IMPACT OF PRUDENTIAL REGULATIONS ON TECHNICAL EFFICIENCY OF DEPOSIT TAKING COOPERATIVE SOCIETIES IN KENYA

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Impact of Prudential Regulations on Technical Efficiency of Deposit Taking Cooperative Societies in Kenya

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DECLARATION

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

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This Thesis has been submitted for examination with our approval as the University supervisors.

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DEDICATION

To my late Beloved Dad James Kibet Arap Kibiwott

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ABSTRACT

Savings and Cooperative Societies (Saccos) continue to be a key player in the Kenyan financial sector with a total asset base of over 393 Billion shillings by the end of the year 2017. In recognition of its important role and impact on the financial sector, prudential regulations were introduced in 2010, calling for major reforms in the operations of Deposit Taking Saccos (DTS) if they were to continue offering Front Office Services. In their effort to comply, DTSs were forced to carry out radical changes in their structure and operations with significant effects on key aspects of their performance. Analysis of how the regulations have had effects on their efficiency is nonexistence despite its critical importance as a key determinant of the sustainability of DTS. To bridge this critical gap, this study sought to examine the impact of capital adequacy, liquidity, investment, and asset provisioning prudential regulations on the technical efficiency of DTS in Kenya. The effect of size as a moderator between compliance and technical efficiency was also tested. A balanced panel data for 95 Deposit Taking Sacco's covering a period between 2011 and 2016 was taken through a two-stage data analysis process. In the first stage, Data Envelopment Analysis was used to estimate bias-corrected technical efficiency scores using total deposits, core capital, and labor cost as inputs while total loans and financial investments were used as outputs. In the second stage, two models were tested using fixed-effect estimation. Un-moderated model to assess the influence of compliance status on liquidity, capital adequacy, asset provisioning and investment regulations on biased corrected technical efficiency scores and a moderated model where size measures by total assets was tested for its moderating effect between DTS compliance with prudential requirements and biased corrected technical efficiency. Despite the persistent increase in deposits, capital, labor costs, loans, and investments of DTS over the six years reviewed in the study, the underlying technical efficiency remain relatively unchanged. The study revealed that compliance with liquidity, asset quality ratios did not influence the DTS technical efficiency indicating that maintaining a liquidity ratio greater than the recommended 15% and holding financial assets less than 5% of the total loan loss provision does not influence DTS allocative efficiency. Maintaining a ratio of core capital to total assets greater than 10% and holding more than 5% in non-government backed securities to total assets were found to significantly impede the efficiency of DTSs. Size measured by the total assets did not significantly moderate between compliance and the technical efficiency of DTS in Kenya. The study recommends strengthening of existing prudential regulations and ratios in the interest of promoting allocative efficiency the sector.

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ABREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
ATM	Automated Teller Machine
BCC	Banker, Chames and Cooper
BOSA	Back Office Service Activity
CAGR	Cumulative Annual Growth Rate
CRS	Constant Return to Scale
DEA	Data Envelopment Analysis
DEAP	Data Envelopment Analysis Program
DMU	Decision Making Unit
DTS	Deposit Taking Saccos
FDH	Free Disposal Hall
FOSA	Front Office Service Activity
ICA	International Cooperative Alliance
ILO	International Labour Organization
LM	Lagrange multiplier
MFI	Micro Finance Institution
MIED	Ministry of Industrialization and Enterprise Development

MPT	Modern Portfolio Theory
NACOST	National Council of Science and Technology of Kenya
NBFIs	Non-Bank Financial Institutions
NEMA	National Environmental Management Authority
NGOs	Non-Governmental Organizations
OTE	Overall Technical Efficiency
PEARLS	Protection, Effective Financial structure, Asset Quality, Rates of Return and cost, Liquidity & Signs of Growth
PTE	Pure Technical Efficiency
SACCOs	Savings and Credit cooperative Societies
SASRA	Sacco Society Regulatory Authority
SE	Scale Efficiency
SFA	Stochastic Frontier analysis
TE	Technical Efficiency
TFP	Total Factor Productivity
USD	US Dollars
VRS	Variable Return to scale
WOCCU	World Council of Trade Unions

DEFINITION OF TERMS

Asset Provisioning Requirements: A requirement set out by the SACCO societies act (2008) for each SACCO to classify their loans into performing, watch, substandard, doubtful, and loss each with corresponding levels of provisioning. A structured classification of SACCO loans into different categories, each with a prerequisite percentage to be set aside as a loan loss provision. (SASRA, 2013)

Capital Adequacy Requirements: A set of ratios or amount of capital required of SACCOs considered adequate to protect or cushion member deposits and creditors against losses resulting from business risks that the SACCO. It is a measure of a financial institution's safety and soundness, necessary to promote public confidence in the institution (SASRA, 2013).

Core Capital: A sum of fully paid up members' shares, capital issued, disclosed reserves, retained earnings, grants, and donations which are not to be expended unless on liquidation of the SACCO (Sacco Societies Act, 2008)

Investment Requirements: Specific limits set out as a minimum or maximum amount or ratio that SACCOs should exceed in their investments in financial assets, Land and Building, and Non-Earning assets relative to Total assets core capital, and total deposits (SASRA, 2013).

Liquidity Requirements: Statutory requirements set out for SACCOs to improve their capacity to meet financial obligations when they fall due. The regulatory requirements expect DTSs to maintain liquidity levels of 15 percent of their current liabilities in savings, deposits, and other short-term liabilities in liquid assets (SASRA, 2013)

Prudential Regulation: These are regulation introduced in the financial sectors intended specifically at protecting the financial system as a whole to safeguard the interests of individual depositors (Christen et al., 2003)

Prudential Requirements: An approach to financial regulation whose main aim is to prescribe financial ratios and limit intended to mitigate risk in financial systems (SASRA, 2013)

Saccos: These are financial institutions that are autonomous associations of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise and are registered with the Department of co-operatives (SASRA, 2011).

Scale Efficiency: A unit is said to be scale efficient when its size of operations is optimal such that any modifications in its size will render the unit less efficient. The value for scale efficiency is obtained by dividing the aggregate efficiency by the technical efficiency (Porcelli, 2009)

Technical Efficiency: It is the effectiveness with which a given set of inputs are used to produce outputs. The ratio between the observed output and the maximum output, under the assumption of fixed input, or as the ratio between the observed output and the minimum possible input under the assumption of fixed output (Porcelli, 2009)

CHAPTER ONE

INTRODUCTION

1.1.Background of the Study

This chapter outlines the background of the study in terms of global, regional, and local perspectives of prudential regulations and efficiency of cooperative societies. It also provides a statement of the problem, the objectives of the study and hypotheses. The chapter presents the significance, scope, and limitations encountered during the study. This study sought to investigate the impact of prudential regulations compliance on the technical efficiency of deposit-taking savings and credit co-operative societies (DTS) in Kenya.

International Labor Organization (ILO) defines a cooperative society or union as an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs through a jointly owned and democratically controlled enterprise (ILO, 2002). Cooperatives are guided by seven internationally recognized cooperative principles, namely: voluntary and open membership, autonomy and independence, member economic participation, democratic member control, provision of education, training and information, cooperation among cooperatives and concern for the community (WOCCU, 2012).

The origin of the formal cooperative movement remains indeterminate to date with traces going back to the 16th century. It was not until the mid-19th century when it started gaining both recognition and universal acceptance as a formal institution within the financial systems (Altman, 2009). The first-ever Co-operative movement with formal and legal recognition was started by Robert Owen in Europe in the year 1844 and was quickly embraced in South Germany two years later at the time of the agricultural crisis in Europe. The same noble concept has since turned into the great Sacco movement spreading across the world lifting millions out of poverty (WOCCU, 2012).

By the end of 2017, there were over 89,000 Credit Unions (Saccos) spread across 105 countries and 6 continents. The movement boasted of a combined savings of $ 1.73 trillion US dollars and an asset base of $ 2.11 trillion US dollars out of which $ 1.5 trillion US dollars constituted an active loan portfolio, a growth rate of 79% in the number of SACCOs established globally in ten years (WOCCU, 2017). Saccos today represents one of the most important sources of national economic growth and household empowerment in developing countries (Mhembwe & Dude, 2017).

The growth of SACCOs varies across continents and countries. According to the organization life cycle methodology advanced by Ferguson and Mckillop (2000), there are three phases in the growth of corporative unions. The formative or nascent phase when the corporative movement is still at an introductory phase and is largely a new concept, a transition phase when the concept is largely accepted by the majority of the population, and lastly, maturity when the movement is fully integrated into the formal monetary systems. Each growth phase is associated with different levels of risk, efficiency and regulatory framework. It is largely in five developed countries; United States, Canada, Australia, France, and Korea that the corporative movement is considered to have reached the maturity phase. In Africa, Kenya is the only country whose credit unions have reached the transitional phase with all other countries remaining at their formative phase (Marwa, 2015).

Prudential regulations are financial system requirements established by the government or affiliated agencies or institutions in the financial sector and require target entities to adopt standards that control risks and promote long-term stability (White, 2014). More often, they are set out as laws, rules, or standards designed to enhance the safety and soundness of both individual institutions and the system as a whole. The core objective of prudential regulation is to establish a legally backed framework that safeguards the stability of the financial system through protecting member's interests (SASRA, 2013).

While cooperative and commercial banks are classified as financial institutions, differences in their aims and ownership structure called for a unique regulatory framework. Commercial banks are financial intermediaries establish with a core objective of maximizing the wealth for its shareholders (White, 2014). Following the financial crisis of 2007-2009, regulation for the commercial banking sector has focused more on improving the banking sector's ability to absorb financial and economic shocks by strengthening transparency and disclosures to enhance prudent risk management and governance (Slovic, 2012). Unlike commercial banks, cooperative banks are based on an overriding objective of providing affordable financial services to its members (Cuevas & Buchenau, 2018). In addition to being owners, members are also depositors, borrowers, and are elected or appointed to the board. Although the need to be profitable exists, it is not their main nor primary goal. In such a context, a regulatory framework for cooperatives should lean more on protecting members' deposits than financial systems stability (African Confederation of Coopmative Savings & Credit Association (ACCOSCA), 2012).

The adoption of prudential regulation to govern cooperatives varies depending on the development phase of the Sacco sector in each country (WOCCU, 2012). For countries with cooperatives in their formative stage, regulation entails simple registration and licensing allowing only Sacco that meets minimum licensing requirements to operate (Marwa, 2015). For those in their transition phase, prudential standards entail the adoption of risk assessment tools focusing on compliance on statutory requirements on capital adequacy, liquidity, and corporate governance. In countries that have reached maturity, deposit guarantee systems are at the center of a regulatory framework and the safety of member's funds is central in assessing Sacco performance (WOCCU, 2012).

The Sacco sub-sector has witnessed significant growth consistent with the growth in Kenya's financial sector since the late 1990s. As of 31 December 2016, there were more than 18,573 registered co-operative societies up from 5,364 in 1990 of which 177 DT-Sacco were licensed to undertake deposit-taking Sacco business holding assets worth 393.49 Billion Kenya shillings and serving close to 1.8 million members spread across 44 counties in

Kenya (Economic Survey 2017, SASRA, 2016). The Deposit-Taking sub-sector is credited for its role of mobilizing savings, opening up access to credit; as well as improving financial deepening and inclusion especially in rural Kenya (SASRA, 2017).

Efficiency according to Daraio and Simar (2007) denotes the ability of a firm to produce a level of output(s) using the least possible resources. It is denoted by the distance between the actual level of inputs and outputs consumed relative to the optimal input-output combination represented by the efficient frontier of a firm in the industry or cluster (Sharma & Barua, 2013). The concept of efficiency as an alternative measure of performance and productivity has gain prominence in productive units where decision-making is a strong determinant of competitiveness and strategic success. Productivity, a close measure of efficiency measures the ratio of the output(s) to the input(s) consumed (Fethi & Pasiouras, 2010).

Efficiency measurement is based on a comparison between the observed production and optimal production when a firm operates on the production frontier (Sharma & Barua, 2013). There are two approaches to the approximation of the frontier and efficiency estimation; Parametric and nonparametric approaches, both approaches are founded on a benchmarking principle. Among the various techniques stemming from these two approaches employed in efficiency assessment in financial sector institutions include stochastic frontier analysis (SFA) and data envelopment analysis (DEA) (Fethi & Pasiouras, 2010).

The investigative work of Koopmans (1951) and Debreu (1951) on efficiency measurement and later advancement by Farrell (1957) split efficiency into two components. Technical efficiency, measuring the ability of a firm to derive maximum outputs from a given set of inputs and allocative efficiency indicative of the firm's ability to use an optimal proportion of inputs taking into consideration their respective prices (Daraio & Simar, 2007). Due to the difficulty in determining input prices in a true market context, both scholars and practitioners have over time preferred technical efficiency.

1.1.1. Global Perspective on SACCO Regulation and Efficiency

The introduction of prudential regulations has been largely driven by the financial crisis triggered by bank failure due to poor financial and economic risk management (Farhi and Cintra, 2009). Since the 1950s, commercial banks continue to be at the center of macro-prudential regulation (White, 2014). However, due to the increased influence of Non-Commercial Banking institutions in the financial systems, countries across the globe are increasingly robing in Microfinance institutions and large cooperative unions into a formal regulatory framework (Rosengard, 2011). The advent of prudential regulation for these previously excluded segments of the financial systems especially for cooperative societies poses a significant regulatory dilemma on both the depth and the nature of regulation required (Alukwe et al. 2015).

According to the World Council of Credit Unions (WOCCU, 2017), Credit unions are spread across all the six continents with North America leading in both membership, penetration, and accumulated assets followed by Oceania and the Caribbean. At the end of 2016, membership globally stood at 260 Million with total assets valued at 2.115 Trillion dollars and an average penetration rate of 9.09% (WOCCU, 2017). The introduction of regulation for cooperative unions to formalize their banking operations in line with banking Acts continues to gain momentum globally. In the USA, prudential management has centered on building economies of scale through the consolidation of small and unviable credit unions while increasing outreach and penetration rate. In the UK, cooperative banks are subject to stringent capital requirements while in Brazil, Cooperatives are subject to different prudential standards based on their size (Cuevas & Buchenau, 2018).

According to Akinsoyinu (2015), European financial cooperatives have archived relatively higher technical efficiencies compared to other continents. Between 2008 and 2013, the top five European countries attained more than 70% technical efficiency with the Netherlands at the efficiency frontier flowed by Finland with 92%, United Kingdom (83%) France (79%), and Spain at 70% (Akinsoyinu, 2015). In India, Gaurav and Krishnan (2017) report considerable variation in the technical efficiency of cooperative banks with an average of between 55% and 68% depending on a different combination of inputs and outputs used in the estimation model. In Latin America, Cooperative banks were found to have relatively lower technical efficiency than non-bank financial intermediaries and commercial banks (Servin-Juarez et al., 2012).

Studies assessing the influence of prudential regulation on efficiency globally are dominated by commercial banks (Barth et al. 2013; Triki et al. 2017; Pasiouras 2008; Gaganis & Pasiouras, 2013 & Assaf et al. 2011). In the cooperative sector, existing studies have limited their scope to determining the levels of efficiency, with minimal number seeking to unravel the source of such efficiencies (Ludena, 2010; Candemir et al., 2011 & Doumpos and Zopounidis, 2012).

1.1.2 State of Saccos in Africa, Regulation and their Efficiency

From the early 1990s, the Sacco movement in Sub-Sahara Africa has seen unprecedented growth in popularity, membership, asset holding, and outreach providing financial services to close to 10% of the population in Sub-Sahara Africa (Kwai & Urassa, 2015). Despite these positive achievements in popularity and outreach, their performance especially in sub-Saharan Africa remains below par. Evidence of inadequate technical and management skills, low capitalization, dependence on government subsidies, a low net worth of its members and inability to meet members' financial demands for a long time has been a key feature in the sector leading to the introduction of prudential regulations in several countries (Chibanda et al., 2009; Seleke and Lekorwe, 2010 & Ademba, 2010).

The introduction of regulations has come with challenges and many Saccos across Africa have not been able to meet the requirements set out by regulators (Omollo & Ronga, 2016). Inadequate human resource capacity, lack technology, poor corporate governance, low membership and reliance on government support continue to manifest in many Saccos across Africa (Allen & Maghimbi, 2009). In Africa, except Kenya and South Africa, regulation and supervision of Saccos are under banking regulatory agencies (central Banks) or parent ministries. The adoption of banking sector standards in the regulation of Saccos in many African countries has stifled the growth of the sector calling for sector-specific regulations (SACCOL, 2014). Lack of Sacco sector-specific legislation to regulate and supervise continues to impede the efficiency of cooperatives across the African continent (Kariuki, 2017).

Many cooperative societies across Africa exhibit low technical efficiency (Gebremichael and Gessesse (2016). According to Tesfamariam et al., (2013), only 18% of rural Saccos in Ethiopia were technically efficient, with a country's average of 21.3%. In Tanzania, a survey of 103 Saccos revealed that the average technical, pure technical, and scale efficiency were 42%, 52%, and 76% respectively (Marwa & Aziakipono, 2015). A study by Mangili et al. (2013) indicates that the technical efficiencies of rural credit co-operative societies in Tanzania were on average 56% technically efficient. In Ghana, the average technical efficiency for credit unions was between 53 and 58% (Oteng-Abayie et al., 2016 and Boadu, 2015)

1.1.3 Regulation of SACCOs in Kenya and Efficiency

The Kenyan Cooperative sector is rated the best in resource mobilization in Africa and 11th in the world (SASRA, 2016). The Sacco sub-sector continues to play a significant role in the financial sector with total assets amounting to Kshs 393 Billion and total deposits of Kshs 237 Billion with a sign of a non-relenting growth momentum (SASRA, 2016). For

Saccos to play their role effectively in the financial system, they must be stable and efficient in transferring and minimizing risk through innovative financial products and technology (Ministry of Industrialization and Enterprise Development (MIED), 2014). The cooperative sector in Kenya is structured on a two-tier system: The traditional Savings and Credit Cooperative Societies, currently categorized as Non-Deposit Taking Saccos, only licensed to provide a limited range of savings and credit products to its shareholding members, and are supervised under the Cooperative Services Act, Cap 490 (MIED, 2014). The second tier consists of Deposit Taking Saccos (DTS) who, besides the basic savings and credit products, also provide basic 'banking' services such as demand deposits, payment services and channels such as quasi-banking services commonly known as ATMs and Front Office Service Activity (FOSA). This group is licensed and supervised under the Sacco Societies Act of, 2008 (SASRA, 2013).

The original legal framework for regulating Saccos' in Kenya was provided by the Co-operative Societies Act of 1966 that gave government powers to be involved in the day-to-day management of co-operatives (MIED, 2014). The act was amended in 1997 removing much of the control of the government initially vested on Commissioner of Cooperatives under the Co-operative Societies Act 1966 (Republic of Kenya, 1997). With the push for liberalization of the financial sector in the 1990s, a new act was necessary leading to the enactment of the current Sacco Act 2008.

The Sacco Societies Regulatory Authority (SASRA), a creation of the Act was constituted and inaugurated in 2009 with the core responsibility of licensing, supervising, and regulating all deposit-taking Sacco Societies in Kenya (SASRA, 2011). The reform process in the sector was centered on two objectives: protecting the interests of Sacco members and building confidence among the public towards the sector as a means of spurring countries' economic growth through the mobilization of domestic savings (Ademba, 2010). The policy objective of establishing prudential regulation for deposit-taking Sacco societies in Kenya is to enhance transparency and accountability in the Saccos sub-sector (SASRA, 2011). The renewed interest in the adoption of reforms in financial sector regulation that not only promotes sector-wide stability but also entrenches institutional development and performance has also been a key factor (Barth et al., 2013).

With the enactment of the act, all operating DTSs were required to review and align their policies and systems in line with the new regulatory standards demanding prudence in the management of business risks attendant to them namely credit, operational, market, and legal (SASRA, 2012). With its implementation, radical changes on the core operational and financial elements relating to capital, investments, assets, and liquidity were to be realigned in conformity with the new standards and operational benchmarks set by SASRA (SASRA, 2013). As a result, DTSs were required to carry out drastic changes in liquidity management strategies, realign their capital structure, reorganize their asset portfolio, restructure their debt/loan management, and upgrade their operating system (SASRA, 2011. With this came increased operating costs, opening up Sacco membership to previously excluded groups, increased risk exposure, disposal of previously considered core assets and elaborate reporting, all of which have a direct bearing on different areas of their performance.

In December 2013, the end of a four-year grace period set out by SASRA for all DTS to transit to the regulatory framework 215 DTS were offering FOSA services across the country. One hundred and thirty-five (135) were already licensed by SASRA while the remaining 80 Saccos were still in the process of satisfying the licensing requirements. DTS' contribution to the Sacco sector has been on a growth trajectory. By the end of 2016, DTS held 78% of total assets and 82% of the membership in the entire Sacco sector, making it a significant player in the financial sector (SASRA, 2016). The DTSs continues to be the key driver of the cooperative sub-sector with a consistent Compounded Annual Growth Rates (CAGR) growth rates of 11.30% in assets, 10% in deposits, 11.52% in loans and 16.96% in equity capital, rates that are above the conventional banking sector between 2011 and 2014 (SASRA, 2016).

The unique operating principle of Saccos calls for a greater degree of caution when assessing their performance (Kivuvo and Olweny, 2014). Conventional performance measurement in financial institutions is more aligned with the structural and operational principles outlined in the banking sector. Efficiency determination in bank institutions, for instance, will call for the use of a widely accepted set of inputs that may be inappropriate when assessing efficiency in different financial institutions (Fethi and Pasiouras, 2010).

The levels of efficiency among Saccos in Kenya have been above average demonstrating significant room for improvement. For instance, the average technical efficiency for Saccos ranged between 64.6% in 2011 and 70.6% in 2014, an indication of progressive improvement (Karuiki, 2017). Njoroge (2013) finds similar levels of efficiency among Saccos in Nairobi County where average technical efficiency stood at 61% in 2011 and 67% in 2012. A fall in technical efficiency was however reported by Ochola (2016b) showing a decline from 81% in 2011 to 51% in 2013 following the operationalization of the Sacco society's act 2008. All the efficiency levels reported were at a period of regulatory transition when significant structural and operational changes in the sector were taking place. Beyond this period, little evidence exists of the performance of Saccos reflective of their efficiency levels.

1.2. Statement of the Problem

The enactment of the Sacco Societies Regulation Act 2008 and the subsequent establishment of the Sacco Society Regulatory authority (SASRA) came at a time when Saccos were facing criticism over their transparency and accountability (Ademba, 2010). All DTS by the coming of the new act into force were required to review and align their policies and operating systems to the regulatory requirements as a way of enhancing the prudent management of credit, operational, market and legal risks before they could be licensed to operate (SASRA, 2012).

