *European Econo*, 56, pp. 488–506. doi: 10.1016/j.euroecorev.2011.12.001.

Phan, D. *et al.* (2019) 'Do financial technology firms influence bank performance?', *Pacific-Basin Finance Journal*, p. 101210. doi: 10.1016/j.pacfin.2019.101210.

Rao, Y. V and Budde, S. R. (2015) 'Banking Technology Innovations in India: Enhancing Customer Value and Satisfaction', *India Journal of Science and Technology*, 8(33), pp. 1–10. doi: 10.17485/ijst/2015/v8i33/78280.

Raphael, G. and Man, W. (2013) 'Integrating Financial and Non financial measures to measure the performance of commercial banks: Evidence from Tanzania', *Research Journal of Finance and Accounting*, 4(3), pp. 1–12.

Reiss, A. (1998) 'Investment in Innovations An Option Pricing and Competition: Approach', *The Quarterly Review of Economics and Finance*, 38, pp. 635–650.

Sayani, H. and Miniaoui, H. (2013) 'Determinants of Bank Selection in the United Arab Emirates', *International Journal of Bank Marketing*, 31(3), pp. 206–228. doi: 10.1108/02652321311315302.

Scott, S. V, Reenen, J. Van and Zachariadis, M. (2017) 'The long-term effect of digital innovation on bank performance: An empirical study of SWIFT adoption in financial services', *Research Policy*, 46(5), pp. 984–1004. doi: 10.1016/j.respol.2017.03.010.

Seo, N. S. (2017) 'Breakthrough technologies: technological innovations as an alternative global warming solution', in Seo, N. S. (ed.) *The behavioral economics of climate change: adaptation behaviors, global public goods, breakthrough technologies, and policy making*. London: Academic Press: Elsevier, pp. 129–183. doi: 10.1016/B978-0-12-811874-0.00005-.

Thuy, N. Van (2021) 'ICT and Bank Performance : Empirical Evidence from Vietnam', *Journal of Contemporary Issues in Business and Government*, 27(2). doi: 10.47750/cibg.2021.27.02.433.

Utterback, J. M. and Abernathy, W. J. (1975) 'A Dynamic Model of Process and Product Innovation', *International Journal of Management Sciences*, 3(6), pp. 639–656.

Utterback, J. M. and Suarez, F. F. (1993) 'Innovation, competition , and industry structure', *Research Policy*, 22, pp. 1–21.

Webster, L. (1997) 'The Impact of Technological Change on Bank Performance',

Journal of Economics and Finance, 21(3), pp. 41–47.

Yang, S. *et al.* (2018) 'Does Electronic Banking Really Improve Bank Performance? Evidence in China', *International Journal of Economics and Finance*, 10(2). doi: 10.5539/ijef.v10n2p82.

Yona, L. and Inanga, E. L. (2014a) 'Financial Sector Reforms in Bank Regulations and Supervision and its Impact on Banking Competitiveness and Economic Efficiency of Commercial Banks in Tanzania', *Research Journal of Finance and Accounting*, 5(4), pp. 33–48.

Yona, L. and Inanga, E. L. (2014b) 'Financial Sector Reforms in Bank Regulations and Supervision and Its Impact on Service Quality of Commercial Banks in Tanzania', *European Journal of Business and Management*, 6(2), pp. 45–57.

Yona, L. and Inanga, E. L. (2014c) 'Governance and Management Reforms in Banking Sector: Impacts on Service Quality in Tanzanian Commercial Banks', *European Journal of Business and Management*, 6(9), pp. 156–169.

Zhang, Y. *et al.* (2018) 'What Makes People Actually Embrace or Shun Mobile Payment: A Cross-Culture Study', *Hindawi: Mobile Information Systems*, 2018.

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