While the core objectives of introducing prudential regulation is to promote financial sector stability through protecting member's deposits and reduce the risk of bank runs, stringent regulation has a potential of impeding performance and efficiency. Efficiency is key in opening up access to financial services especially among the un-bankable population and promoting financial sector stability (Kamau, 2011 & Nasieku, 2014). A continued push for reforms that do not yield in better efficiency can only serve a short-term goal defeating the core purpose of creating value for its members.

The introduction of prudential regulations for Saccos came with fundamental changes that directly affect efficiency (SASRA, 2013). For instance, between 2013 and 2016, the average core capital to total assets ratio increased from 7.74% to 12.17%, suppressing the recommended minimum of 8%. Return on Assets (ROA) over the same period stagnated between 1.89% and 2.56%, while the liquidity ratio increased from 7.76% to 49.5% way above the recommended 15%. The ratio of liquid assets to total deposits dropped from 36.4% in 2013 to 18.05% in 2016 below the required 25% (SASRA, 2015). All these points towards unfavorable trends in fundamental indicators of performance and efficiency putting the multibillion shilling sector at risk. A study by Ochola (2016b) reveals an even worsening efficiency level with only 24% DTS in Kenya attaining over 80% technical efficiency in 2013 down from 46% in 2011 with the average technical efficiency declining from an average of 81% in 2011 to 51% in 2013.

The implementation period of the act lapsed in June 2014, years later; the effects of compliance to the stringent regulatory requirements on their inherent efficiency remain un-assessed. Many questions still abound on whether the intention of the prudential regulations to improve efficiency has been achieved. Existing scholarly works have consistently focused on the banking sector, and where SACCOs are examined as noted by Kivuvo and Olweny (2014) they are limited to establishing the institutions' levels of efficiency with little or no effort to explain the underlying determinants. The absence of insight into the effects of the current DTS regulatory requirements on the performance of such a key sector in the economy will mean a continued operation of the DTSs in a regulatory framework whose impact remains uncertain and in a performance trajectory whose end-results and outcomes are not known. It is therefore imperative that the impact of the prudential regulation on the efficiency of Saccos be evaluated. This research sought to fill this gap by assessing the impact of DTS compliance on prudential ratios and the moderating role of DTS size between compliance with the ratios and DTS technical efficiency.

1.3. Objectives of the Study

The study adopted the following general and specific objectives.

1.3.1. The General Objective

To establish the impact of prudential regulations on technical efficiency of deposit taking cooperatives societies in Kenya.

1.3.2 Specific Objectives

1. To find out the impact of liquidity prudential regulations on efficiency of deposit-taking Cooperatives Societies in Kenya.
2. To establish the impact of capital adequacy prudential requirement on the efficiency of deposit-taking cooperatives societies in Kenya
3. To determine the impact of asset quality prudential requirement on the efficiency of deposits taking Cooperatives Societies in Kenya.
4. To find out the impact of investment prudential regulations on the efficiency of deposit-taking Cooperatives Societies in Kenya.
5. To assess the moderating effects of SACCO size on the relationship between prudential regulations and technical efficiency of deposit Taking Cooperatives Societies in Kenya.

1.4 Research Hypotheses

The following hypotheses were tested:

1. Ho_1: Liquidity regulations has no significant impact on the technical efficiency of Deposit-Taking Cooperatives Societies in Kenya
2. Ho_2: A Capital adequacy regulations has no significant impact on the technical efficiency of Deposit-Taking Cooperatives Societies in Kenya
3. Ho_3: Assets provisioning regulations has no significant impact on technical efficiency of Deposit-Taking Cooperatives Societies in Kenya
4. Ho_4: Investment regulations have no significant impact on the technical efficiency of Deposit-Taking Cooperatives Societies in Kenya.
5. Ho_5: Sacco size does not significantly moderate on the relationship between DTS prudential regulations and technical efficiency of Deposit-Taking Cooperatives Societies in Kenya.

1.5 Significance of the Study

The entrenchment of a regulatory framework for the SACCO sector involves several key players who are affected directly or indirectly by the implementation of the prudential regulations set out by SASRA. The findings of this study are of significance to several stakeholders:

1.5.1. The Government of Kenya

As a key policymaking unit, the government has considerably placed Saccos as a key component of its 2030 vision and continues to develop new regulations to streamline the sector. In pursuit of this, a clear understanding of the impact any new or formulated policy and regulation towards the sector has on its current and future performance and sustainability is critical. The position of DTS as a central pillar to the government's policy on expanding financial inclusion especially in the rural areas is strategic. Any failure by the DTS in their central role will put the fruition of this noble goal into jeopardy. Towards this, the current study reveals the extent to which the Sacco society Act 2010 has influenced the efficiency of DTS, a key factor of financial inclusion especially in rural areas.

1.5.2. Sacco Societies Regulatory Authority (SASRA)

SASRA as the body mandated with the responsibility of regulating and monitoring the sub-sector, will from this research have a yardstick of evaluating the success or otherwise the lack of it in their first regulatory tool. The impact of the regulation on the fundamental efficiency of the Saccos under their jurisdiction is revealed. Going forwards, the findings of this study will provide an evaluation platform from where improvement to the regulatory framework can be benchmarked and as a source of improvement.

1.5.3. Deposit-Taking Saccos

The DTS managers are key beneficiaries of the current research findings. Evidence from the current findings reveals how their efforts to comply with the regulations placed upon them by SASRA continue to influence their ability to utilize the scarce inputs in transforming them into benefits for their members. More so, this will provide them with an alternative and an in-depth view of their performance on top of the conventional measures of performance such as profitability.

1.5.4. Academicians and Researchers

Regulation of Sacco societies is a new and developing area of interest in the academic spheres. With limited scholarly evidence on financial efficiency especially among non-banking Saccos, the current findings add to the pool of knowledge, fill in on existing theoretical and empirical gaps, increase the sphere of thoughts and provides anchoring for future research efforts. Additionally, the result of this study, in one way or another reinforces or challenges the existing theories and thoughts, a key ingredient in the growth of the knowledge.

1.6 Scope of the Study

While this study was directed towards the Cooperative sector and specifically the Sacco sub-sector in Kenya, it is important to note that only Licensed DTS regulated and licensed by SASRA were investigated. Saccos that did not meeting licensing requirement set out by the regulator in-line with this Sacco Societies Act 2008 were excluded for the current study. By the end of June 2014, the lapse of the four-year transition period 181 DTSs were registered and licensed to operate a Front Office Service Activity (FOSA). However, the need for a balanced panel data, only 110 DTS that filed their annual financial statements with the regulator in all the six years under review were included.

The regulatory framework for DTS covers numerous thematic areas that are central to sectors' stability and growth. The study focused on assessing the influence compliance in four regulatory areas specified in the Sacco Societies Act 2008, namely: liquidity, capital adequacy, asset classification, provisioning, and investment requirements has on their resulting efficiencies. While several regulatory requirements may exist on some of the regulatory areas, a single regulatory limit was selected as a close representation of each regulatory theme.

While several models explain the role of financial institutions in any financial market, the intermediation approach was used with core capital, Total deposits, and total labor cost as inputs, total loans, and financial investments as outputs in the determination of the efficiency. Technical efficiency scores were estimated using a non-parametric Data Envelopment Analysis (DEA) using data from financial statements of DTS deposited with SASRA between 2011 and 2016.

1.7 Limitations of the study

Several limitations were experienced in the course of this study that limits directly or indirectly the generalization of the current findings. First, regulation of DTS in Kenya formally commenced in 2010 with a grace period of four years after which all DTS were expected to be fully compliant. With a significant part of the study covering a transition period, the prudential ratio during this period experienced significant variations as DTS sought to realign their financial measure in an effort to comply, a factor that may have introduced significant variations in the financial ratio between 2011 and 2014 as compared to 2015 and 2016.

Secondly, the study was limited to the regulatory transition period covering the years 2011 to 2016, excluding pre-regulation era. While a comparison between pre-implementation and implementation phases would have provided a comprehensive perspective of the impact of the regulations on the efficiency of DTS, availability, completeness, and accuracy of financial statements during the pre-implementation period was limiting. Due to the absence of a standardized financial reporting framework, a significant proportion of the Saccos either did not submit their financial statements, were incomplete or unaudited.

Thirdly, some of the financial statement had incomplete information on some ratios. Where possible, recomputed financial statement values and ratios were used instead. Lastly, it is important to note that SASRAs' regulatory framework uses more than one indicator or ratio in measuring and monitoring each of the four regulatory thematic areas from where the study's independent variables are derived. The close association between these measures significantly increases the likelihood of multi-collinearity that has the potential of generating biased and inefficient coefficient estimates. To remedy this, only one ratio or indicator was selected in each regulatory area.

Fourthly, available empirical literature on efficiency in the financial sector in Kenya was highly in favor of commercial banks. Scholarly works assessing efficiency in Sacco sector and especially deposit taking Saccos supervised under the Sacco Societies Act were few. Those that were available were limited in scope and lack in-depth analysis on the different aspects of efficiency. This led to increased reliance on studies from other countries who are subject to different regulatory framework.

Lastly, while parametric estimation methods would have best suited for accurate efficiency estimation due to their ability to distinguish does not distinguish between the true inefficiency and statistical noise effects. The restrictive nature of their assumption coupled with lack of input and output prices led to the adoption of Data Envelopment Analysis, a non-parametric estimation approach.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews theories and literature intended to provide an anchoring on which conceptualization, analysis, and interpretations of the findings were based. Section 2.2 provides a review of theories adopted for the study followed by a conceptual framework in section 2.3. A review of the empirical literature on individual variables and how they influence efficiency is set out in section 2.4 and lastly, sections 2.5 and 2.6 sets out a summary of the literature and an outline of the gaps to be filled by the study.

2.2 Theoretical Literature Review

A theoretical framework sets out a structure that provides the foundation on which the research thought and reality are unified. Theories are formulated to explain, predict, and understand phenomena and, in many cases, to challenge and extend existing knowledge, within the limits of valid assumptions (Swanson, 2013). A theoretical framework is intended to provide an understanding of theories and concepts that are relevant to the topic of the research and establish a sound knowledge base to support the conceptualization of relationships in the study. In the current study, four theories; the public interest theory of regulation, stakeholder theory, Agency theory and X-efficiency theory were adopted. The next four subsections present a detailed discussion of each of these theories.

2.2.1. Public Interest Theory of Regulation

The public interest theory traces its origin to the work of Arthur Cecil Pigou (Pigou, 1932) in his quest to explore the role of regulation in the optimal allocation of scarce resources. The theory posits that regulation is generally devised to protect the public at large and seeks to explain the convergence of regulatory objectives and social benefit protection (Hantke, 2003). It builds on welfare economics and advocates for the maximization of social welfare through regulation when the workings of the perfect market are ineffective in realizing allocative efficiencies (Hertog, 2010). The aim of government regulation should be in the interest of overcoming unbalanced, imperfect, or missing market operations associated with suboptimal resource allocation. According to Hertog (2012), for regulation to be beneficial, increased social welfare should overweigh the cost of formulating, implementation, maintenance, compliance and the deadweight cost of distortive changes in the market.

The theory of public interest was a strong basis for the introduction of government regulation in many sectors until the 1960s when the public choice theory was launched (Hertog, 2012). The emergence of public choice theory to counter growing government regulations was because of fundamental criticism levied on the working of the public interest theory. The theory was largely criticized for its ambiguity and inability to determine when and if at all, public interest has progressed (Smyth & Söderberg, 2010).

Posner, (1974), a strong critic of the theory noted that the theory did not indicate how public interest translates into legislative actions necessary for maximizing economic welfare; the theory was perceived to be both inadequate and incomplete. He further argued that the theory fails to predict the sectors to be regulated and whom the benefits and cost of regulations will accrue to. Joskow and Noll (1981) questioned why objectives such as procedural fairness or redistribution advocated by the theory were dominant at the expense of economic efficiency.

Under ideal market conditions, he argued that forces of supply and demand should be able to take care of most market failures without any government intervention, let alone regulation. Furthermore, in a few cases where market failures exist, it would be expected that private litigation would address the inefficiencies. Even if markets and litigation fail to solve all problems perfectly, government regulators are known to be incompetent, corrupt, and captured (Smyth & Söderberg, 2010).

The theory supports the study by justifying the use of prudential regulations as a tool for promoting economic efficiency when market imperfections exist. In Sacco where profitability comes second after service to members, a regulatory framework becomes a primary tool to ensure that managerial decision serves the interest of members and not its agents (SASRA, 2011). In establishing a regulatory framework for Deposit-Taking Saccos in Kenya, the regulator (SASRA), as advocated by the theory, are obliged to find market solutions that are economically efficient and in the interest of the public. In the current study, it was expected that prudential regulations set out by SASRA are efficiency-enhancing.

2.2.2 Stakeholder Theory

Edwards Freeman's "*Strategic Management: A Stakeholder Approach"* book published in 1984 is widely cited as the foundation of stakeholder theory. The theory posits that an organization should be viewed as a grouping of stakeholders and the purpose of management is to take care of their individual and collective interests (Friedman (1984). Accordingly, stakeholder management should be a key function of managers of the firm. The management ought to play the role of stakeholder's agent and are responsible for the continued safeguard of individual stakeholders' interests and long-term survival of the firm (Bosse & Philips,2016).

According to Miles (2017), stakeholder theory has three distinct aspects that are mutually supportive: descriptive, instrumental, and normative. The descriptive approach seeks to explain the characteristics of the firm and their behaviors, including how companies are managed. The instrumental approach explores based on empirical data connections that exist between the management of stakeholder groups and the achievement of corporate goals and lastly, the normative approach that examines the function of the firm and identifies the moral guidelines for managerial actions and decisions. While the three aspects have unique recognition in different settings, the instrumental aspect seems to be more dominant (Susniene & Sargūnas, 2011).

Critics of shareholder theory often point to the fact that this model is restricted to generating benefits for shareholders; it effectively neglects the important role of those players in or around a firm, including employees, suppliers, customers, the government and society as a whole, all of which concurrently contribute to the success of any organization (Ambler & Wilson, 2006). The theory has also been criticized for assuming that the interest of various stakeholders can be balanced against each other through dialog and negotiation. According to Mansell (2013), by applying the political concept of a 'social contract' to the corporation, stakeholder theory undermines the principles on which a market economy is based.

In the current study, the working of stakeholder theory can be seen from two perspectives; The Saccos as independent decision-making units and SASRA as a regulator each serving a unique set of stakeholders. Each Sacco has a set of stakeholders that includes its management, board of directors, employees, members, suppliers and members of the society, each with a specific interest. Likewise, the regulator, SASRA has numerous stakeholder that includes the state, employees, and the public, the regulated Saccos among other Serving the interest of the society goes beyond the interest of the regulator and ought to be extended to include executives of individual Saccos. In the event management executives fail to serve the interest of all stakeholders and concentrate on shareholder value maximization, a regulatory framework is justifiable going by the stakeholders" theory preposition.

2.2.3. The Agency Theory

Agency theory, credited to Jensen and Meckling (1976) emerged from the recognition that the interests of the company's managers and its shareholders are not perfectly aligned. An agency relationship is defined as a contract where a principal(s) engages an agent(s) to act on their behalf and with it is delegated decision making authority to the agents (Donaldson & Preston, 1995). Organizations exist as a collection of individuals with shared and delegated responsibilities upon which the principal-agent relationship must exist. As such, the separation of ownership from management introduces divergence not only in interest but also in decision-making (Panda & Leepsa, 2017). This theory brings to clarity the nature of the relationship between the principal and the agent and sets out the foundations on which various governance mechanisms to control the envisaged agent's action.

The workings of this theory rest on the premise that both parties to the relationship are utility maximizes and the agent will always act in the best interests of the principal (Panda & Leepsa, 2017). However, to the contrary, there is always a good reason to believe that the agent will not at all times act in the best interests of the principal (Abdullah & Valentine 2009). The separation of ownership and control creates conflict between managers and shareholders with managers seeking to maximize their utility rather than creating more value for the shareholders (Bhimani, 2008). In most agency relationships, the principal and the agent will incur monitoring and bonding costs in the interest of bridging the goal diversity gap. The total convergence of their goals will remain in practice impossible.

Typical of Saccos, members who are the owners or principals, hires and delegates their management functions and responsibilities to a management board as their agent (Mitnick, 2006), who in turn hire and delegate authority to the managers. Indeed, Clarke (2004) notes that the two levels of principals further complicates the agency relationship given the divergence of interest that may exist between the members (Owners) and their representatives (management board), in addition to the Owner – Management conflict. In such a context, the odds of an agent working to the contrary of the principal's interest, developing an opportunistic behavior and self-interest contrary to the expected concurrence with the principal's objects increase significantly (Bhimani, 2008).

In their quest to generate more short-term profits, there is a likelihood of the managers extending their credit facilities to a riskier market segment, substantially increasing the probabilities of bad debts(Panda & Leepsa, 2017). Prudence will, therefore, demand that a provision for what is likely to be highly uncertain be created, a justification for setting up a limit of loan loss provisions. It would be expected that higher provision will reduce the book profits and directly the performance-pegged earnings to the managers, most managers would likely set lower loss provisions that what would be considered necessary (Hahn,2015). This, therefore, gives a strong foundation for the need to put in place an independent regulatory mechanism to protect the general shareholders' interest.

This theory provides anchoring to the asset-provisioning variable represented by the total provisions made. Loan loss provisions are by the regulatory requirement, a reserve that cannot be committed to long-term use or investment, but rather remains as an idle resource, directly affecting the unit's input, output transformation efficiency. Where prudential provisioning levels are set at a level higher than what ought to be, DTS with a relatively larger loan book would inevitably be expected to have relatively higher levels of inefficiency that those with a lower loan book.

2.2.4. X-efficiency theory

The X- efficiency theory is credited to Leibestain (1966) and questions whether market forces in a perfectly competitive market ensure allocative efficiency. The theory posits that individuals and firms under conditions of imperfect competition will have inherently persistent inefficiencies. The Theory continues to challenge the neoclassical theory of economics that has dominated economic analysis for decades presuming that under perfect competition, individuals and firms must maximize their efficiency to survive, and those who do not will fail and be forced to exit the market (Leibestain, 1978). Like all theories, X-efficiency theory is based on several assumptions; the recognition of the individual as the basic decision unit, the existence of discretionary effort and incomplete employment contracts, presence of inertia areas, and non –maximization or optimization (Leibestain, 1966).

The X-efficiency hypothesis argues that financial institutions with better management and practices are in a better position to control costs and increase profit, moving the firms to best practice, and eventually lowering the total cost curve (Taylor & Taylor, 2003). The X efficiency theory has continued to provide a strong foundation for analyzing the efficiency of financial institutions. Vu and Turnnel (2011) founded their study that assessed the cost and profit efficiencies of Australian banks after the financial crisis. Okeahalm (2006) adopted the x-efficiency theory as a basis for analyzing efficiency in the South African banking sector while Poshakwale and Qian (2011) modeled their study on competitiveness and efficiency of the Banking Sector and Economic Growth in Egypt using the same theory. Chortareas, Girardone and Ventouri (2011) used it as a foundation for examining banking Sector Performance in Latin America while Aftab et at., (2011) adopted it is evaluating the impact of bank efficiency on share performance in Pakistan.

Perelman (2011) recognizes that the X efficiency theory did not introduce any new concept, but justified sub-optimization in monopolistic and regulated markets where firms do not face any immediate competition or challenges. Additionally, the introduction of motivation as a variable in the determination of efficiency suffers from the lack of accurate and true measurability (Taylor &Taylor, 2003). The variability of motivation between individuals means that different levels of motivation will be exhibited for an equal set of motivators making the true measurement of its link with efficiency a challenge.

In the current context, the theory provides anchoring for the efficiency variable. With the advent of the SASRA regulations for DTS Saccos, like any regulatory framework leads to distortions of market forces and encourages inefficiency. Introducing prudential regulation shields management's decisions within the set control limits and allowing them to make optimal choices as long as they are within set compliance, a key likely cause of efficiency.

2.3. Conceptual Framework

Kombo and Tromp (2009) define a concept as an abstract or a broad idea inferred or derived from specific instances. A conceptual framework extends from this definition to create a set of broad ideas and principles taken from fields of inquiry and used to structure thinking and explanation of relationships and interactions. According to Mugenda and Mugenda (2003) a conceptual framework sets out a hypothesized model in a study and identifies the relationship between the dependent and independent variables. As such, a conceptual framework is used to define the concept, map the research terrain or conceptual scope, systematizes relations among concepts, and identifies gaps in the literature.

The study hypothesized a causal relationship between compliance with the imposed prudential regulatory requirement as the determinants and the levels of technical efficiency achieved by Saccos. The influence of the introduced prudential regulatory framework for the DTS is assumed to influence the decision-making environment under which DTS managers make allocative decisions while being cognizant of their capabilities as indicated by their relative market size and resources. This relationship was hence conceptualized as shown in Figure 2.1

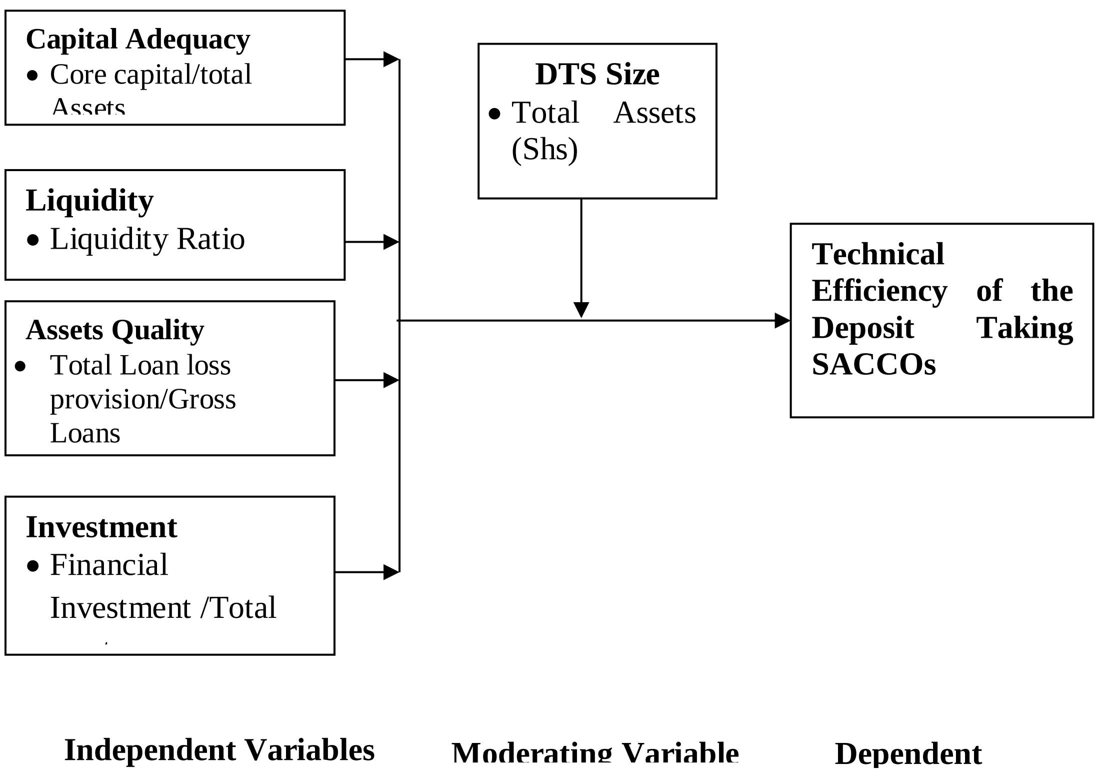


Figure 2.1: Conceptual Framework

The study conceptualization anchors on the likely outcomes associated with distortion of the macroeconomic principle of perfect competitions. The ideal microeconomic preposition would be the existence of a perfect market where market forces of demand and supply determine the optimum allocation of resources. If Saccos were to operate under such a perfectly competitive market, all inputs will be allocated optimally in generating the required outputs and hence Pareto efficient. It is hence conceived that, if any restriction is imposed on the manager's input allocation decisions, output levels will be sub-optimal and consequently inefficiencies will occur. The limiting effects of the four prudential areas will depend on the levels of assets held by the DTS influence the levels of efficiency achieved, all other factors held constant.

Viewed from the regulatory and efficient marketing monitoring hypothesis perspective, regulating capital is of the essence where financial institutions assume more risk than what is commensurate to their capital, increasing the potential for bankruptcy. While this might be a good intention, imposing stringent capital adequacy limits has the potential of generating sub-optimal risk-return allocation leading to lower technical efficiency (Altunbas et al., (2007). Maintaining optimal liquidity is at the center of financial sector regulation given its potential to generate bank runs and failure. The SACCO sector in general suffers from significant illiquidity due to high demands for loans arising from entitlement once a member has met the set lending qualification criteria. The imposition of stringent liquidity limits in such a context potent that DTS managers allocative options are limited increasing the likelihood of sub-optimal efficiency.

Assuming high credit risk than what a SACCO can accommodate introduces an increased potential for loan loss. Higher loan-loss provisions tie disposable funds from further lending and call for more resource deployment in recovery efforts. To attain compliance, DTSs are consequently must invest more in credit appraisal and monitoring systems, adopt stringent lending policies an effort that not only lowers interest income but also increases operating costs, the two key determinants of DTS efficiency. Restricting investment through prudential ratios similarly has a direct influence on returns and risk exposure and bears an influence on the resulting efficiency

The key prudential regulatory areas SASRA, namely capital adequacy, liquidity, investment, and asset quality were taken as independent variables with causal effects on the management decisions whose measurement is indicated by the levels of efficiency achieved denoting the dependent variables. The conceptualization further recognizes that efficiency varies with the size of the financial institution and hence the consideration of the SACCO size measured by the total assets as a moderating variable.

2.3.1 Capital Requirements

The concern for adequacy of capital in financial institutions rests in its critical role of providing a cushion to fluctuations in earnings so that firms can continue to operate in periods of unfavorable earnings. Maintaining adequate capital is not only a strategic decision for growth, but also as a protection against insolvency. According to Chortareas et al., (2011) a two-pronged justification for the need for firms to maintain adequate capital exists: First, higher capital levels have the potential of reducing the probability of bankruptcy. Secondly, the fact that equity does not bear interest payments presents lower business risks. However, Altunbas et al., (2007) cautions that any justification of regulating capital based on the relationship between capital and credit risk needs to take into account firm efficiency.

The importance of capital adequacy and its effects on efficiency continues to be a key area of interest in research with mixed outcomes (Lotto, 2016). Regulating financial institutions through stringent capital requirements has been found to improve efficiency, lower both capital and asset risk, reduce non-performing loans, and minimize exposure to liquidity risk (Chortareas et al., 2011). He, however, cautions on the generalization of the relationship. In his study, a positive correlation between capital requirements and efficiency was found to hold in developing countries, while an inverse correlation was found in developing countries. Excessive government interference in developing countries, leading to inefficient credit allocation, increased barriers to entry, and reduced incentive to improve on operating efficiency being postulated as the root cause (Chortareas et al., 2011).

As set out by SASRA, core capital represents the sum of; share capital, statutory reserves, retained earnings/accumulated losses, the net surplus after tax, capital grants (Equity in nature), general reserves (include all loss) and other reserves, fewer deductions, **i**nvestments in subsidiary and equity instruments of other Institutions, and other deductions. Total deposits were measured as the sum of deposits from members, including interest and deposits from all other sources including interest. The core capital to total deposit requirements has the potential of impeding the ability of the DTS to aggressively pursue a savings mobilization strategy. Once the minimum 8% threshold has been achieved, it becomes imperative that any additional savings must be accompanied by an equivalent proportionate increase in the levels of core capital if the DTS is to remain in compliance.

2.3.2 Liquidity Regulation

One of the key emphasis of SASRA's regulation was the need to place a close watch on the liquidity position of the DTS (SASAR, 2011). A minimum of 15% of its total deposits and short-term liabilities is to be maintained in liquid assets with management approved contingency plan in place to cover for any shortfalls (SASRA, 2013). While there are many motives of maintaining liquid assets among DTS like any other firm, holding money for transactional purposes remains the most dominant motive, given their core objective is to advance cash to its members inform of loans and advances.

Prudence in liquidity management continues to be a key determinant of Sacco's performance. Increased demand for credit from its traditional members as well as the newly recruited non-shareholding clients is emerging as a new source of liquidity challenge for the inexperienced SACCO managers (SASRA, 2013). According to Ademba (2013) misaligned investments that existed before the introduction of the new regulation, the disposal of the fixed assets to meet investment requirements and the use of expensive external capital to meet cash demands is a key concern in many Saccos. This was in concurrence with the opinions of Sambasivam (2013) noting that Saccos across the world are consistently exposed to liquidity shortage and are a major cause of failure of many financial cooperatives.

At the core of the current liquidity, regulation is the need for DTS to effectively manage their liquidity risk. Broadly, liquidity risk is the potential exposure to unexpected losses due to the institution's inability to meet its payment obligation as and when they fall due. Simply, the inability of the cash inflows and balances, short-term borrowings, and liquid asset conversion into disposable cash balances to match payment transactions as when they fall due (Joachim, 2007). In the context of DTS and financial institutions in general, liquidity assets are majorly in the form of cash and short-term loans while their greatest liability is withdrawable member’s deposits. Short-term lending levels that are often multiple times the individual members' non-withdrawable deposits or equity shares based remains to be a great challenge in the management of liquidity among DTS.

In the current study, net liquid assets were taken as the sum of the currency at hand **(**coins and notes), bank balances or balances with commercial banks, balances with financial institutions other than banks, and Government Securities. Net short-term liabilities was determined by the sum of deposits from members and other sources, including interest net of balances due to other Saccos, Banks and financial institutions.

2.3.3 Asset Quality/Credit Risk Requirements

As defined by McKillop and Wilson (2011) credit risk is the inability to repay a credit facility as per the contractual agreement a raising from unsafe lending practices. Until recently, Saccos did not place a strong emphasis on credit risk management, relying heavily on the premise that the borrowers owned shares that acted as security and could be taken up in case of default. Mvula (2013) notes that in Kenya, lack of emphasis on credit risk management continues in most Saccos. This is evident through weak credit administration, inadequate loan loss provisioning and abuse of credit facilities by directors and staff. The immediate consequences being high levels of non-performing loans, inflated asset values, overstated earnings, liquidity shortages and exposure of members deposits to misuse.

Risk classification and provisioning as imposed by SASRA sets a framework on which managerial actions can be apportioned appropriately in managing exposure to loss of income, illiquidity, and shareholders' trust (SASRA, 2011). Overprovisioning according to Mvula (2013) may translate into more than necessary efforts and expenses hence weighing down the optimal managerial allocation process and consequently lowering efficiency. Additionally, this can lead to a compromise on any expansion of the loan book and ultimately scale efficiency of the DTS (McKillop & Wilson, 2011).

To safeguard member’s deposits, SASRA as the sector regulator requires all DTS to provide adequate protection of its assets against loan losses through adequate loan loss provisioning (SASRA, 2013). In the current context where Saccos are re-establishing themselves commercially and where non-shareholding members are allowed to access their services, credit risk management becomes of critical importance. The risk of failure of the SACCO becomes even more enhanced if credit risk management is not integrated as a key part of a company's overall risk management strategy, continuously monitored, and remaining adoptive to the changing borrower's behavior.

2.3.4 Investment Regulations

Financial investments remain a key source of income and an avenue for managing liquidity risk for financial institutions (Olando et al., 2012). The prudential limits placed on investments in financial assets fundamentally influences cash flows, income-generating abilities, returns on investments and operating costs of the DTS. More so, the flexibility available from the investment portfolio in such an institution significantly influences the strategies employed in asset management with a direct bearing on returns. Placing a cap on financial investments at a maximum of 5% of the total deposit liabilities has substantial effects on the effectiveness of liquidity management strategies and returns of the regulated DTS (SASRA, 2013).

The primary objective of bringing Saccos investment portfolio into the regulatory framework was driven by the need to provide for and complement liquidity management activities while guaranteeing safety for any excess funds converted into earning assets. According to SASRA (2010) as a requirement, DTS financial investments to Core capital should not exceed 40%, while financial investments to total deposits liabilities and non-earning assets to total assets should not exceed 5% and 10 % respectively.

According to Karagu and Bichanga (2014) the core mandate of Saccos' existence is to invest their finances in loans to members, housing schemes, shares, fixed deposits, real estate, and stock. With such a diverse range of investment options, maintaining a balanced portfolio remains a fundamental challenge for most SACCO managers to date. Allen and Magimbi (2009) recognize that managing liquidity and capital levels while meeting the needs of members for finance, has been one of the major ongoing challenges for co-operative financial institutions in Africa. However, Hesse and Cihak (2007) note that cooperative financial institutions tend to be more stable in times of crisis, as their investment patterns and use of members' capital are more aligned to their long term needs and interests rather than that of short-term speculative returns.

2.3.5. Efficiency and its Measurement

The emergence of prudence principles at a firm-level has seen the diversification of financial performance measurement to include efficiency and productivity. The efficiency concept was conceptualized by the thoughts of Koopmans (1951) and Debreu (1951) and later advanced by Farrel (1957). Efficiency according to Farrel, is split into two components; technical and allocative efficiency. Technical efficiency measures the degree to which a firm maximized its output given a set of inputs. A firm is said to be technically efficient when it produces an output using the least possible amount of inputs or maximizes its outputs given a set of inputs.

A key advantage of technical efficiency is in its ability to decompose the efficiency score into Pure Technical Efficiency (PTE) and Scale Efficiency (SE) (Farrel, 1957). Based on the underlying return to scale assumption, Pure technical efficiency assumes a variable return to scale and measures inefficiency associated with managerial decisions. When the size of the Decision-Making Unit (DMU) is taken into consideration together with the optimality of input/output combination, the resulting efficiency will denote an Overall Technical Efficiency (OTE). Scale efficiency, on the other hand, measures the relationship between output levels and average cost associated with the firm size. Three operating possibilities exist when assessing scale efficiency; Constant Return to Scale when the relationship between inputs and outputs remains constant; Increasing Returns to Scale, where outputs are increasing at a higher rate than inputs and Decreasing Return to Scale where the rate of increase in outputs is less than the rate of increase in inputs (Kumar & Gulathi, 2008b).

Allocative efficiency on the other hand is cost centered and takes into consideration not only the number of inputs used but also their prices. When the selection of inputs results in a least-cost combination given the desired output, the firm is said to be allocative efficient, that is when the marginal rate of substitution between two inputs required in the production of a defined output is equal to the ratio of input prices (Kumbhakar & Tsionas, 2005). Allocative efficiency is greatly dependent on the quality of managerial decisions and is more critical where input prices experience significant variability.

The estimation and analysis of efficiency in financial institutions have seen tremendous development since the inception of the concept. According to Sharma et al., (2013), two broad approaches have emerged parametric and non-parametric. Among the parametric approaches, Stochastic Frontier Analysis (SFA) credited to Aigner, Lovell, and Schmidt, (1977), Thick frontier Approach (TFA) that was developed by Berger and Humphrey (1991) and Distribution Free Approach (DFA) credited to the works of Berger (1993) are the most widely used. Data Envelopment Analysis (DEA) was credited to the works of Charnes, Cooper, and Rhodes (1978) and Free Disposal Hull (FDH) developed by Deprins, Simar, and Tulkens (1984) dominates the less restrictive non-parametric approach.

2.3.6. Sacco Size

Intuitively, it is expected based on the economies of scale principle for medium-size financial institutions to achieve better technical and scale efficiencies compared to large and small institutions. As the size of the firm increases, a positive relationship accrues from their ability to develop technical, financial, human and material resources competencies enhancing their efficiency (Attah, 2017). This however is likely to be accompanied by higher agency, coordination and dysfunction problems, with the opposite view expected in smaller firms. Consequently, estimation of the average cost function will likely yield a U-shaped profile, where the average cost will decrease as the size increases up to an optimum level before they will start to increase, suggesting that medium-sized financial institutions are more likely to be efficient than those that relatively larger or smaller (Barret et al., 2010). The finding of Alukwe et al. (2015) affirms this relationship and demonstrates that SACCO size moderates the relationship between SACCO governance and regulatory compliance.

Several factors often favor larger firms, despite the disadvantages that come with it. Deis and Guffey (2005) in their support for larger financial institutions, justify that being large supports access to large and low-cost capital, wider market coverage through the extended branch network and the likelihood of better information exposure. Viewed for a cost perspective, larger banks and financial institutions, in general, are more likely to achieve better efficiency. However, when both the cost and revenue generation associated with the costs are taken into consideration; smaller banks are known to be more efficient (Berger & De Young, 2010). This is an indication that growth in size support cost efficiency and less comparative income-generating efficiency.

Elsewhere, evidence on the relationship between size and performance has in the past remains inconclusive. Jackson and Fethi (2000), Vijayakumar and Tamizhselvan (2010), Krray and Chichty (2013), and Attah (2017) found bank size as significant factors affecting technical efficiency. To the contrary, Barret et al. (2010), reports an inverse relationship. As a moderating variable, Rauch et al. (2009), examined a set of studies and concluded that the size of the firm is indeed an important moderator. In their conclusion, they present a strong case in support of size as a moderator between different environmental factors and key performance measures of organizations.

A study by Rahim et al., (2013) examining technical efficiency using DEA and intermediation approach of Islamic banks in Middle Eastern, North African, and Asian countries revealed that bank size based on their scale of the operation was the main source of inefficiency. In the US, Wheelock and Wilson (2011) used annual data of retail credit unions for 1989 to 2006 to assess the effect of size on the exploitation of both ray scale and expansion-path scale economies. The study revealed the majority of credit unions operated under increasing returns to scale and were too small to effectively exploit their economies of scale. The study affirms the benefit of scale expansion as a result of growth in size through competition.

In Kenya, a study by Kithinji (2018) assessing whether size moderates between bank restructuring and financial performance among commercial banks is the closest in reviewing moderating effects of size in financial institutions. In her review of data from 44 commercial, a significant moderating effect of size on the relationship between capital restructuring and profitability was evident.

2.4. Empirical Review

This subsection reviews existing empirical literature to provide a strong anchoring for the contextualization of prudential regulations and Sacco efficiency. It also sets a framework upon which findings were discussed.

2.4.1. Regulatory Compliance by Saccos in Kenya

The enactment of the Sacco societies act 2008 herald a new operational framework for deposit-taking Sacco in Kenya. Among others, DTSs were consequently required maintain minimum capital adequacy, meet set standards on liquid assets, restrict their business model within what is prescribed by SASRA, reform their governance strictures, open up membership to previously excluded sections of the community, and adhere to stringent financial reporting standard (SASRA,2010). All two hundred and fifteen (215) DTSs that were in operation before the act coming into force were expected to meet the prescribed regulatory requirements and continue with their operations. However, only 83(38%) were compliant in 2010, and by the end of 2014, when the grace period for implementation lapsed, 184 (85.6%) of DTS were compliant (SASRA, 2010 and SASRA, 2014).

While attaining compliance may have been a challenge for most licensed DTS, sustaining it continues to be even a challenge for many DTSs. For instance, in 2014 and 2015, nine (9) Sacco previously authorized to operate FOSA operations had their licenses revoked or placed under statutory management for failure to meet minimum capital requirements (SASRA, 2014 and SASRA, 2015). In 2013, the 135 licensed DTS held 92% of total assets in the sub-sector while the remaining unlicensed DTS holding a paltry 8%, an indication that the regulatory framework was in favor of institutional stability.

2.4.2. The Influence of Capital Regulations on Efficiency of DTS

Capital adequacy remains the most preferred tool in financial sector regulation. Capital Adequacy Ratio (CAR) in the context of BASEL III, a framework for financial sector regulation globally denotes internal strength to withstand losses in the advent of a financial crisis (Bhatia and Mahendru, 2015). Derived as capital to risk-weighted asset ratio, CAR enhances stability and efficiency in economic systems globally. According to Dang (2011) banks with higher CAR, require less external funding and hence lower financial cost, higher profitability efficiency.

The introduction of the prudential capital adequacy regulation in Kenya was mainly due to the need to safeguard the interest of depositors and shareholders through minimizing the credit and liquidity risks among DTS. The prudential regulations set by SASRA places stringent capital requirements, placing a cap of a minimum 10 million-core capital amount, a 10% minimum ratio of core capital to total assets, a minimum of 8% of institutional capital to total assets, and a similar ratio of core capital to total deposits (SASRA, 2013). Statutory minimum levels were set for four key capital measures and ratios: a Minimum of 10 Million shillings core capital, a 10% minimum for Core capital/total assets ratio, a minimum of 8% for both Institutional capital/Total assets and Core capital/total deposit ratios (SASRA, 2010).

According to SASRA (2013) by the close of the 2013 financial year, DTS in Kenya had a combined core capital of 2.28 million USD way above the required 0.12 Million USD. The ratio of core capital to total assets stood at 15% compared to the required 10%, while core capital to total deposit liabilities stood at 17% against the prudential minimum of 8%. If the prudential capital ratios are taken as the most optimal levels then, Saccos in Kenya are overcapitalized. Inherently, this raises that question of the capacity of the DTS to effectively utilize that excess capital to translate them into the required returns. Due to its restrictive nature to the fulfillment of the DTS intermediation role, the requirement on core capital to total deposit was used as an independent variable.

Studies carried out in commercial banking dominate existing empirical evidence on the relationship between capital adequacy and efficiency of financial institutions. A study carried out in Odunga et al. (2013) found that Capital adequacy measures alone did not affect the operation efficiency of banks in Kenya. They warn that regulatory agencies should not concentrate on capital adequacy alone but must integrate all aspects of a firm's operations. Amer et al. (2011), in their study of determinants of operating efficiency for lowly and highly competitive banks in Egypt found out that capital adequacy positively influenced the operating efficiency of commercial banks.

In his findings, Lotto (2018) finds a positive and significant relationship between capital ratio and operating efficiency of commercial banks in Tanzania. Intuitively, this meant that commercial banks that were facing stringent capital regulation were more likely to attain higher operating efficiency. His finding, therefore, proposes that stringent regulation of capital through a requirement that banks maintain a higher capital ratio does not only strengthen their stability by providing a larger capital cushion but also prevents a moral hazard between debt holders and shareholders that translates to better operational efficiency. A secondary implication of higher capital adequacy would be the fact that stronger corporate governance, effective risk management strategies, stringent credit evaluation, and strong internal control procedures are likely to be in place because of increased regulation on capital adequacy (Lotto, 2018).

A study by Nasieku (2014) investigating the effects of the Basel capital adequacy framework on the economic efficiency of banks in Kenya between 2001 and 2011. Using Data Envelopment Analysis (DEA) to analyze banks' economic efficiency, the study revealed that the level of capital held by the bank and the country’s economic situation influenced resource allocation and utilization (efficiency). Das and Ghosh (2006) assessed the association between capital adequacy and DEA generated bank's efficiency in India using ten-year panel data (1992 – 2002). They noted that there was a strong positive correlation based on the justification that adequately capitalized banks were more likely to report higher profitability, attract more customers, create more deposits, have higher lending and are more efficient in their intermediation activities.

A study by Maghyereh and Awartani (2014) in assessing the effect of market structure, regulation, and risk on bank efficiency among Gulf cooperation council countries revealed that capital adequacy coupled with strong supervisory power and the market discipline improved bank efficiency. The study strongly recommends improvements in the regulatory conditions to strengthen banking supervision and monitoring as a way of improving efficiency. Based on their findings from Canadian chartered banks, Guidara, Lai, Soumare, and Tchana (2013) argue that reforms that promote higher capital requirements and improved risk management equips banks with resilience in times of financial crisis.

Conversely, there is evidence to support the existence of a negative relationship between capital adequacy requirements and technical efficiency. Schliephake and Kirstein (2013) for instance, found that an increase in minimum capital requirement negatively affects efficiency because it increases the cost of intermediation. Bitar et al. (2018), in their study of 1992 banks across 39 OECD countries over four years (1999–2013) found that the imposition of higher capital ratios negatively affects the efficiency and profitability of highly liquid banks. In Japan, cooperative banks holding larger capital were found to not only be relatively inefficient but also had a higher risk profile (Deelchand & Padgett, 2009).

In the Sacco sector, higher capital adequacy ratios have a positive effect on both performance and efficiency. A longitudinal study by Kivuvo and Olweny (2014) provides a justification for a higher capital requirement for improved financial stability in the Sacco sector based on Altman ‘Z” score. In their study of 30 Deposit, taking Sacco randomly selected from a population of 215 registered DTSs that were in operation between 2008 and 2013 revealed that higher working capital to total assets and equity to total debt ratios significantly influenced performance and reduces the chances of falling into bankruptcy. Other studies that have reported a significant relationship between capital adequacy and performance includes Barus et al., 2017; Ndungu, 2015; Karagu & Okibo, 2014, and

Nyamsogoro, 2010).

2.4.3. The Influence of Liquidity Requirement on the Efficiency of DTS

As for liquidity, a 15% limit on the ratio of net liquid assets to total short-term liabilities has been set as the only requirement for compliance by the DTSs. A universal liquidity ratio may potent either excess or inadequate liquidity relative to the characteristics of the Saccos operations and clientele. That is, if it leads to excessive liquidity, for instance, in small DTSs with a few members and limited borrowing potential, then excessive liquidity is more likely. Large DTSs on the other hand, are more likely to experience inadequate liquidity compromising on its ability to meet its financial obligation, negating the fundamental reason on which the regulations were introduced in the first place.

According to Mughambi et al. (2015), the determination of optimal liquidity and in particular cash balance requires a unique combination of investment and financial decisions to the extent that the overall cost is minimized. Holding costs as seen from the foregone investment’s opportunity cost and frequent short-term acquisition costs define the effectiveness of the liquidity management practices adopted by the firm’s management (Huseyin, 2011). When managers have cash or liquid instruments available for their discretionary investment, the pressure to account for their investment actions more often demanded in external borrowing is significantly reduced and hence, managers can undertake investments that negatively affect efficiency and shareholders' wealth.

As noted by Maghimbi (2010) one of the main issues of Saccos in Africa is associated with liquidity. Managing liquidity and capital levels, while meeting the needs of members for finance, has been one of the major ongoing challenges for cooperative financial institutions in Africa. This is in concurrence with the arguments of Amer et al. (2011) who in their study of determinants of operating efficiency for lowly and highly competitive banks in Egypt found that in highly competitive banks, the operating efficiency is positively influenced by the levels of liquidity maintained.

In Kenya, Song'e (2015) in his study of the effect of liquidity management on the financial performance of deposit-taking Saccos in Nairobi County finds a significant relationship between Sacco's liquidity and funding liquidity risk. Barus (2017), while studying the effects of liquidity on the performance of 83-deposit taking Saccos in Kenya finds a significant influence of liquidity levels on profitability recommending stronger liquidity management policies for Saccos in the sector. Odunga et al. (2013), using published statements of accounts of the 40 commercial banks found that the liquid asset to deposits ratio positively affects the operating efficiency of the banks in Kenya. A study Kaberia (2015) on the effect of liquidity management on the efficiency of 22 Saccos in Muranga County revealed that cash flow is the most important aspect of liquidity management and has a significant influence on the efficiency of a SACCO. Other scholars who have reported similar finding include; Kariuki (2017), Alukwe, et al., (2015) and Kipesha, (2015).

2.4.4. Asset Provisioning/Quality Requirements and Efficiency of DTS

According to Osoro and Muturi (2015) loans remain to be the major assets and a key determinant of Saccos' profitability. Loans are the most valuable assets of a SACCO financed through shares and deposits and in some cases external borrowing. Traditional practices in credit management were more centered on loan quality indicators such as delinquency, non-accrual, and risk rating trends. In the modern-day where financial systems are dynamic, effective loan portfolio management is based on prudent risk analysis, selection, and individual credit risk monitoring as a way of maintaining favorable loan quality. Therefore, stringent assessment and control of loan approvals processes and a close watch on individual loan performance remain essential.

As noted by Richardson (2002) many Saccos in their formative stages have neither the resources nor the expertise to operate a sound credit management system, a key factor hindering their efficiency, growth, and performance. Similarly, Dhakal (2011) noted that risk management in Saccos across Africa remains below par due to the lack of institutionalized culture and capacity to implement sophisticated systems and technical tools for risk management. Provisioning for loan losses has not been previously part of the SACCO managerial practice who has relied on the check-off system for decades (WOCCU, 2010). The new SASRA's asset risk classification and provisioning prudential requirement for DTS has four loan categories; performing, watch, substandard, doubtful, and bad debts and for each, a standard provision is made (SASRA, 2013). As to emphasize its importance, DTSs are expected to file their returns on such provisioning to SASRA every month.

A restricted level of provisioning for each category of loans offered portents that, Saccos medium to long-term investments. More often additional provision limits that amount of funds that is available for onward lending to members. Additionally, high levels of loan loss provision will have negative effects on the firm's credit rating, limiting its access to external funding and the cost of such funds. For this study, the total provisions made for loans filled by DTS with the regulator annually were used.

2.4.5 The influence of Investment Requirements on Efficiency of DTS

Before the introduction of the current regulatory framework for the DTS, Co-operative Management Committees were noted to be notorious for diverting members' funds into investments of dubious value (KUSCCO, 2007). In confirmation of this, Makori, Munene and Muturi (2013) while assessing the challenges facing Saccos in Gusii region in Kenya revealed that high investment in non-quality earning investments and inadequate managerial competence contributed to the failure of Saccos in Kenya and recommend clear prohibition in investments that are not related to the core objective of the society.

Empirical evidence confirms the existence of a positive relationship between investment policies and the underlying efficiency in banks and other financial institutions. Kipesha (2012) while assessing the efficiency of MFI in Tanzania found that there is a positive impact on total assets on both Technical and scale efficiency. Yucel (2010), in applying Data Envelopment Analysis in assessing portfolio efficiency in Turkey found out that there is a strong complementary relationship between efficiency and diversification of investment portfolios with higher efficiency bringing higher returns. Surender et al. (2013), in establishing the determinants of Efficiency of MFIs in India found that there was a strong positive correlation between the value of total assets and investments with pure technical efficiency and scale efficiency.

Following the specification by SASRA, financial investment was taken as the sum of the short-term deposits (fixed deposits, special savings) and non-withdrawal deposits (BOSA member deposits). Financial Investments constitutes the sum of investments in government Securities (Treasury Bills/bonds), other Securities such as Commercial papers/Bonds, Balances with other SACCO Societies, and investments in other company's shares/stocks.

2.4.6 Efficiency of DTS in a Regulator Context

Empirical evidence linking regulation and efficiency in financial institutions is rather limited and tilted towards commercial banking. In a regulated framework, efficiency among commercial banks, Microfinance institutions, and Saccos continues to post mixed results across the globe. Hassan and Sanchez (2009) in their investigation of technical efficiency and scale efficiency of MFI in Latin America, the Middle East, and North Africa and South Asia countries found out that technical efficiency was higher in formal and regulated MFIs than those not subject to any form of regulation. In India, Jaffry et al. (2007) found enough evidence to support the conclusion that technical efficiency increased and converged across the Indian subcontinent in response to the introduction of reforms and regulation.

Pasiouras (2008) while investigating the impact of several regulations on banks' technical efficiency in 615 publicly quoted commercial banks operating in 74 countries across the globe during the period 2000-2004 provides evidence-based on Basel II that strict capital adequacy, powerful supervision, and market discipline power promote technical efficiency. On the contrary, Berger et al. (2008) based on the same pillars of Basel II regulations finds that heavier capital requirements, powerful supervision by monetary authorities, excessive private monitoring, and regulatory restrictions on bank activities are associated with greater banking system inefficiency.

In India, Arora (2014) used a balanced panel of 54 commercial banks during 1991–92 to 2006–07 period to study the effects of reforms and ownership on bank efficiency. Using DEA analysis and ANOVA, the study established that bank with high levels of non-performing assets were least efficient implying that asset quality was positively influencing bank efficiency. There was no conclusive evidence regarding the relationship between size and efficiency. However, efficient banks were found to achieve higher Net Profit as percentage of Total Assets and higher Profits per Employee.

Within the African continent, the relationship between regulation and efficiency are inconclusive. Cihak and Hesse (2007) in their study on East African banking sector reforms, found that the banking systems of Kenya, Tanzania, and Uganda were inefficient despite the introduction of the regulatory reforms. Kablan (2010) while investigating regulation and efficiency of banks in Sub-saharan Africa found out that Better regulation aiming at improving the quality of the bank credit environment, encouraging law enforcement and better information had a significant positive effect on bank efficiency. Despite being the frontier in SACCO growth in Africa, research examining the link between efficiency and regulation across East Africa remains nonexistent.

While there is a strong case to support the use of traditional financial measures in analysis such as profitability, financial ratios, and Return on Investments (ROI) in evaluation MFIs and Saccos performance, they suffer from several limitations. Ho and Zhu (2004) argue that traditional approaches have failed in estimating true firm performance and efficiency for several reasons. First, their univariate nature limits the sphere of assessing firm performance. Secondly, they present a single unit that cannot capture the complete picture of the performance of an entire organization over the breadth of its activities. Thirdly, is due to lacks an objective standard for selecting a measure that would satisfy the needs of all users) and lastly, they can only be used on an assumption that a firm manages a single input to generate a single output.

It is important to recognize that, Saccos differ from conventional banking in their operational model and calls for careful consideration in modeling their efficiency. Unlike commercial banks, Sacco's economic objective is to maximize the members' welfare/benefits who are also users of their service(s) and hence they take up a dual role of producer co-operative when accepting savings from the members, and a consumer co-operative when providing loans to the members (Marwa & Aziakpono, 2015). In their current state DTSs, are transformed and allowed to receive deposits and issue loans to both members and non-members (SASRA, 2010).

The implication of this unique and voluntary model is the need to combine both economic and social objectives and the right choice of approach in selecting the inputs and outputs in determining its efficiency. Currently, two main approaches have gained dominance in providing a framework on which inputs and outputs are defined: The production approach advanced by Benston (1965) and the intermediation approach modeled by Sealey and Lindley (1977). The production approach views financial institutions as productive units that use physical inputs, employees and expend money to obtain deposits, lend out loans and collect revenues (Kipesha, 2013) & Das and Ghosh, 2006). Despite its ability to model financial system on foundations of the economic model, production approach, obtaining prices on inputs and outputs patents a major challenge, limiting its application to the measurement of branch level efficiency.

The intermediation model formulated by Sealey and Lindley (1977) on the other hand, view financial institutions as agents, liaising funds between demand sources (investors) and supply sources (savers), by using inputs in the form of labor and physical capital to convert deposits and other funds/liabilities into loans, securities, investment, and other earning assets. In this sense, the Saccos are in the core business of providing intermediation services and in the process creating wealth to its members. The objective in DTS Saccos in Kenya closely matches the intermediation approach, as they are primarily mobilizing savings and offering loans and hence was adopted in this study. More so, the choice of the intermediation approach is also partly influenced by the quality and availability of data for accurate estimation.

Moffat (2008) and Kipesha (2015) warn that the choice of inputs and outputs in the production or intermediation approach must be given careful consideration due to the sensitivity of the empirical results to the nature of inputs and outputs selected. Cost of labor, capital, deposits, and fixed assets dominates the choice of inputs while Loans, advances, earning assets, Incomes, and revenues dominate as the preferred choice of outputs in most efficiency analysis in banks, MFIs, and Saccos (Mousa, 2015). Despite deposits being a widely used factor, it is important to note that there is a controversy as to whether deposits should be considered inputs or outputs (Kipesha, 2012).

The choice of efficiency in the measurement of performance has received prominence among scholars in the recent past due to its ability to be decomposed into different variations, each capturing a specific performance dimension. Technical efficiency, pure technical efficiency, scale efficiency, profit efficiency, cost efficiency, revenue efficiency, economic efficiency, and allocative efficiency remains to be the most preferred among scholars (Coelli et al., 2005) The type of efficiency adopted is predominantly influenced by the objectives of the study, availability, and quality of data available (Magalia and Pastory, 2013). In financial institutions, efficiency is decomposed into three components: technical efficiency (TE) assessing the overall efficiency in resource transformation; scale efficiency (SE) capturing the optimal scale of operation, and pure technical efficiency (PTE) that examines the managerial effectiveness of the decision-making unit (DMU).

The original work of Koopmans (1951) technical efficiency is defined as “an input-output vector is technically efficient if, and only if, increasing any output or decreasing any input is possible only by decreasing some other output or increasing some other input”. In expanding this definition, Marwan and Aziakpono (2015) point out that technical efficiency estimates the ratio of the distance between a selected reference to the Constant Returns to Scale (CRS) frontier and an inefficient firm’s distance from the same frontier. This means that a firm is technically efficient if an increase in output requires a reduction in at least one other output or an increase in at least one input, and if a reduction in any input requires an increase in at least one other input or a reduction in at least one output (Marwa & Aziakpono, 2015).

There are two main approaches in determination of Technical efficiency; The Input approach that evaluates the ability to avoid waste by generating output as much as input usage allows. It is defined by the ability to minimize inputs keeping outputs fixed. The Output approach where we consider the ability to avoid waste by using as little input as output production allows, concisely, the ability to maximize outputs keeping inputs fixed. Morita and Avkiran (2009) notes that the resulting efficiency score is directly affected by the input and output variables used, a call for caution in the selection process. Not only should the selected inputs and outputs directly express the core performance of DMUs, but also must be founded on a strong theory, expert knowledge or accepted practices that are empirically sound. Additionally, Coelli et al. (2005) caution that the choice of orientation must be made taking into consideration the nature and quantity of inputs and outputs based on the manager’s control domain.

The introduction of Frontier Analysis by Aigner et al. (1977) has revolutionized the efficiency analysis by overcoming key limitations associated with the traditional approaches. Its superiority lies in the usage of the programming or the statistical techniques in obtaining better estimates of the underlying performance of DMUs while removing the effects of the input price differences and other exogenous market factors affecting the standard performance ratios (Mousa, 2015). Stochastic frontier analysis in particular has been credited with a strong frontier modeling framework and its ability to estimate inefficiency (Kiyota, 2011).

Data Envelopment Analysis (DEA), introduced by Charnes, Cooper, and Rhodes (1978) is one of the non-parametric mathematical programming technique that measures the efficiency of a Decision-Making Unit (DMU) relative to other similar DMUs with a simple restriction that all DMUs lie on or below the efficiency frontier, remains the most widely and extensively application in evaluating efficiency in financial institutions (Greene, 2008 and Mousa, 2015). In the original paper, Charnes, Cooper and Rhodes (1978) proposed an input orientation model assuming constant returns to scale (CRS) that is, considering all DMUs operates in a similar environment and technology. Advancement of the model to adopt variable returns to scale (VRS) was later introduced by Banker, Charnes and Cooper (1984). Under this approach, DMUs are assumed to have inherent differences in the technology and operating conditions, splitting efficiency estimation into technical efficiency (TE) and scale Efficiency (SE).

Data Envelopment Analysis (DEA) has been extensively used in modeling efficiency in diverse fields such as the banking sector, microfinance, health sectors, and agriculture (Kiyota, 2011). The main advantage of DEA is that it does not require an a priori assumption about the analytical form of the production function, therefore imposing very little structure on the shape that the efficient frontier will take. Instead, it constructs the best practice production function solely based on observed data, and therefore the possibility of misspecification of the production technology is zero. A notable disadvantage with DEA is in the sensitivity of the frontier to extreme observations and measurement error and that all deviations from the frontier indicate inefficiency (Kablan, 2012).

2.4.7. SACCO Size and Efficiency

The decision on whether a variable takes on a moderating or mediating role rests on three conditions set out in the pioneering work of Baron and Kenny (1986). The moderator variable should be exogenous, uncorrelated with the dependent and bears influence on the strength and or direction of the relationship between the dependent and independent variable. Theoretical and empirical literature supports the hypothesis of bank size moderating between exogenous variables and performance. Studies by Muriithi (2016), Matanda, Oyugi and Lishenga (2015) and Omwantho (2017) report a significant role of bank size as a moderating variable between different bank characteristics and their performance.

Intuitively, a positive relationship would be expected between the size and performance of financial institutions. Banks and similar institutions with more assets are more likely to access or hold adequate resources that can be invested in improving their technical, financial, and human resource capacity compared to small institutions (Gwahula, 2012). Equally, agency, coordination, and dysfunction problems are better managed in larger banks and hence smaller banks, compared to their large counterparts are more likely to be relatively in-efficiency holding all other factors constant.

Empirical evidence on the potential impact and significance of size on the measured efficiency of financial institutions yields no consensus (Karray and Chichti, 2013). Drake and Hall (2003), in their assessment of Japanese banks, noted that there was evidence to suggest a strong relationship between bank size, technical efficiency, and scale efficiency. Karry and Chichti (2013) used DEA and Tobit regression analysis in a panel of 402 commercial banks from 15 developing countries over the period between 2000 and 2003. They found that the highest levels of pure technical efficiency and the most serious problems of scale inefficiency were experienced among banks with higher total assets and a vice versa for smaller Banks. In India, Singh, Goyal and Sharma (2013), in assessing the determinants of efficiency among MFI found out that total assets as a measure of size was a significant determinant of technical efficiency and not Scale efficiency. Battaglia et al. (2010), in assessing the impact of environmental conditions on the efficiency of cooperative banks in Italy found out that the number of ATM and point of sale as an indicator of size had a significant influence on both cost and profit efficiency.

Bassem (2008) in his study estimated the efficiency of 35 microfinance institutions in the Mediterranean region during the period 2004–2005 using DEA revealed that medium-size MFIs were more efficient than larger ones and attribute it to the effects of economies and diseconomies of scale. Fernando and Nimal (2014) in testing if ownership and size influence bank efficiency in Sir Lanka found that there were no significant differences between the efficiency scores of the large and small banks. Delis and Papanikolaou (2009) in examining the effect of bank-specific, industry-specific and macroeconomic determinants of bank efficiency in 10 European Union countries noted that the relationship between bank size and efficiency is non-linear, with efficiency increasing with size to a certain point and decreasing thereafter.

In the Kenyan context, Karanja (2013) sought to assess the relationship between size and cost efficiency of Saccos in Kenya for the period 2008 – 2012. Efficiency was measured as the ratio between non-interest expense and the sum of non-interest income and net interest income. He found that larger Saccos, especially those that were adequately capitalized were more efficient than smaller Saccos. A study by Njoroge (2013) assessing the determinants of Efficiency of Saccos in Nairobi County revealed that size positively and significantly influenced the efficiency of Saccos as larger firms were able to spread the fixed costs of production over more production units culminating into lower average costs per unit. He also found that capitalization, management quality, the effectiveness of the marketing strategies, the level of experience, and the effectiveness of training programs positively and significantly influenced the efficiency of Saccos.

The adoption of SACCO size as a moderating factor in the current study is based on the recommendations of Rauch et al. (2009) recognizing the size of firms as an important moderator. Rauch et al. (2009), in their survey of existing empirical evidence observed that there was a consensus in recognizing the size of the firm as a moderator linking changes in environmental factors and efficiency or performance. In support of this Chi (2004) clarified that organizational size has a significant impact as a moderator of its performance given that as firms grow, they are better positioned to exploit any inherent economies of scale but to a limited extent.

The relationship between size and technical efficiency remains inconclusive with evidence of several studies reporting positive, Negative, or the lack of a significant relationship between size and associated technical efficiency. For instance, Rosman et al. (2014), using a DEA analysis in examining the effects of size on 79 Islamic banks during the economic crisis in Middle Eastern and Asian countries finds a significant positive relationship between bank size and their technical efficiency. To the contrary, Homma et al. (2014) in examining farm growth and efficiency in the banking industry in Japan found a negative relationship while those that reported no significant relationship between size and technical efficiency of financial institutions include Al-Gasaymeh (2016) and Singh, and Fida (2015).

2.5. Critique of Existing Literature

Although studies on the efficiency of formal financial institutions and its determinant are numerous, empirical analysis in microfinance and other financial institutions such as Saccos remains relatively limited. There is a big gap that needs to be filled, considering the importance of these institutions and their economic and social roles in the economy. The non-parametric DEA remains a dominant efficiency estimation methodology in both production and intermediation oriented studies using either input or output approach. The choice of inputs and outputs among scholars shows a considerable variation across both studies and regions. The rest of this subsection presents a critique of relevant empirical studied to evaluate the efficiency and the determinants in MFIs and Saccos.

In India, Guarav and Krishnan (2017) reviewed panel data of 297 cooperative banks between 2012 and 2014 using both parametric and non-parametric frontier analysis. From their findings, the choice of input variables and the location of the bank were found to considerably influence technical efficiency. Despite adopting both parametric and non-parametric approaches, the study fails to bring to the fore the differences in efficiency attributed to each approach. A similar study by Raju (2018) comparing the efficiency of urban cooperative banks in the conduct of core banking and off-balance sheet activities in India using both parametric (Stochastic Frontier Analysis) and non-parametric (Data Envelopment Analysis) established significant differences inefficiencies between the two activities and estimation approaches. Deposit and loans were also established as significant determinants of technical efficiency. Both studies fail to link efficiency with regulation and size.

In Malysia, Othman, Mansor and Kari (2014) assessed the performance of cooperatives in Malaysia using a DEA approach with a sample of 56 cooperatives spread across all regions of the country. The results from their Tobit regression revealed that turnover, profits, members' equity or capital and membership had a significant influence on the efficiency scores. Further, the study showed that an increase in capital (equity) and membership had a negative influence on technical, scale and pure technical efficiency suggesting that larger cooperatives were less efficient. Hafez (2018) investigated the relationship between the efficiency of banks in Egypt and capital adequacy ratios from a sample of 40 banks comprising Islamic banks, conventional and conventional banks with Islamic windows pre and post the global financial crisis. Using bank data from the year 2002 to 2015 and DEA, the study established that there is a significant positive relationship between capital adequacy ratios, credit risk, profitability, bank size, the quality of management and the efficiency of banks. However, there was a significant negative relationship between the efficiency with liquidity.

Chortaeas, Girardone and Ventouri (2010), in assessing the influence supervision and regulation on bank efficacy in European Union using DEA analysis, where personnel expenses, total assets, total deposits, and funding were used as inputs, and loan and total earning assets considered as outputs. Strong supervision and regulation were found to negatively affect bank efficiency, raising a red flag on the strategies and effectiveness of supervision and regulation of the banking sector. They warn that excessive and stringent supervision and strong regulations impeded private monitoring, limit bank activities and consequently lower efficiency.

Barth et al. (2013) used DEA with Total loans, Earning assets and Operating incomes as inputs and Total deposit, Labor input, capital, and Loan loss provisions as outputs. In their panel analysis of 4050 bank observations in 72 countries spread across the globe over the period 1999–2007, they found that bank regulation, supervision, and monitoring enhance or impede bank efficiency. Tighter restrictions on bank activities were also found to negatively associate with bank efficiency. Stringent capital regulation was found to marginally and positively associate with bank efficiency. They also noted that the strengthening of official supervisory power has a positive influence on bank efficiency in countries where independent supervisory authorities exist. Additionally, they noted that independence together with a more experienced supervisory authority tends to enhance bank efficiency. Another notable finding from their study was the positive association between Market-based monitoring through enhanced financial transparency and bank efficiency. While Barth et al., (2013) reveals the effects of the elements that are subject to regulation, it focuses on Banks they are subject to the BASEL framework that has limited application in the context of the DTS.

In West Africa, Sedzro and Keita (2009) did a study on the efficiency of MFIs in seven countries of the West African Economic and Monetary Union using DEA with output orientation and both the CRS and VRS. The model used unbalanced data with 539 observations, representing 161 in 2000, 210 in 2001 and 168 in 2002 in the context of both production and intermediation approach. In the production approach, labor, physical capital, and financial capital were taken as input while the number of savers, the number of borrowers, and investments were used as output variables. In the intermediation approach, total deposits, labor, and physical capital were taken as inputs in producing loans, interest income, and investments. Their findings indicate that there was a significant difference in efficiency when a comparison was made between the production and intermediation approaches, with the underlying cause being the introduction of unifying supervision policies for MFIs (Sedzro & Keita, 2009).

In Ghana, Oteng-Abayie et al. (2016) examined the technical efficiency of sixty-six (66) credit unions (CUs) using a four year (2009-2012) panel data and Cobb-Douglas stochastic frontier production and intermediation models. The study reports significant levels of inefficiency, confirming high inefficiency levels among Credit unions in Africa. However, a consistent increase in technical efficiency attributed to improvement in technology signifies improved efficiencies in the future. The study further reveals improved staff productivity and exploitation of economies of scale as significant sources of efficiency.

Gabremichael and Gessesse (2016) adopted a pan African approach to evaluate the technical efficiency of Microfinance Institutions (MFIs). The study also assessed whether there were significant differences in efficiency between different types of MFIs. The study adopted a stochastic frontier analysis (SFA) assuming that the trans-log production functions in estimating technical efficiency of 134 Microfinance Institutions spread across 36 African countries. The study reports significant inefficiencies among MFIs with average technical efficiency of 0.489. Ownership structure was found to influence technical efficiencies with NGO and non-bank financial institutions achieving relatively better efficiency than cooperatives/credit unions. Despite the study making a significant contribution to the debate on the effects of ownership on technical efficiency, it fails to account for underlying causes of inefficiency, especially in cooperative and credit unions.

Kipesha (2012), undertook to compare technical efficiency under Constant Return to Scale (CRS) and Variable Return to Scale (VRS) of 35 MFIs from five East African countries (Tanzania, Kenya, Uganda, Rwanda, and Burundi). A DEA input based production approach with total assets and operating revenues as inputs while Loan portfolio and financial revenues were used as outputs. The findings revealed that MFIs in east Africa had higher technical efficiency with an average score of 0.706 (2009), 0.798 (2010) and 0.852 in 2011 under constant return to scale and 0.823, 0.892 and 0.891 under variable return to scale for three years respectively. The findings also revealed that banks and MFIs were relatively more efficient compared to financial institutions run by Non-Governmental institutions and cooperatives societies. Cross-country comparison revealed that Kenya and Rwanda had higher average technical efficiency scores under constant return to scale while Uganda and Tanzania were relatively more efficient under variable return to scale. These results imply that efficiency variations were country-specific and influenced industry return to scale.

In Banking, Triki et al. (2013) assessed the effects of Bank regulation on efficiency in 298 banks operating in 45 countries using input-oriented. DEA, a non-parametric approach was used with Total costs made up of interest and non-interest expenses, fixed assets and total deposits inclusive of short-term funding as inputs. Total loans, other earning assets and non-interest income measured by net fees and commissions were used as outputs. In their finding, financial regulation through price controls, liquidity, and diversification, requirements were found to have a positive effect on bank efficiency while supervision quality, financial safety nets, and overall capital stringency did not statistically influence bank efficiency in Africa.

Similarly, Pasiouras et al. (2009) while assessing cost efficiency among 615 banks from 74 countries across Africa, based their DEA analysis on the value-added approach with the cost of borrowed funds, the cost of physical capital and the cost of labor, as the cost of inputs while loans, total earning assets, and total deposits were used as outputs. In their findings, it was evident that increased transparency requirements reduce the efficiency of African banks suggesting that the cost of information disclosure in Africa outweighs the benefit of private monitoring performed by capital market stakeholders.

A study by Marwa (2015) reviewing performance Saccos in Tanzania reveals the need for institutional changes in the sector if Saccos were to play their role effectively. Using DEA analysis and data from 103 Saccos spread across the country to estimate efficiency; the study reveals that the majority of Saccos were both inefficient and unsustainable. The average technical efficiency score stood at 32% and 61% were financially sustainable while 51% were both operationally and financially sustainable. Only 12% of the Saccos were found to be both efficient and sustainable. Limited capital, low levels of member's education on matters related to cooperatives, poor leadership and governance structures were identified and key determinates of inefficiency and poor performance. Due to the inexistence of formal regulations to govern Saccos in Tanzania at the time of the study, no attempt was made to assess the effects of regulations on both efficiency and financial sustainability.

In Tanzania, Magali and Pastory (2013) employed the Data Envelopment Analysis approach in assessing variations of technical efficiency of rural Saccos across and within regions. Membership deposits and expenses were used as inputs with loans issued as output. Rural Saccos in Morogoro, Dodoma and Kilimanjaro regions had on average 62%, 60% and 46% technical efficiency respectively an indication that they were relatively inefficient. Technical efficiency was also found to vary across and within regions. The study attributes the inefficiencies to the high cost of operations calling for the adoption of prudent cost management strategies.

In Kenya, a study by Ochola (2016b) remains the closest and the strongest evidence of the trend of efficiency among Saccos in Kenya in a regulated framework. In his study of 94 DTS from across the country using DEA and Tobit regression, he established that efficiency was largely determined by factors that are central to the intermediation role of the DTS. Based on input and output data of DTS reported between 2011 and 2013 revealed a 47% decline in the number of efficient Saccos. Both technical and scale efficiency fell from 81% to 51% and from 94% to 67% respectively over the same period an indication of unfavorable performance trends in the sector. From his Tobit regression, an increase in loans and deposits was found to negatively influence efficiency levels among the Saccos. However, the study does not take into account the regulatory effects.

The analysis on the impact of prudential regulation of financial performance of deposit-taking savings and credit cooperative societies in Kenya by Kahuthu (2016), remains to be the closest research to be done in assessing the effects the introduced regulations have had on the performance of DTS in Kenya. The study sought to assess pre and post-regulation betas of 124 Saccos. The findings revealed that core capital, credit management, membership growth and liquidity beta significantly improved upon the enactment of prudential regulations. The introduction of prudential regulation as a moderating variable resulted in a significant positive increase in the strength of predictor variable betas, an indication that financial performance was significantly improved because of Saccos implementing the prescribed regulatory requirements. The study, however, was limited to traditional measures of performance and more specifically Return on Assets (ROA) and not efficiency.

Kariuki (2017) assessed the influence of firm characteristics on the intermediation efficiency of DTSs in Kenya using DEA and financial data of 103 DTSs. Between 2011 and 2014 capital adequacy and liquidity were found to not influence the intermediation technical efficiency of Saccos while asset quality and profitability were found to significantly improved technical efficiency. Unexpectedly, income diversification was found to be inefficiency enhancing contrary to the portfolio theory that advocates for diversification. The study makes a significant contribution to revealing determinants of technical efficiency at a firm level. However, it fails to take into consideration the likely effects of prudential regulation considering that between 2011 and 2014, deposit-taking saccos in Kenya were undergoing significant changes in the operation to comply with a new regulatory framework.

A study by Lari, Ronoh and Nyangweso (2017) assessing determinants of technical inefficiency of Saccos in Kenya, makes a significant contribution to efficiency analysis in Saccos. Using non-parametric DEA and Stochastic Frontier Analysis to assess data from 46 Saccos, the study reports a relatively high mean technical efficiency of 97.6% compared to similar studies. Managerial inefficiency, macro variables as well as Sacco specific variables were found to significantly influence the levels of inefficiency witnessed between 2007 and 2014. Insignificant changes in inefficiency were reported when a comparison was made between the pre and regulation period. The choice of the inefficiency as opposed to conventional efficiency by the authors provides a unique perspective in the assessment of Sacco efficiency in Kenya. However, the study fails to justify a relatively high technical efficiency score compared to other studies and lacks comparative methodological assessment.

Njoroge (2013) in a relatively limited study, sought to establish the determinants of technical efficiency of Saccos in Nairobi County. The study adopted DEA a non-parametric approach used savings and total expenses as inputs and loans and total income as outputs. From a three-year (2010 -2013) panel data, Saccos in Nairobi had a mean technical efficiency of 63.7%. Size, capital, credit risk management and management quality were found to significantly influence the technical efficiency of cooperative societies. While the study makes a significant contribution to efficiency studies in the Sacco sub-sector in Kenya, it has two shortcomings. First, no attempt was made to correct technical efficiency for potential bias and secondly, it does not take into consideration the potential effects of changes in both policy and operations due to the adoption of new regulations for the sub-sector.

Looking at the literature critiqued, there is notable similarity and differences in the approach adopted by most scholars. First, the use of panel data is dominant and is highly justified by its ability to strengthen the quality and reliability of the empirical findings reported. Secondly, Data Envelopment Analysis (DEA) is strongly preferred in efficiency analysis as an efficiency estimation tool. Thirdly, the determinants and firm-specific factors that influence efficiency are not only numerous but also have a varying degree and direction of influence. Lastly, the influence of regulatory changes on performance and efficiency largely remains unassessed except for Lari, Ronoh and Nyangweso (2017).

2.6. Summary of Literature Reviewed

From the literature reviewed, it is evident that regulation of financial institutions and in particular Saccos depends on their growth stage. The effects of prudential regulations on the performance of such institutions continue to post mixed results with mainstream banking receiving much attention throughout the reviewed literature. The regulatory framework adopted by most countries in regulating Saccos borrows heavily from the BASEL II framework where capital adequacy, liquidity, credit risk, and investments are regulated and monitored as fundamentals for achieving stability in financial institutions. Regulation of Saccos varies considerably across Africa with Kenya considered among the pioneers where considerable progress has been made in the establishment of strong DTS that can effectively compete within the robust banking sector. A summary of efficiency studies carried out by scholars across Eastern Africa is presented in Table 2.4

Table 2.1: A summary of Empirical Studies on the Efficiency of Banks, MFIs and Saccos

Author	Title of the study	Year of study	Methodology Used	Major Findings
Kipesha (2012)	Technical efficiency of MFI in East African countries	2013	DEA– production approach under both CRS and VRS; with input variables as, total assets, personnel/staffs and operating revenues while output Variables were gross loan portfolio and financial revenue	An MFI in Kenya had a higher Technical efficiency and lower scale efficiency compared to other countries in the region. Bank and Non-Bank MFI were more efficient that NGO and cooperative MFI
Mangili and Pastory (2013)	Technical Efficiency of the Rural Savings and Credits Cooperative Societies in Tanzania	2013	DEA–Intermediation approach Technical Efficiency membership, Total expenses total savings and deposits were used as inputs while loans issues were the only output	The technical efficiency of Saccos varies across and within the regions. Higher costs of operations for rural Saccos attributed to low efficiency
Marwa and Aziakpono (2014)	Technical and Scale Efficiency of Saving and Credit Cooperatives in Tanzania	2014	DEA – Intermediation approach. Technical, Pure Technical and Scale efficiency Total Cost, Total Fixed Asset, and Total Deposit as inputs and Total Loan Portfolio and Total revenues as outputs	An average efficiency score of 42%, 52% and 76% for technical efficiency, pure technical efficiency, and scale efficiency respectively Very small and very large Saccos were relatively less efficient compared to medium and large Saccos

Kahuthu (2016)	Prudential requirements and financial performance of DTS in Kenya	2016	Regression: core capital, Credit management, membership growth and liquidity as independent variables and Return on assets as dependent Variable	Prudential regulations enhanced the strength of predictors of Financial performance after their introduction.
Kariuki(2016)	Firm characteristics and efficiency	2016	DEA- Intermediation approach Technical efficiency with Capital, Labour cost and deposits as inputs and turnover, loans and financial investments as outputs	Insignificant relationship between capital adequacy, liquidity, and intermediation efficiency. Asset quality, diversification, profitability, and size had a significant relationship with intermediation efficiency.
Ochola (2016a)	Evaluation of Efficiency of MFI in Kenya	2015	DEA – Intermediation approach: Relative efficiency Inputs; total operating expenses and total assets while the outputs are financial revenue and gross loan portfolio.	MFI had an average efficiency under both the financial revenue and gross loan portfolio output scenarios over 70% of the MFIs were efficient under each scenario respectively
Ochola (2016b	A two-stage study of the efficiency of savings and Credit cooperatives societies in Kenya	2011-13	DEA- Intermediation approach Technical and scale efficiency with membership, total assets and deposits as inputs and turnover, loans and advances are outputs	The efficiency of Saccos have significant decline over the three years (2011 2013) Deposits and loan and

		A Tobit regression for assessment of determinants of efficiency	Advances are negatively associated with efficiency Saccos with a higher number of members, loans and advances ad turnover were more efficient

Intermediation approach remains the most preferred approach in modeling inputs and outputs in the financial sector with Data Envelopment Analysis (DEA) as the preferred efficiency estimation model. Despite the tremendous growth, Saccos in Kenya still face numerous challenges that directly affect their performance and efficiency. The efficiency of Saccos in Kenya varies considerably, ranging from as low as 30% to a high of 90% going by the limited empirical evidence available. If the evidence from the banks is to go by, SASRA's prudential regulations should have considerable effects on the efficiency of the newly regulated DTS.

2.7 Research Gap

From the reviewed empirical literature, it is evident that there is considerable variation in the efficiency of financial institutions that remains unexplained. Studies carried out in East Africa Kipesha, (2012), Marwa and Aziakpono (2014), Mangili and Pastory (2013) Ochola (2015b)), are all limited to determining efficiency levels and none explaining the underlying causes or determinants of such efficiencies in financial institutions. In Kenya, to the best of the researcher's knowledge, Ochola (2016a) and Kariuki (2016) remains to be the only researchers who not only determined the efficiency of DTS but also has attempted to establish its determinants. However, it leaves out the influence of the regulatory compliance aspect and more so on the SASRA prudential regulations in the explanation of the drastic decline in the efficiency scores.

Despite the country being the leader regionally in SACCO performance and outreach and as a matter of great importance, implementation of prudential regulations whose effects are far-reaching, yet limited scientific evidence exist. This will mean leaving the performance of such a critical sector of the economy to a destiny defined by chance. Furthermore, a decline in efficiency contrary to the goals of prudential regulation raises significant questions that remain unanswered by existing empirical works. To fill this gap, the current study sought to assess the impact of complying with existing prudential regulations on the technical efficiency of DTS in Kenya.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides a discussion of the methods that were used in collecting and analyzing data. A detailed description of the research design, target population, sampling design, instruments, and data analysis models and methods are set out in the following subsection.

3.2 Research Philosophy

The study was anchored on a positivists' epistemological assumption. According to Holden and Lynch (2004), a research philosophy is a foundation on which data about a phenomenon should be gathered, analyzed and interpreted. Positivist believes that reality is stable and provides an objective reality upon which research assertions can be validated (Creswell, 2008). Saunders, Lewis, & Thornhill, (2009) asserts that the positivist position is based on natural science and allows for the testing of hypothesis through measurement of observable social realities. Positivism presumes knowledge is valid if it is based on observable objective external reality and that universal laws exist or that theoretical models can be developed that are generalizable, predictive and can explain cause and effect relationships (Saunders et al., 2009).

The choice of a positivist paradigm in the current study rests on the recognition that the position of the researcher is independent of what is being observed and seeks to identify a causal relationship between regulations imposed and the efficiency of DTS. More so, the research develops through generalization, facilitated by hypothesis testing, an understanding of the impact of the regulatory requirements on the inherent efficiencies of the DTS. Through positivist - inductive reasoning, the study makes conclusions from the analysis performed on the hypothesized relationship between prudential regulations and technical efficiency.

3.3. Research design

According to Upagade and Shende (2012), a research design is a definite structure that sets out the procedures and condition for the collection and analysis of data in a manner that combine relevance to the research purpose with economy in procedure. It describes a general plan or strategy for conducting a research study necessary for arriving at pertinent answers to research questions (Coopers and Schindler, 2011). The study adopted an explanatory research design. According to Grey, (2014) explanatory research seeks to explain and account for descriptive information, looks for causes and reasons and provides evidence to support or refute an explanation or prediction. Additionally, it provides a basis on which relationships among different aspects of the phenomenon under study are explained (Sekaran, 2010). Explanatory research design is strongly recommended when assessing trends and relationships with quantitative data that requires an explanation or reasons behind the resultant trends (Creswell, et al., 2003)

The choice of explanatory research design was based on the need to expand on the existing knowledge on the impact of compliance with prudential requirements set out by SASRA on the technical efficiency of deposit-taking Saccos. Prudential regulation is a relatively new concept and remains largely unexplored in the Sacco sector compared to conventional banking. Several studies among others; Mugo, Muathe and Waithaka (2018), Barus (2017), Ronoh et al. (2017), Kioko and Wario (2014) have used the explanatory research design in expanding the understanding of the influence of environmental factors on performance deposit taking Saccos in Kenya.

3.4. Target Population

According to Kombo and Tromp (2006), population refers to an entire group of individuals, events or objects, or items having a common observable measurable characteristic. In a research context, the population represents the entire group of people, events, or things of interest that the researcher wishes to investigate and on which the generalization was inferred (Sekaran and Bougie, 2011). Financial cooperatives licensed to offer Front Office Services Activity (FOSA) in Kenya were targeted. By the end of 2016, there were 18,573 cooperatives registered in Kenya of which 8,914 were classified as financial cooperatives (Ministry of Industry, Trade and Co-operatives (MITC), 2017). Not all registered financial Saccos in Kenya are licensed to operate FOSA services, where withdraw-able deposits are accepted. In 2011, 110 Saccos were licensed to operate FOSA, a number that grew to 177 in 2016.

3.5. Sampling Frame

According to Sekaran and Bougie (2011) sampling frame is a physical or listed representation of all the elements in a population from which the sample is drawn. A list of all DTS licensed to operate every year is gazetted by SASRA both as a requirement by the Saccos act and for public awareness. As a legal document and an authority for DTS to operate, the gazette notice (see Appendix II) lists all 110 DTS fully licensed to operate in the year 2011. To enhance the quality of panel analysis, DTSs that were in operation between 2011 and 2016 were included, providing a balanced panel for the study. However, the license of one Sacco was revoked due to undercapitalization leaving 109 DTSs available for analysis.

3.6. Sample and Sampling Technique

The study adopted a census approach where all the 109 DTSs licensed to offer FOSA services in 2011 and remained in operation through 2016 were included in the analysis. Saunders et al. (2009) recommend census technique where it is practical to do so since it eliminates sampling errors and yields better inferential results. Published financial statements deposited with the regulators by the DTSs annually were the key source for secondary data.

3.7. Data Collection Instruments

As noted by Cooper and Schindler (2011) the quality of any research findings depends on the choice and the design of the data collection instrument used. In this study, a data collection template was used to collect in a systematic manner financial data from DTS financial statements (Appendix I). Secondary data was the sole source of data used in the analysis. The choice of the secondary data was anchored on the need to collect specific and accurate financial performance data that may not be easy to recall when a questionnaire is used. Regulating financial institutions based on prudential regulations is more often than not accompanied by standardized financial reporting on the predetermined time framework set out on a monthly, quarterly, or yearly basis. All licensed DTSs in Kenya are required by law to file monthly regulatory returns, and at the end of the financial year, to present complete and audited financial statements.

A data collection template (see Appendix I) was used to collect data from audited financial statements submitted to SASRA by DTS for each of the six years under study. Total deposits, Total labor expenses, Gross loans and advances, Core capital, Net liquid assets, Total loan provisions, financial investments, and Total assets were collected. The reliability and validity of secondary data rest highly in the data collection methods and the authenticity of the source (Dochartaigh, 2002). The authority and reputation of the source strongly denote the underlying validity and reliability of secondary data. To minimize on source bias, all DTS financial statements were sourced from SASRA. As a prerequisite, the statements must have been approved and deposited with the regulators as the final statement for the financial year. As part of the standardization that comes with SASRA monitoring reports, all DTS must classify, treat and present their financial entries as set out in a formal reporting template inline with the international financial reporting standards (IFRS). The definition of the key financial entries in the financial statements, therefore, remains consistent across all DTS, significantly minimizing ubiquity in the terminologies used in the financial reports.

3.8. Data Collection Procedure

A research permit and an introduction letter were obtained from Jomo Kenyatta University of Science, Technology, and National Commission for Science, Technology and Innovation (NACOSTI). Before collecting data from SASRA, formal approval was sought to facilitate access to financial statements of the selected DTSs from where the required information was extracted into a data collection template.

3.9. Data Analysis

Predicting efficiency based on a set of selected environmental factors was achieved through a two-stage analysis process. In the first stage, efficiency scores were estimated using a set of inputs and outputs and corrected for estimation bias as recommended by Casu and Molyneux (2003) with the aid of Benchmarking package embedded in R statistical software. In the second stage, a fixed effect regression analysis was used to explore the impact of the four regulatory compliance levels on biased corrected efficiency scores and the moderating effect of DTS size using STATA software.

3.9.1 Measurement of Study Variables

According to Sekaran (2003) through the operationalization of the variables, each variable is assigned a meaningful quantitative attribute within the context of a study thus allowing the hypotheses to be tested. Four prudential regulatory areas set out by SASRA, namely capital adequacy, liquidity; investment, and asset quality were taken as independent variables with causal effects on the management allocative decisions indicated by technical efficiency achieved. The conceptualization further recognizes that efficiency varies with the size of the financial institution and hence the consideration of the SACCO size measured by the Total Assets as a moderating variable. The study's variables were conceptualized as shown in Table 3.1.

Table 3.1: Operationalization of Key Variables in the Study

Variable	Data Type	Measurement	Source
Independent Variables (Prudential regulations)			
Capital Adequacy requirement (Core Capital /Total assets)	Binary	The ratio of Core capital to Total Assets	SASRA (2010) Sacco's societies act (2008)
Liquidity Requirements (Liquidity Ratio)	Binary	Determined as Cash and cash Equivalent divided by Total short-term liabilities and Short-term deposits	SASRA (2010) Sacco's societies act (2008)
Assets Quality Requirement	Binary	The ratio of Total loan loss provision/Gross Loans	SASRA (2010) Sacco's societies act (2008)
Investment Requirements (Financial Investment /Total assets)	Binary	The ratio of Total financial investments (Quoted andNon Quoted Investments) to Total Assets	SASRA (2010) Sacco's societies act (2008)
Dependent Variable (Efficiency)			
Technical Efficiency	Continuous (Right Censured)	DEA Efficiency scores Using Total Deposits, Total Labor Expenses Core Capital as inputs. Gross loans and Financial Investments as outputs	Bassem (2008) Rauch, et al, (2009) Pasiourus (2007)
Sacco Size	Binary	Large DTS: Total Assets > Shs 1 Billion Small DTS Total Assets < Shs 1 Billion	SASRA (2010) Rauch, et al, (2009) Niringiye et al (2010)

3.9.2. Efficiency Estimation Using Data Envelopment Analysis (DEA)

A non-parametric, Data Envelopment Analysis (DEA) approach was used as an efficiency estimation tool anchored on an intermediation approach and input orientation. Intermediation approach models banks and micro-financial institutions as units that collect funds between surplus units often from depositors and channels them to deficit units in form of creditors or borrowers (Gulati, 2015). Intermediaries use innovative financial products or services to collect deposits and other liabilities for onward lending and investment in interest-earning assets, investments and securities. Burki & Niazi, 2010 recommends the intermediation approach in the analysis of bank-level efficiency.

DEA models measure efficiency through two broad orientation, the input and output approach. Input oriented DEA determines how much inputs contracts if used efficiently for a given level of output. In contrast, Output oriented DEA models assume fixed inputs and test the deviation of outputs against an efficient frontier (Othman et al., 2014). The choice of the input orientation was anchored on the preposition that input quantities are primarily proxies to the economic factors of production and decision variables within the control of DTS management. Based on an input-output suitability test Total Deposits, Core Capital, and Labour Cost were selected as inputs while Total Loans and Financial Investments were used as outputs.

Assuming that the number of DTSs in the sample are *s* and each DTS uses *m* inputs and produces *n* outputs. If DTS_k is assumed to be one of *s* DTS, $1 \leq k \leq s$ and taking *m* inputs which are marked with $X^k{}_i$ (i = 1... m), and n outputs marked with $Y^k{}_j$ (j = 1... n). Taking efficiency the ratio of total outputs divided by total inputs, the efficiency of DTS_k was computed as:

$$\text{The efficiency of } DTS_k = \frac{\sum_{j=1}^{n} u_{jY_j^k}}{\sum_{i=1}^{m} v_i X_i^k} \quad \ldots\ldots(1)$$

$X_i^k, Y_j^k \geq 0$, $i = 1,\ldots, m$, $j = 1,\ldots.n$, $k = 1,\ldots,s$

$u_j, V_i \geq 0$, $i = 1,\ldots, m$, $j = 1,\ldots.n$

Where V_i, U_j are virtual multipliers (weights) for the i th input and the j th output. When the CCR model is considered, constant returns to scale (CRS) are assumed to apply; meaning that one unit of input delivers a fixed value of output. The BCC model, on the other hand, assumes variable returns to scale (VRS). In this study, the CCR dual model for estimating Overall Technical Efficiency (OTE) takes the following form;

Minimize

$$\theta - \varepsilon\left[\sum_{i=1}^{m} S_i^- + \sum_{k=1}^{n} S_j^+\right] \qquad \ldots\ldots (2)$$

Subject to:

$$\sum_{i=1}^{s} \lambda_r X_i^r - \theta X_i^k + S_i^- = 0 \qquad i = 1, \ldots, m$$

$$\sum_{i=1}^{s} \lambda_r Y_j^r - S_i^+ = Y_j^r \qquad j = 1, \ldots, n$$

$$\lambda_r \geq 0 \quad r = 1,\ldots, s$$

$$S_i^- \geq 0 \quad i = 1,\ldots, m$$

$$S_j^+ \geq 0 \quad j = 1,\ldots, n$$

Where

= Efficiency of DTS

Si^{-} = A slack variable representing the input excess value

Sj^{+} = Surplus variable representing the output shortfall value

ε = A non-Archimedean number representing a very small constant

λ_r = Proportion of referencing DTS_r when measuring the efficiency of DTS_k

To estimate the efficiencies under VRS, the CCR dual model above was subjected to the following additional constraint;

$$\sum_{r=1}^{s} \lambda_r = 1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The above constraint frees the CCR model from a CRS assumption and introduces a VRS orientation to the efficiency estimation. Efficiency scores obtained from CCR model represent the overall technical efficiency (OTE) scores and are confounded by scale efficiencies while those that are obtained from the BCC model are pure technical efficiency (PTE) scores and devoid of scale efficiency effects. Consequently, Scale efficiency (SE) for each DMU was determined by a ratio of OTE score to PTE score.

DEA efficiency scores are relative efficiency index and violate the independence within the sample assumption required by regression analysis. To overcome this limitation, bias-corrected technical efficiency scores were generated based on a bootstrapping technique advocated by Simar and Wilson (1998). The entire efficiency estimation process was done using the Benchmarking package embedded in R software. In the second phase, fixed-effect regression models were fitted using the bias-corrected efficiency estimates obtained from DEA as the dependent variable and the compliance status on prudential regulatory indicators as independent variables was carried out based on the following model:

$$\theta_{it} = \beta_o + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where i = 1,2, …,110, and t = 1,2,3,4,5,6

Where:

θ_{it} = Bias Corrected Technical efficiency scores of DTS i at time t

β_i = Coefficients to be estimated ($i = 0 \ldots 4$)

X_{1it} = Capital requirement Compliance of DTS i at time t

X_{2it} = Liquidity requirement compliance of DTS i at time t

X_{3it} = Asset Quality requirement compliance of DTS i at time t

X_{4it} = Investment requirements compliance of DTS i at time t

ε_{it} = Error Term

The introduction of the moderating variable into the model was done through a dummy variable (Z) as indicated in equation (5).

$$\theta_{it} = \beta o + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + Z(\beta m + X_{1it} + \beta m_2 X_{2it} + \beta m_3 X_{3it} + \beta m_{4it} X_{4it}) + \varepsilon_{it} \quad \ldots\ldots(5)$$

Where: β_i ($i = 0 \ldots 4$) X_i ($i = 1 \ldots 4$) and ε are as defined in equation (3)

βm_i, ($i = 0 \ldots 4$) Are coefficients of the moderated/interaction term

Z = Dummy variable for DTS size:

Z = 1 if Large DTS (total assets > 1 Billion shillings)

Z = 0 if Small (Total Assets ≤ 1 Billion shillings)

3.9.3 Panel Model Specification

Despite the attractiveness of panel data in regression estimation due to its ability to provide more information, increased precision of the estimates, more degrees of freedom, and less collinearity among the independent variables, poses estimation and inferential challenges (Gujarati, 2012). Three possible estimation models exist for panel data; a Pooled OLS model that combines or pools all the cross-sectional data and estimates the underlying model based on the ordinary least squares (Equation (6)); Fixed Effects Model (FEM) allows individual unit's intercepts to vary (Equation (7)) and a Random Effect Model (REM) improves the OLS estimation process by accounting for cross-sectional and time-series disturbances (Equation (8)) (Gujarati, 2012).

$$Y_{it} = \alpha + \beta X'_{it} + \varepsilon_{it} \quad (6)$$

$$Y_{it} = \alpha + \beta X'_{it} + \mu + \varepsilon_{it} \quad (7)$$

$$Y_{it} = \alpha + \beta X'_{it} + \mu_{it} + \varepsilon_{it} \quad (8)$$

$\mathbf{Y_{it}}$ = Efficiency score for DTS i at time t.

$\mathbf{X'_{it}}$ = Vector representing independent variable for DTS i at time t

β = Vector of independent variable coefficients

μ = Fixed effect

ε_{it} = Error term

μ_i = between entity error term

α = Intercept of DTS i

Each of the three estimation methods has merits and demerits worth consideration. The pooled OLS model bears with it the advantages of the traditional OLS estimation with the assumption of constant intercept and slope being its core drawback. The fixed-effects model is known to produce unbiased estimates of β, but those estimates under certain conditions, are highly sample-dependent, that is, overly sensitive to the random error in any given dataset (Clark and Linzer, 2012). The random effect model on the other hand has greater capability in constraining the variance of estimates leading to estimates that are closer, on average, to the true value in any particular sample. However, in rare circumstances, it has been found to introduce bias in estimates through partial pooling and calls for compliance with an assumption of no correlation between the covariate and the unit effects.

The choice of the best analysis model was achieved through a series of diagnostic tests seen in Table 3.9.1. Breusch Pagan LM test was used to assess the suitability of the Pooled OLS model vis-a-vis a random effect model, Hausman test provided a means for segregating between random and fixed effect models while the F test was used to assess the need for time dummies in fixed effect.

Table 3.2. Panel Model selection tests

Test	Test used	Decision Rule
Fixed Effect Vs Pooled OLS	Poolability Test	If $p < 0.05$, Fixed effect is Preferred
Pooled Vs random-effects model	Breusch Pagan LM test	If P-Value >0.05, use the pooled effects model.
Random or fixed effects	Hausman test	If P-Value>0.05, use a random-effects model
Time Fixed Effects	F statistics	If P-Value >0.05, there are no time fixed effects

Table 3.3: Data Analysis Methods

Objective	Independent Variable	Dependent Variable	Hypothesis	Analysis Tool
Capital adequacy requirement and efficiency	Capital adequacy Requirements (Core capital/Total Assets)	DEA Efficiency scores	Ho: $\beta 1 = 0$ H_1: $\beta 1 \neq 0$ Tested at $\alpha = 0.05$	
Liquidity Requirement and efficiency	Liquidity Requirements (Net Liquid Assets / Total short-term liabilities)	DEA Efficiency scores	Ho: $\beta_2 = 0$ H_1: $\beta_2 \neq 0$ Tested at $\alpha = 0.05$	DEA Fixed effect with Time dummies
Risk classification of assets and provision requirement and efficiency	Asset quality requirements (Total loan provisions/Total loans and Advances)	DEA Efficiency scores	Ho: β_3, = 0 H_1: β_3, $\neq 0$ Tested at $\alpha = 0.05$	
Investment requirement and efficiency	Investments Requirements (Financial Investment /Total deposit liabilities)	DEA Efficiency scores	Ho: $\beta_4 = 0$ H_1: $\beta_4 \neq 0$ Tested at $\alpha = 0.05$	
Mediating effects of DTS's size between	Mediating Variable: Dummy of DTS size Total Assets	DEA Efficiency scores	Ho: $\beta_{M1}, \beta_{M2}, \beta_{M3}, \beta_{M4} = 0$ H_1: $\beta_{M1}, \beta_{M2}, \beta_{M3}, \beta_{M4} \neq 0$	DEA, Fixed effect with Time dummies

prudential requirement and efficiency	(Shs) (1 = large DTS, 0 = Small DTS)		F change Statistic Tested at $\alpha = 0.05$

*Based on the Bootstrapping technique to overcome Efficiency score dependence within the sample.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1. Introduction

This chapter presents findings and discussions structured according to the specific objectives of the study. It begins with an assessment of the success rate of the secondary data collection process. This is followed by a description of the inputs, outputs, and compliance status of DTS. The results of the two-stage analysis methodology are presented where technical efficiency scores estimated using a linear programming Data Envelopment Analysis model with bootstrapping to correct for within-sample bias are presented. In the second stage, the results of the fixed effect regression model are discussed. The last section of the chapter presents the results of the hypotheses test.

4.2 Sample Representation

The units of analysis in this study were Savings and Cooperative Societies (Saccos) licensed to operate front office services in Kenya as prescribed in the Saccos Societies Act 2008. Out of the 215 Saccos in operation in 2011, a time when SACCO regulations were introduced, 110 Saccos were fully licensed and were expected to maintain operation in perpetuity formed the target population of the study. However, the license of one (1) DTS was revoked in 2015 due to persistent undercapitalization, leaving 109 DTSs available for the study. Eight (8) Saccos were found to have incomplete financial records and were dropped while financial statements for another six (6) DTSs were inaccessible during the data collection period due to annual inspection, leaving six-year panel data from 95 Saccos available for analysis, an 87.2% response rate.

4.3 Descriptive Analysis

This section presents descriptive statistics of independent, dependent and moderating variables of the study. The descriptive analysis explored the status of inputs and outputs used to model Sacco efficiency, prudential ratios and DTS compliance status over the six years reviewed.

4.3.1. Performance of DTS on Indicators Subject to Prudential Regulation

The objective of this study was to assess the influence of complying with prudential requirements set out by the regulator (SASRA) often set as minimum or maximum financial ratio on the efficiency of DTSs. To determine the levels of compliance, eight key financial measures namely; core capital, total deposits, gross loans, financial investments, liquid assets, total assets, and short-term liabilities were extracted from the financial statements of the DTS to facilitate the computation of key ratio and determination of the individual's DTS compliance status. Table 4.1 presents a descriptive summary of the eight variables.

Core capital, a measure of DTS's financial soundness and its ability to absorb reasonable amounts of loss without impairing its operations increased progressively over the six years under review from the initial mean of 115 (*SD* = 263) million shilling in 2011 to 539.8 (*SD* = 842) million shillings in 2016, a 369% increase. The increase is highly attributed to the enforcement of minimum core capital of 10 million Kenya shillings and an equivalent 10% of its total deposits as minimum core capital, a position that the majority of DTSs were not compliant at the inception of the regulatory framework in 2010 but has been progressively achieved over the transition period.

The mean annual deposits more than doubled over the six years increasing from an initial mean of 1.1 (*SD* = 2.07) billion shilling in 2011 to 2.35 (SD = 4.67) billion shillings in 2016. The radical move by the regulator to allow previously excluded non-members to operate deposit accounts in DTS FOSA sections, raising membership from an initial 2.6

million in 2011 to 3.6 million members in 2016 is highly attributable to the buildup of deposits (SARSA, 2011, 2016). The variation of deposits within the sample was however wide with standard deviation consistently more than double the mean annual deposits in all the six years under review. This can be explained by the nature of the SACCO sector in Kenya where small DTS with deposits of less the 15 million shillings operating in the same environment with large DTS with deposits above 25 billion shillings.

Table 4.1: Summary Statistics of Study Financial Performance Indicators

Year	Core Capital	Total Deposit	Gross Loans	Financial Investments	Liquid Assets	Loan Loss Provision	Total Assets	Deposits and Other ST Liabilities
2011	115.4	1,112.6	1,331.3	65.5	137.8	103.7	1,590.8	1,475.4
	(263)	(2,068)	(2,764)	(166)	(211)	(866)	(2902)	(2,817)
2012	149.8	1,291.4	1,541.8	70.3	166.4	114	1,838.9	1,689.1
	(200)	(2,350)	(3,148)	(172)	(262)	(919)	(3,309)	(3,215)
2013	254.1	1,515.3	1,722.2	70.9	184.8	73.7	2,169.4	1,915.2
	(461)	(2,669)	(3,084)	(136)	(275)	(443)	(3,734)	(3,340)
2014	358.1	1,718.1	2,013.7	90.4	205.2	84	2,565.6	2,211.3
	(710)	(2,983)	(3,481)	(193)	(3930	(453)	(4,440)	(3,820)
2015	467.2	2,034.8	2,249.0	112.1	232.7	186.9	2,924.4	2,457.2
	(831)	(3,515)	(4,155)	(224)	(376)	(1,232)	(5,023)	(4,276)
2016	539.8	2,341.8	2,591.6	107.9	318.2	258.5	3,379.9	2,840.2
	(842)	(4,024)	(4,672)	(195)	(520)	(1,358)	(5,723)	(4,993)

Note: (1) The Figures in parenthesis are Standard deviation. (2) The figures are in Ksh millions

The growth in deposits was accompanied by similar levels of growth in gross lending that grew from an annual mean of 1.33 (SD = 2.76) billion shillings in 2011 to 2.59(SD = 4.67) billion shillings in 2016, a 95% increase over the six years. In each of the six years, the mean annual gross loans surpassed the mean annual deposits by a margin of between 10.6% and 9.6%, a similar trend reported by the regulator over a similar period (SASRA, 2012-2016). The ability of DTS to lend more than its total deposits is attributed to two key factors. One is the nature of their deposits where non-withdraw-able deposits account for close to 80% of the total deposits, an amount that can be used as security when acquiring a loan. Secondly, it is fundamental that an increase in deposits, through the principle of money multiplier should create more than an equivalent loan portfolio. This calls for caution when comparison has to be made between efficiency levels of commercial banks and financial institutions based on membership guaranteed lending.

Financial investments posted a weak growth trajectory over the six years with a mean annual financial investment of 65.5(SD = 166) million shillings in 2011 increasing marginally to a mean of 107.9(SD = 195) million shilling in 2016. Stagnation in the mean investment levels was evident in 2012-2013, a similar trend reported by Karuiki (2016). A decline in 2016, notably a period that coincides with the electoral periods in Kenya points to a conservative approach in investments by DTS managers due to increased political risk a similar view held by Kariuki (2016) and pointed out in SASRA (2016). Minimizing political and economic risk associated with elections in Kenya is more likely to be the reason for conservative investments by DTS during these periods.

Similarly, levels of liquid assets maintained a modest growth between 2011(*M* = 137.8, SD = 211) and 2016 (*M* = 318, *SD* = 520), a cumulative 132 % jump in the mean annual liquid assets in six years. Liquidity remains a key challenge in most Saccos because of entitlement upon meeting less stringent requirements for one to access credit (Ademba, 20100. Furthermore, the leading reason for increased membership in the sector is often due to quick access to relatively cheaper credit facilities compared to commercial banks. While the increase in deposits and capital should have translated to higher liquidity levels, the demand for loans however could have reduced the liquidity levels significantly as noted in the industry regulator (SASRA, 2016).

With the mean annual gross loans increasing by 95% over the six years, the loan provisions over the same period increased by 168%, an indication that default risk exposure increased substantially. While the significant decline was witnessed in 2013 and 2014, at the onset of the new regulations, provisions made in 2015 and 2016 were significantly higher. With the provisions translating to more than 5% recommended by WOCCU, it is a pointer to managerial inefficiencies given that the credit-lending model in the DT-Saccos is more secure as it is mostly premised on guarantor-ship and deposits collateral meant to cushion DTS against bad loans (WOCCU, 2016).

The SACCO sector in Kenya is highly credited for its immense ability to mobilize assets with a substantial proportion funded by growth in deposits and lending. In the six years reviewed, the annual mean total assets grew from 1.59 (SD = 2.9) billion shillings in 2011 to 3.38 (SD = 4.99) billion shillings in 2016 representing a 92.3% and a year-to-year average growth of 16.3%. This is higher than year-to-year growth rates reported by the regulator over the same period (SASRA, 2017) of 14.7%. The marginal difference can be attributed to the difference in the number of DTS used in the sample as compared to all the DTS used by the regulator. According to Kariuki, (2016) opening up of the common bond to allow for expanded membership and better stability envisaged with the introduction of regulation for the sectors could have a key driver of the growth witnessed in both assets and loan portfolios.

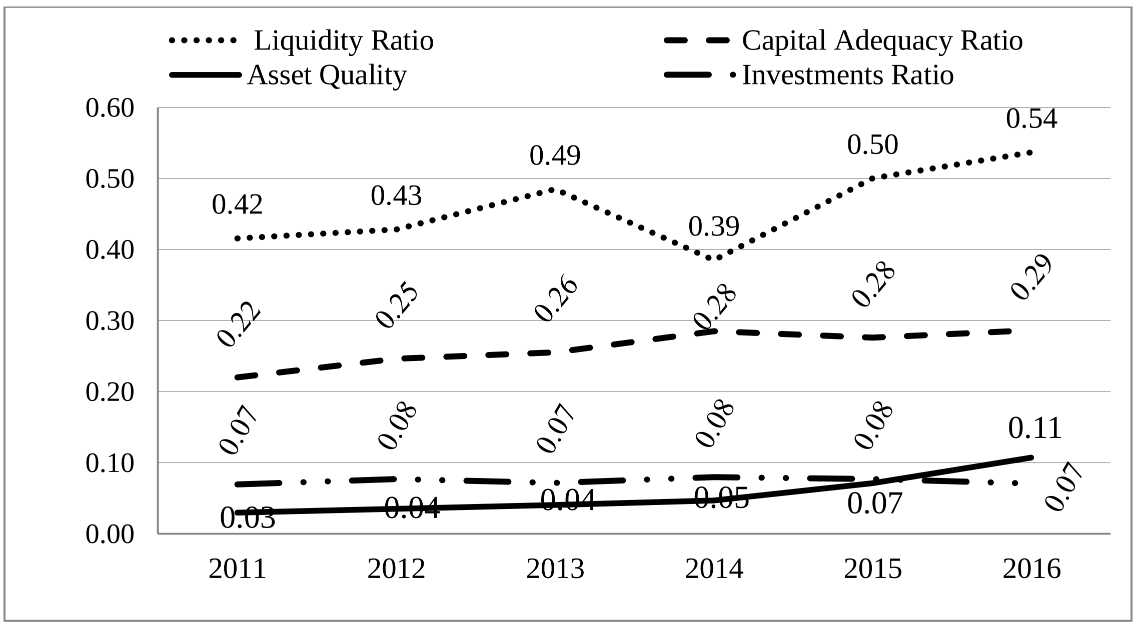
The mean annual deposits and other short-term liabilities maintained a mean year-to-year growth rate of 12.4% between 2011 (M = 1.475, SD = 2.82) and 2016 (M = 2.84, SD = 4.99). Theoretically, this is expected given the intermediation role of Saccos in the financial system where they are expected to bridge between net savers and deficit units largely seen as investors or loan borrowers. This is a pointer to increased overall liability acquired by DTSs to finance their loan portfolio and operating expenses. While this gives DTSs a relatively cheaper source of finance, higher levels of such liabilities could potentially increase liquidity risks (Osoro & Muturi, 2015).

4.3.2. Trend Analysis of DTS Prudential Ratios between 2011 -2016

Financial prudential regulations are predominantly denoted as a ratio of two financial indicators or a minimum or a maximum limit upon which compliance is judged. SASRA in defining the regulatory framework on which all DTS are regulated has set out a minimum core capital amount of 10 million Kenya shillings in addition to other three capital adequacy ratios; core capital to total deposits (Minimum 10%), core capital to total assets (Minimum 8%), and institutional capital to total assets set at a minimum of 8%. A ratio of net liquid assets to total short-term liabilities set at a minimum of 15% was selected as an indicator of liquidity risks while total loan loss provision to gross loans was pegged at less than 5%. To limit risk exposure emanating from poor investment decisions, four ratios are set out. The value of land and building to total assets capped at a maximum of 5%, financial investments to core capital at a maximum of 40%, financial investments to total deposits at a maximum of 5% and non-earning assets to total assets pegged at a maximum of 10%.

From the four capital ratios, the 10 million minimum core capital did not potent a major challenge for DTS due to the open membership model. All the DTS were compliant in all the six years under review. Core capital to total deposits ratio was also less a burden for most DTS with the majority meeting the required 10% levels in their first three years after the coming into force of the regulatory framework in 2010. Potential inconsistencies in the reporting of institutional capital due to lack of clarity in its determination would potent possible estimation errors, increasing the risk of biased estimators and inferential results and hence was consequently dropped. Core capital to total assets ratio was a challenge to more than a third of the licensed DTS during the six years under review, a factor that led to its selection for analysis. Studies that have used the same ratio in assessing the performance of Saccos include Kariuki (2016), Ochola (2016b), Kipesha(2012) and Kahuthu (2016).

Differences in asset valuation methods were likely to pose a great challenge in obtaining the true value of land, building, and non-earning assets rendering the respective ratios less efficient and as a truly representative ratio of the actual investments (Miriti, 2014). With financial investments to core capital limit of a maximum of 40% too ambitious, none of the DTS was in violation and hence was dropped from the analysis, leaving financial investment to total deposit the preferred investment ratio for analysis. The liquidity ratio and loss provision ratio was the only ratios in their category that were incorporated into the analytical models. The mean annual ratios of each of the selected prudential ratios over the six years under review were as seen in Figure 4.1.



Note: the ratios represent annual means. Liquidity ratio = net liquid assets ÷ Total short-term liabilities and withdraw-able deposits. Capital adequacy = core capital ÷ Total Assets. Asset Quality ratio = total Loan loss provision ÷ gross loans. Financial investment ratio = Financial investments ÷ Total deposits

Figure 4.1. Trend Analysis of DTS Prudential Ratios between 2011 and 2016

The mean annual ratio of core capital to total assets maintained a steady increase over the six years from 22% in 2011 to 28.7% in 2016 an indication that more DTS were maintaining a relatively higher capital adequacy ratio that the prescribed 10% minimum. Kariuki (2017) reported similar findings. Higher ratios were however reported by the regulator over the same period (SASRA, 2016). While this could be an indicator of a sound financial position for the DTS sub-sector, 21.5% of the licensed DTS had not met this regulatory requirement by the end of 2016 (SASRA, 2016). This could be a pointer to a significant number of large DTS holding higher core capital exposing them to potential inefficiency while a significant proportion of smaller DTS facing changes in matching their capital with an increase in assets. This is corroborated by evidence seen in Figure 4.9.2.

Asset quality measured as a ratio of loan loss provisions to gross loans remained within recommended limits between 2011 and 2014; however, in 2016 the ratio significantly grew to 11%, a 3% jump from the previous year 2015, a position that is significantly higher than the recommended level of 5%, raising concern on future default rates. Higher loan-loss provision potentially increases non-performing loans and loan losses placing a strain on the ability of management to convert deposits into interest-earning assets effectively. The higher loan-loss provision means increased credit risk arising from liberal lending policies.

The investment ratio did not show any significant growth over the study period with the mean annual ratio stagnating at between 7 - 8% of the total deposit liabilities. As per the SASRA's regulation (48) (4), DTSs are prohibited from making financial investments in non-government securities above five percent of its total deposits liabilities. This is an indication that most DTSs have not made any major adjustments to the pre-regulation investment levels. While the core objective of restricting DTS investment choices to less risky option was to promote prudence, this has the potential of significantly reducing non-interest income. Limiting investments in non-government securities places a cap on the risk levels that a DTS can accommodate, significantly affecting optimal allocation resources within available investment opportunities that would otherwise yield better return.

The mean annual Liquidity ratio maintained an increasing trend except for the year 2014 where the ratio dropped from 49% to 39%, the lowest in the six years under review. With the majority of DTS maintaining liquidity levels over and above the prescribed minimum levels of 15%, it was an indication that the sector was faced with lower liquidity risk expose. Growth in capital and deposits as well as limited investment options occasioned by capping on investments in land and building may have left most DTS with high liquidity. It is, however, ironic that most DTS continues to report challenges in meeting short-term lending obligations (SASRA, 2016). This is occasioned by demand for loans, where a member once qualified is deemed a right (Osoro & Muturi, 2015).

4.3.3. Compliance Status of DTS on prudential Ration between 2011 and 2016

The proportion of DTSs that met the prescribed minimum or maximum ratio set out by SASRA in the four regulatory areas over the six years reviewed were as indicated in Figure 4.2.

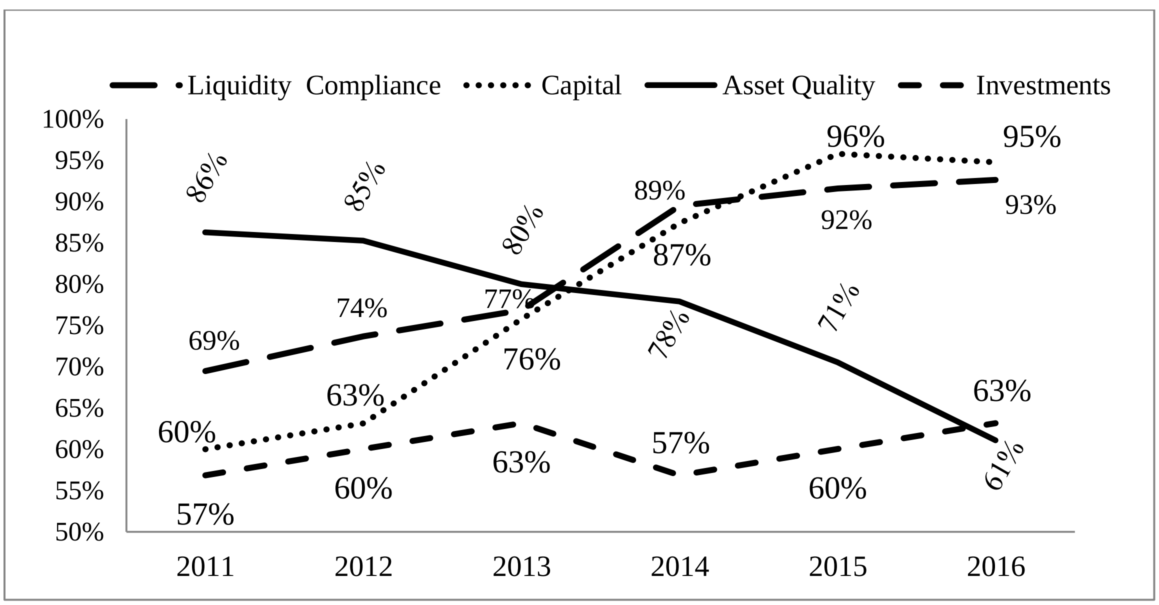


Figure 4.2: Status of DTS Compliance on Prudential Ratios between 2011 -2016

Capital adequacy has been widely considered a strong determinant of institutional stability and the first-line defense in times of financial crisis (Chortareas et al., 2011). The number of DTS that exceeded the minimum 10% ratio of core capital to total assets increased consistently from 60% in 2011 to 95% in 2016 (see Appendix IV for yearly distribution of DTS compliance). This is an indication that more DTS accumulated sufficient capital and strengthened their stability as envisage in the Sacco regulatory framework, a similar position held by Kivuvo and Olmeny (2014). Further analyses indicate that majority of the DTS that had not achieved compliance were small DTS limited in both membership and outreach having been licensed a few years before the introduction of the Sacco Societies Act 2008.

The proportion of DTS that also met the minimum 15% ratio of liquid assets to withdraw-able deposits and short-term liabilities shows an upward trend increasing from an initial 69% in 2011 to 93% compliance in 2016. This indicates that most DTSs were in a better position in meeting their short-term obligation on demand deposits and other short-term liabilities. Average liquidity ratio of between 39% and 49% in the six years is an indication that DTS in Kenya were holding more liquid assets at the expense of meeting their lending obligations. Appendix III provides the distribution of DTSs complying with the set liquidity ratio between 2011 and 2016. The findings are in tandem with the findings of Njeri (2014) indicating growth in the liquidity position of Saccos since the introduction of prudential regulations. While moderate liquidity enhances transactional efficiency, excess liquidity impairs efficiency as it translates into an idle resource with no returns and increased liquidity management costs.

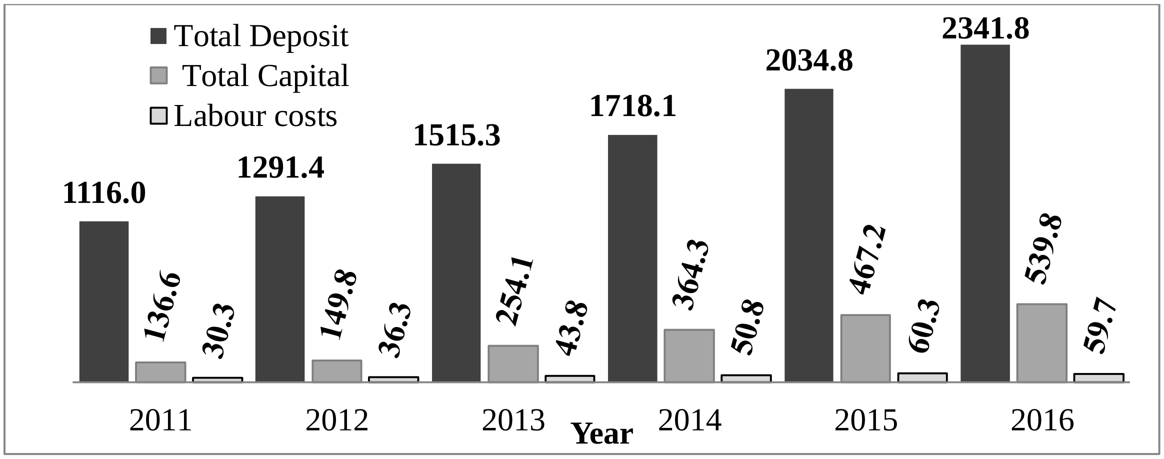
Contrary to the improvement seen in compliance with liquidity and capital ratios, there was a significant reduction in the proportion of DTS meeting the recommended 5% loan loss provision to total loans ratio. From an initial compliance level of 86% in 2011, the number of DTS attaining compliance drastically dropped to 61% in 2016 (also see Appendix V), a trend that denotes increased lending risks and sub-optimal credit management strategies. Significant increase in the loan portfolio, diversity in membership to include members outside the common bond and weak lending policies could have led to increased default rates.

Compliance with the maximum 5% financial investments in risky non-government securities in proportion to total deposits improved marginally from 57% in 2011 to 63% in 2016 as seen in Appendix VI. This was a similar trend reported by SASRA over the six year. This is a possible indication that DTSs are reluctant in disposing off some of their financial investments in risky portfolios due to lack of aggressive investment strategy in government-backed secured securities and continued reliance on interest income as a dominant income source.

4.3.4. Inputs and Outputs Trends Between2011 and 2016

Evidence from reviewed literature evaluating efficiency in financial institutions shows a preference for specific inputs and outputs. For instance, Kipesha (2012), Marwa & Aziakpono (2014), Kariuki (2016) and Ochola (2016b) adopted total assets, total deposits, total loans, financial investments, membership, labour cost and total revenues as preferred inputs and outputs. The levels of control over the specific input and the direct influence that the selected Saccos have on the output underpin the choice of inputs and outputs. Based on this conceptual framework, total deposits, capital and labor costs were selected as inputs while total loans and financial investments were selected as outputs.

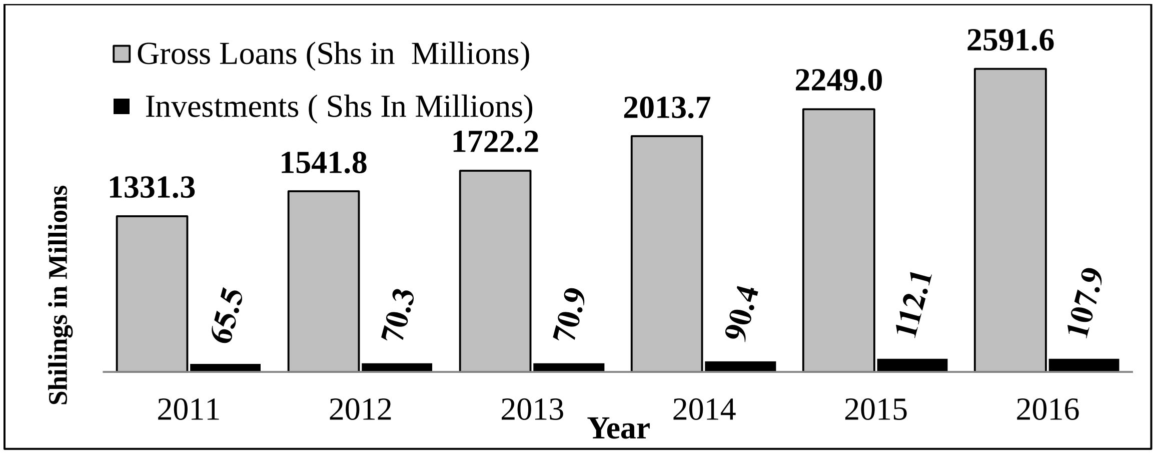
As seen in Figure 4.3, in the six-year under review, the mean annual deposits increased from 1.116 billion shillings in 2011 to 2.341 Billion shillings in 2016, representing a 109% increase over the six years. This can be closely attributed to the opening up of SACCO membership to the previously excluded general public raising the SACCO membership form 1.9 million in 2010 to 3.6 Million members by the end of 2016 (SASRA, 2011 & SASRA, 2016). The Mean annual core capital more than tripled over the same period from 136.6 million shillings to 539.8 million shillings, a growth that is more attributed to the concerted effort by DTS to meet higher capital adequacy ratios introduced by the SASRAs DTS regulations 2010. The average labor cost over the same period increased marginally from 30.3 million in 2011 to 59.7 million shillings having attained the highest level in 2015 at 60.3 million shillings repressing a 97% growth in six years. There is a strong similarity between the reported trend and those found by Kariuki (2016) and Ochola (2016b).



Note: The figures represent arithmetic means in Kshs Millions

Figure 4.3: Input Trends between 2011 and 2016

The growth in outputs as shown in Figure 4.3 follows a similar trend as inputs. Over the six years, the average annual gross loans increased consistently form 1.331 billion shillings in 2011 to 2.591 billion shillings, a 94.7% increase in six years under review. This could point to a heightened aggressiveness by DTS managers in convert-increased liquidity arising from increased deposits into loan assets. The average investments over the same period marginally increased by 64.7% from 65.5 million shillings in 2011 to 107.9 million shillings in 2016. A notable factor that might have contributed to the slow growth in investments being stringent restrictions on the investment risks that DTS can assume in line with the Saccos DTS regulations 2010.



Note: All the figures are in Million Kenya Shillings

Figure 4.4: Outputs Trends between 2011 and 2016

4.4. Estimation of DTS Technical Efficiency Using Data Envelopment Analysis

The choice of DEA in estimating DTS technical efficiency was based on several advantages discussed in the literature review section. One greatest advantage is the removal of the need to specify functional formats and model specification allowing for the use of multiple inputs and outputs without any prior judgment of their relative importance and subjectivity in allocating weights (Tsai et al., (2016). DEA, however, sets two conditions for accurate estimates; an isotonic relationship that must exist between inputs and outputs and correct specification of the industry return-to-scale. A confirmation of these assumptions was done and findings were presented in subsection 4.41.

4.4.1. Input-Output Isotonicity Test and Determination of the Sector's Return to Scale

For accurate efficiency estimation, DEA requires an isotonic relationship between input and output variables and a correct choice of industry's return to scale. Selecting the right combination of inputs and outputs in DEA analysis is paramount if the estimated efficiency scores are to be a true representation of managerial allocation quality. The Isotonicity test is performed on the selected set of inputs and outputs to ascertain whether the levels of outputs are at least the same, and do not fall when inputs increases (Adusei, 2016). Correlations between inputs and outputs should be positive and statistically significant.

With all input and output variables measured on a continuous scale and linearly related, Karl Pearson's product-moment correlation was used. Pearsons correlation under the standard assumption of normality is known to yield good statistical properties (Cooper & Schindler, 2011). The correlation analysis results seen in Table 4.2 returned Pearson's correlation coefficients of between 0.536 and 0.985 an indication of a unidirectional (positive) relationship between inputs and outputs. With all the coefficients attaining statistical significance at 0.05 levels of significance, it was a confirmation that an increase in inputs translates to a significant increase in outputs, and thus the selected inputs and outputs were appropriate for the DEA model.

Table 4.2: Karl Pearson's Correlation Coefficient between Inputs and Outputs

	Inputs			**Outputs**	
	Core Capital	**Total Deposit**	**Labour Cost**	**Gross Loans**	**Investments**
Core Capital	1				
Total Deposit	0.829***	1			
Labour Cost	0.817***	0.827***	1		
Gross Loans	0.825***	0.985***	0.803***	1	
Investments	0.579***	0.552***	0.536***	0.554***	1

Note: The coefficients are based on the DTS annual amounts (n = 570)

***. Correlation is significant at the 0.01 level (2-tailed).

Estimation of DEA efficiency scores is anchored on the definition of an efficient frontier in a production possibility set. The shape of the efficient frontier upon which the individual DMUs efficiency is estimated rests on the nature of the Returns-to-Scale on which the industry operates. To determine the underlying return to scale, a procedure developed by Simar and Wilson (2002) testing a null hypothesis of constant return to scale verses an alternate hypothesis of variable return to scale was employed. A test static ($\hat{S}$) determined by the ratio of constant returns to scale $\widehat{\theta}^{crs}$ efficiency scores to variable return to scale $\widehat{\theta}^{vrs}$ efficiency score is computed as shown in equation (9)

$$\hat{s} = \frac{\widehat{\theta}^{crs}(x,y)}{\widehat{\theta}^{vrs}(x,y)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(9)$$

Due to the presence of a univariate parameter in the computation of the test statistic whose distribution is not known, Samar and Wilson (2002) proposes a bootstrapping technique. Using a bootstrap of 1000 replications, the approximation of the sampling distribution of the estimates was generated to facilitate the hypothesis testing process. The resulting test statistic bootstrap $(\hat{S})$ returns a *p*-value of less than 0.05 as seen in Table 4.3 led to the rejection of the null hypothesis of constant return to scale, an indication that the industry operates in a continuously changing technological environment and consequently the adoption of a variable return to scale.

Table 4.3: Determination of Underlying Return to Scale

Test hypothesis	Test Statistic	P-Value
H_0: S(x, y) =1 H_1: S(x, y) < 1	S = 0.8479	0.033

Note: x, y represents a set of inputs (Capital, Deposits and Labour cost) and outputs (Loans and Investments) of DTS.

4.4.2. Estimation of Technical Efficiency and its Components

Data envelopment analysis, a non-parametric linear programming technique based on input orientation based on a variable return to scale was used to estimate the DTS intermediation technical efficiency scores based on the three inputs and two outputs. The choice of input orientation was informed by the recognition that DTS managers have little control over the outputs but have a significant influence on the deployment of inputs available to them. This is in concurrence with the orientation adopted by Kariuki (2016), Kamau (2013) Marwa and Aziakpono, (2013) in estimating efficiency in financial institutions.

The ability to decompose Technical efficiency into Pure Technical Efficiencies (PTE) depicting managerial capability to organize the inputs in the production process and Scale Efficiencies (SE) measuring the ability of managers to choose the optimum size of resources reveals the true sources of efficiency (Kumar & Gulati, 2008). Using the DEA approach, Technical Efficiency (TE), Pure Technical Efficiency (PTE), and Scale Efficiencies (SE) of each DTS based on BCC and CCR models were estimated under input orientation. The mean annual Technical, Pure Technical, and Scale efficiencies for the six years reviewed in the study were as presented in Table 4.4.

Over the six-year, the mean Technical efficiency of the sampled DTSs was 72.9%, while Pure Technical and Scale efficiency stood at 57.9% and 78.9% respectively. A year-to-year review shows that technical efficiency dropped in 2012 by 2.4% compared to 2011, followed by a consistent increase between 2013 and 2015. Notably, there was also a 19% drop in 2016 to a mean of 59.2% compared to 78.2% mean efficiency in 2015.

Table 4.4: Summary of Mean Efficiency Scores Between2011 and 2016

Year	Tech Efficiency(VRS)	Pure Tech Efficiency(CRS)	Scale Efficiency
2011	0.753	0.654	0.869
2012	0.729	0.410	0.562
2013	0.744	0.637	0.856
2014	0.773	0.653	0.844
2015	0.782	0.713	0.909
2016	0.592	0.410	0.693
Mean	0.729	0.579	0.789
Maximum	0.834	1	1
Minimum	0.0852	0.095	0.120
SD	0.1698	0.257	0.234

The pure technical and scale efficiency scores witness over the six-year shows a close association, leading to a relatively stable trend in technical efficiency scores as depicted in Figure 4.5. This suggests the presence of a significant level of information asymmetry in the sector and variation in allocative decisions attributed to individual managerial capabilities. The distribution of DTS based on their technical efficiency scores maintained an upward trend between 2012 and 2015 followed by a drastic decline in 2016 (Appendix IX). These trends are similar to those found by Kariuki (2016) between 2011 and 2016 and by Kimutai et al. (2019) between 2012 and 2016 among licensed DTS. The most plausible reason for the current trend is the political cycles in Kenya.

In 2012 and 2016, a significant decline in efficiency was witnessed, a trend that was also evident in the findings of Kimutai et al. (2019). Both years were pre-election periods in Kenya and are characterized by negative growth in investment, household consumption, and economic uncertainty (World Bank, (2011); MITC, (2017)). In such an environment, private-sector lending and investments are significantly suppressed, compounded by the need for DTS to take a cautious position that minimizes both political and economic risk exposure.

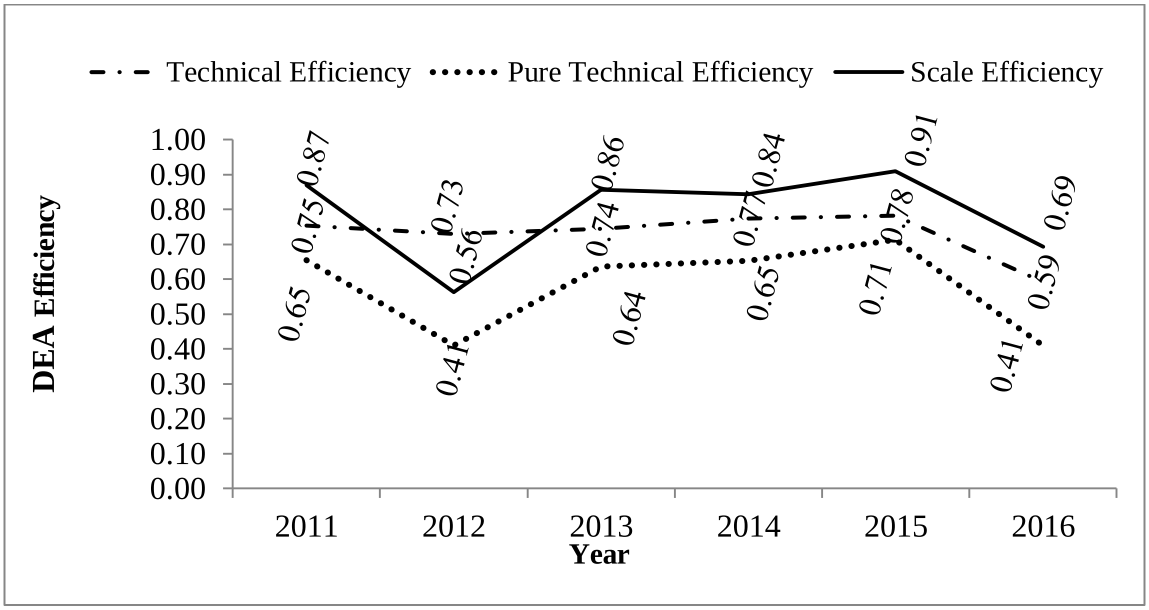


Figure 4.5: Efficiency Trends between 2011 and 2016

4.4.3. Analysis of Efficiency Changes between 2011 and 2016

Efficiency changes over time present critical information in understanding the influence of environmental factors on efficiency over time. To explore the changes in DTS efficiency over the six years, the Malmquist Productivity Index (MPI) based on the Data Envelopment Analysis approach was used. The choice of MPI in exploring efficiency changes over time has gained wider acceptance among scholars due to its ability to handle large set information in panel data as well as having favorable interpretive properties (Gwahula, 2013).

Malmquist Productivity Index decomposes productivity changes into Technical Efficiency (TE) changes ("Catch up effect") and Technological (TeCH) change ("frontier shift effects"). TE change is further decomposed into Pure Technical efficiency (PTE) change and Scale efficiency (SE) changes. An additional measure, Malmquist Total factor productivity (TFP) change is also introduced to measures the changes in total factor productivity of the DTS between two successive years by calculating the ratio of each data point relative to a common technology. A Data Envelopment Analysis Computer Program (DEAP) developed by Coelli (1996) was used in generating the efficiency changes indices between 2011 and 2016 as seen in Table 4.5.

Table 4.5: Summary of Efficiency Change Indices between 2011 -2016

Year	TE Change	TeCH Change	PTE Change	SE Change	TFP Change
2011-2012	1.038	0.946	1.043	0.995	0.982
2012 -2013	0.807	1.101	0.849	0.95	0.888
2013 -2014	0.544	1.826	0.685	0.795	0.994
2014-2015	2.523	2.157	1.793	1.408	5.442
2015-2016	0.54	1.872	0.759	0.711	1.011
Mean	**0.909**	**1.503**	**0.962**	**0.945**	**1.367**

Note: All the index averages are geometric means.

Mixed results were found on the four efficiency indicators and productivity change measures during the six years under review. The mean technical efficiency decreased by 9.1%, while Technological efficiency change significantly increased by 50.3% over the same period. Pure technical efficiency change on the other hand decreased marginally by 3.8%, while scale efficiency change decreasing by 5.5%, cumulatively resulting in a 36.7% increase in the total productivity change. The changes that took place between 2014 and 2015 in all the five measures of efficiency were notably incremental, with the highest contribution to change in productivity attributed mainly to frontier shift changes (115% improvement) compared to 79.3% improvement in management input allocation efficiency.

Productivity changes were notably on the decline between 2011/2012 to 2013/2014 similar to what was found by Karuiki (2016). This was followed by an increase during the 2014/2015 and 2015/2016 reporting periods. The decline in productivity change during the initial periods points to a possible regulatory shock and likely reorganization of input allocation systems among DTS to achieve compliance, negatively affecting their efficiency.

4.4.4. Bias Corrected Technical Efficiency Scores

The estimation of efficiency score through DEA is based on a comparison of efficiencies of the individual DMU relative to an efficient frontier generated by a combined set of all DMUs (Simar & Wilson, 1998). This means that the efficiency score is a relatively efficient index rather than an absolute index. Where efficiency scores are part of estimation or predictive model, Chernik and LaBudde (2011) caution that the assumption of independence within the sample is violated and consequently the estimated coefficients are inherently biased and inconsistent.

In addressing this shortcoming, Simar and Wilson (1998) proposed a bias correction procedure based on a bootstrapping technique as discussed in the methodology chapter. A bootstrapping procedure based on 200 bootstrap samples selecting five DTS with replacement was implemented using rDEA package running on statistical R software. The results examining the full sample, large and small DTS were as summarized in Table 4.6.

Table 4.6: Technical and Biased Corrected Efficiency Scores Distribution by Size

YEAR	Panel 1 : Full Sample(n = 95)		Panel 2: Large DTS		Panel 3 Small DTS	
	TE Eff	Bias Corrected	TE Eff	Bias Corrected	TE Eff	Bias Corrected
2011	0.753	0.583	0.738	0.582	0.600	0.583
2012	0.729	0.464	0.727	0.448	0.731	0.477
2013	0.744	0.478	0.789	0.479	0.704	0.477
2014	0.773	0.603	0.806	0.615	0.738	0.590
2015	0.782	0.653	0.823	0.685	0.731	0.613
2016	0.592	0.481	0.598	0.489	0.583	0.468
Mean	0.729	0.544	0.744	0.552	0.681	0.535
Max	1	0.957	1	0.933	1	0.957
Min	0.1195	0.099	0.1195	0.099	0.1618	0.156
SD	0.234	0.175	0.239	0.184	0.225	0.165

Note: Size based on Total Assets Large DTS > 1 billion Kshs, Small DTs < 1 billion Khs

The mean bias-corrected VRS Technical efficiency score was higher in large DTS (55.2%, SD =18.4%) as compared to small DTS with a mean TE score of 53.5% (SD = 16.5%), a marginal decrease of 1.7%. A decline in the mean bias-corrected efficiency score was evident in the year 2012 and more significantly, in 2016, a similar trend noted in the findings of Kariuki (2016), a pattern that is mainly attributed to a turbulent economic environment associated with electoral cycles in Kenya. Larger DTS exhibited better technical efficiency on average than Smaller DTS, a difference that can be attributed to the exploitation of economies of scale.

All Bias corrected efficiency scores were less than the initial TE score in all six years understudy, an indication that technical efficiencies were overestimated. This was expected given the fact that determination of efficiency score using DEA relies on an estimated rather than true frontier obtained from a finite sample subject to sampling variation, an occurrence that leads to over-estimation of technical efficiency scores (Badunenko and Mozharovskyi, 2016)). Consequently, biased corrected Technical efficiency scores were used in the subsequent analysis in place of original technical efficiency scores.

To assess the variations of the individual DMU intercept and changes in slope over time to provide a basis on which the possible optimal model can be identified, an overlay graph of bias-corrected technical efficiency score was generated. According to Torres (2007) visually inspection of an overlay graph of the dependent variable over time reveals both individual DTS intercepts behavior and their slope over the panel period.

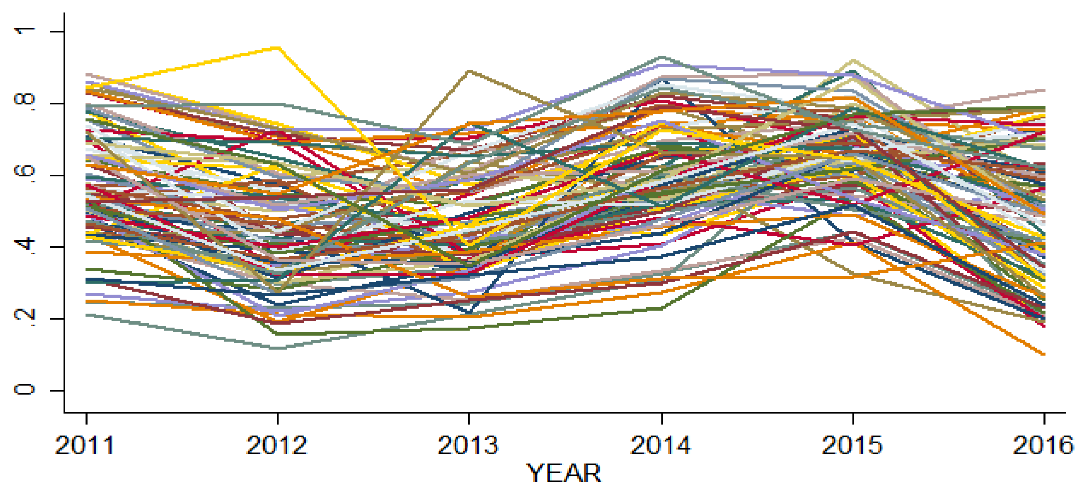


Figure 4.6: Overlay Graphs for Bias Corrected TE Efficiency Scores

Year to year changes in bias-corrected DTSs technical efficiency as seen in Figure 4.5. varied between individual DTSs while their slopes maintained a similar trend over time, an indication that there are no temporal effects and fixed-effect models would be the most likely suitable model of analysis subject to confirmatory tests. The year-to-year intercept indicates a drop in 2012 and a gradual three-year increase between 2012 and 2015 before a final drop in 2016. A similar pattern with a less magnified drop in 2012 was reported by Karuiki (2016) between 2011 and 2014, with a possible reason attributed to sampling variations.

4.5. Selection of Panel Estimation Model

The study sought not only to establish the influence of prudential regulations as defined by the levels of compliance with a set ratio on DTS technical efficiency but also to assess mediation effects of DTS size on the relationship between the compliance and allocative efficiency. Two-panel estimation models; moderated and un-moderated models were formulated as earlier discussed in the methodology chapter.

Compared to single period data, Panel data often contains more information and allows for precise and efficient estimated coefficients (Hoechle, 2007). While this is a desired attribute in the estimation process, the selection of the right estimation model is critical and involves a series of statistical tests. Three estimation models; pooled Ordinary Least squares method (Pooled OLS), Fixed Effect Model (FEM) and Random Effect Model (REM) dominated panel estimation techniques.

Pooled OLS combines the entire time series into cross-sectional data and estimates the underlying model based on the Ordinary Least Squares approach. Pooled OLS has three benefits. First, it overcomes the imbalance between too many explanatory variables and too few cases in small sample studies. Secondly, it permits better analysis of variables that elude studies in simple cross-sectional or time-series due to negligible variability or one existent across either time or space and lastly, it has an increased possibility of capturing not only the variation inherent through time or space but also the variation of these two dimensions simultaneously (Gujarati, 2012). However, it suffers from several limitations; lack of independence of errors across subsequent periods, correlation of error term across units, the possibility of homoscedasticity, existence of errors containing both temporal and cross-sectional components, and non-random across spatial and/or temporal units (Hsiao, 2007).

Fixed Effect Models allow for the intercepts in the regression model to differ across units in recognition that each unit of analysis possesses unique characteristics (Gujarati, 2012). The fixed-effects model produces unbiased coefficient estimates, but those estimates are open to high sample-to-sample variability and can lead to an overly sensitive coefficient to the random error in a different dataset. Additionally, fixed effects models require the estimation of a parameter for each DMU, substantially reducing the model's power and increasing the standard errors of the coefficient estimates (Linser & Clark, 2007).

In a Random Effects Model, it is assumed that unique time attributes within individual units are a result of random variation and hence, intercepts are random and do not correlate with the individual regressors. Random effects models enable estimation of coefficient with lower sample-to-sample variability by partially pooling information across units (Gelman & Hill 2007). A notable advantage with random effects models is that it does not involve the estimation of a set of dummy variables but instead uses the mean and standard deviation of the distribution of unit effects, consequently saving many degrees of freedom (Linser & Clark, 2007). However, the most recognizable drawback of the random effects is the inherent bias that partial pooling can introduce in the process of estimating coefficients. Several tests are available to guide the model selection process as presented in the following subsections.

4.5.1. Random or Pooled OLS

Breusch and Pagan Lagrangian multiplier test whether the data can be best-fitted using random effect compared to a pooled OLS regression model. A null hypothesis pitting the pooled OLS as the preferred model based on a postulation that variances across DTSs are zero is tested against a non-zero variances preposition. Both the moderated and non-moderated models yielded a similar outcome as seen in Table 4.7.

Table 4.7: Breusch and Pagan Lagrangian Multiplier test for Random Effects

Model	**Chi-Square Value**	**P-Value**
Un-moderated	188.70	0.000
Moderated	145.79	0.000

With the resulting Chi-Square *p*-values of both models less than 0.05, the null hypothesis of pooled OLS was rejected in favor of a random effect model, an indication that variances of bias-corrected technical efficiencies of the DTSs were significantly different from zero in both the moderated and the moderated models**.** Consequently, the pooled OLS was dropped.

4.5.2. Random Versus Fixed Models

To decide between fixed and random effects, a Hausman test recommended by Green (2008) was used postulating that unique errors (*ui*) are correlated with the regressors. If accepted, the random effect model would, therefore, be the preferred estimation model else a fixed effect model would be a preferred choice. As seen in Table 4.7.3, the Hausman test results for both unmoderated and moderated models returned *p*-values that were less than 0.05, leading to the rejection of the null hypothesis, an indication that the preferred estimation technique was the fixed-effect model. These results corroborate with evidence from the overlay graph in Figure 4.8.

Table 4.8: Hausman Test Results for Fixed vs Random Model

Model	Variables	(b) Fixed	(B) Random	(b-B) Difference	S.E.	Test Results
Un moderated	Liquidity	-0.0368	-0.0337	-0.0031	0.0087	Chi sqr =13.81
	Capital	0.0615	0.0361	0.0254	0.0084	
	Asset Quality	-0.0202	0.0161	-0.0364	0.0097	P-Value = 0.0079
	Investment	-0.0293	-0.0002	-0.0290	0.0149	
Moderated Model	Liquidity	-0.041	-0.040	-0.001	0.004	Chi sqr = 34.34
	Capital	-0.052	-0.065	0.014	0.005	
	Asset Quality	-0.052	-0.033	-0.018	0.007	
	Investment	-0.060	-0.018	-0.042	0.011	
	DTS Size	0.037	0.073	-0.036	0.027	
	Size_ Liquidity	-0.008	-0.009	0.001	0.006	P-Value = 0.000
	Size _ capital	0.016	0.018	-0.002	0.005	
	Size_ Asset Quality	0.067	0.072	-0.005	0.008	
	Size_ investment	0.002	-0.030	0.0317	0.012	

4.6. Fixed Effect Models Assumption Tests

Similar to the prerequisite to OLS regression model estimation, fixed-effects models are subject to several assumptions that must be met for coefficient estimated to be unbiased and efficient. Testing for homoscedasticity across both time and individual DMUs, normality of residuals, absence of serial correlation, multicollinearity, and specification bias are prerequisites test for accurate inferences. The results of each test were as highlighted in the following subsections.

4.6.1. Test for Heteroscedasticity

Deriving accurate and unbiased coefficients in a regression model requires residuals to have constant variance (homoscedastic) across time and panel units. Violation of homoscedasticity assumption leads to smaller standard errors of estimates than these of conventional OLS, resulting in biased test statistics and inferences (Gujarati, 2004). Modified wald test for group-wise hetero-scedasticity in fixed model regression was used to test a null hypothesis of constant variance against an alternate hypothesis of hetero-scedasticity. The findings were as presented in Table 4.9.

Table 4.9: Modified Wald Test for Heteroschedaticity Results

Model	Chi-square Value	P-Value
Un-moderated	2154.14	0.000
Moderated	4675.75	0.000

Both the moderated and un-moderated models' Chi-square test statistic had *P-Value*s less than 0.05, leading to the rejection of the null hypothesis, an indication that hetero-scedasticity was present in both models. Where hetero-scedasticity is present, hetero-scedastic robust standard errors, also known as Huber/White or sandwich estimators should be used instead as proposed by Huber (1967), a recommendation that was adopted in both estimation models in this study.

4.6.2. Normality of Residuals

The second assumption that must be adhered to for unbiased and efficient estimators is the normality of residuals. While many empirical studies have placed less emphasis on the need for residuals to be normally distributed, it is known for enhancing the accuracy of statistical results through improved confidence intervals and test statistics (Greene, 2012). An assumption of multivariate normality is difficult to verify considering the stringency associated with Hypothesis tests and limitation in multivariate diagnostic plots where only two variables can be assessed at a time (Doornik & Hansen 2008). A multivariate normality test, Doornik-Hansen test based on skewness and kurtosis of the data, and a null hypothesis of normally distributed residuals were used. The results for both the unmoderated and the moderated models were as summarized in Table 4.10.

Table 4.10: Doornik-Hansen Normality Test Results

Model	Chi-Square	P-Value
Un-moderated	1.657	0.4364
Moderated	2.533	0.2790

The *p*-values of the Doornik-Hansen test statistic, (chi-square) were higher than 0.05 leading to the acceptance of null hypotheses in both models an indication that the distribution of the residuals in both models follows a normal distribution. These results were confirmed by residual plots in Figures 4.6 and 4.7.

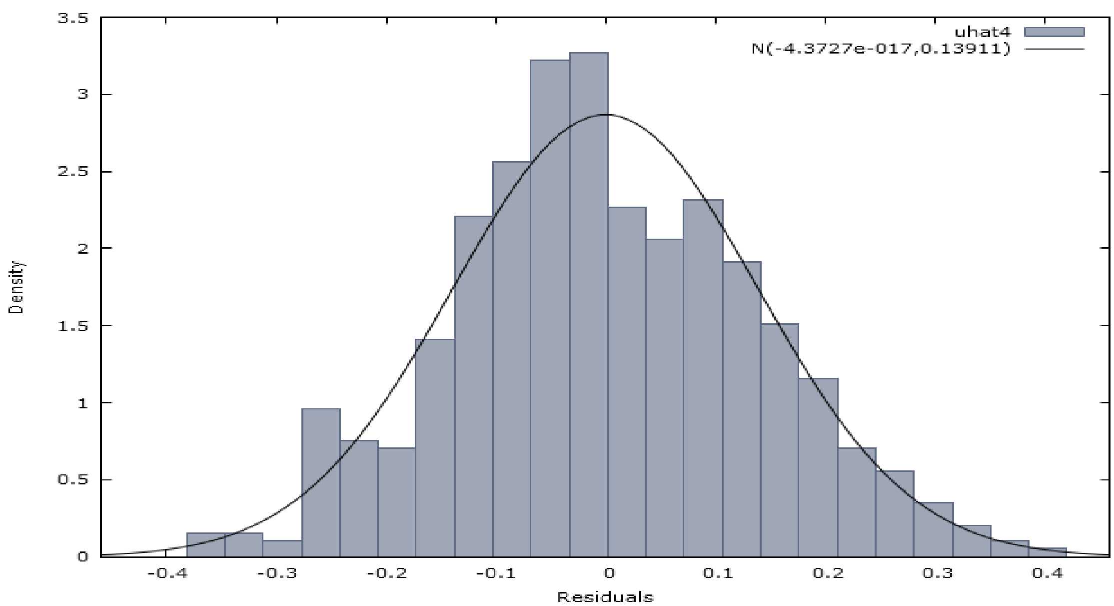


Figure 4.7: Residual Density Plot for the Non-moderated Model

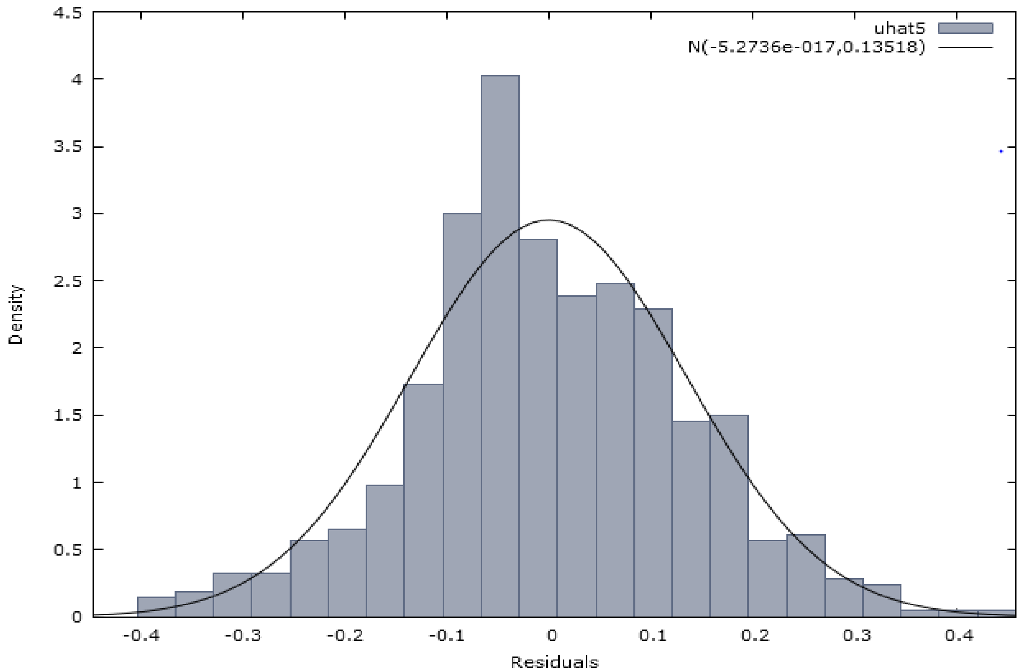


Figure 4.8: Residual density plot for Non-moderated model

4.6.3. Test for Omitted Variable and Model Mis-specification

The omission of important variable/s or underfitting the estimation model generates biased coefficients, wrong model intercept, biased standard errors, and misleading hypothesis test results (Gujarati, 2012). Specification tests pitting a null hypothesis that "the model is correct" against an alternate hypothesis that "the model is inadequate" (Greene, 2012). Ramsey's Regression Specification Error Test, (RESET Test) was used to test the moderated and the non- moderated models. The summary of the test results as seen in Table 4.11 shows that the F test *p*-values of both models were greater than 0.05, leading to the acceptance of the null hypothesis, a confirmation that both models were adequate and correctly specified.

Table 4.11: RESET Test Results for Model specification and Omitted Variables

Model	F Value	P-Value
Un-moderated	F(1, 94) = 0.57	0.4508
Moderated	F(1, 94) = 1.37	0.244

4.6.4. Test for the Presence of Time Dummies

Where the fixed effect is a preferred estimation model, unique errors (*ui*) should not correlate with the regressors across units and over time. A poolability test to examine whether the dummies for all the six years were significantly different from zero was carried out as recommended by Pillai (2016). The test results were as presented in Table 4.12.

Table 4.12: Time Dummy Poolability Test Results

Model	F Value	P-Value
Un-moderated	F(5, 446) = 10.99	0.0000
Moderated	F(5, 466) = 11.46	0.0000

As seen from the results, both the moderated and unmoderated model returned *p*-values were less than the set statistical significance level of 5% leading to the rejection of the null hypothesis that the dummies for the six years were jointly equal to zeros. Given this outcome, the efficiency of the DTS was therefore significantly changing across the period, calling for time fixed effects to be incorporated in the estimation model.

4.6.5. Test for Cross-Sectional Dependence and Serial Correlation

Cross-sectional dependence arises when the presence of common shocks and unobserved components becomes part of the error term. Where residuals are correlated across entries in panel data, coefficient estimates are biased significantly increasing the probability of incorrect inferences (Pasaran, 2004). To assess whether there were cross panel dependencies, the Pasaran CD test was used based on a null hypothesis of uncorrelated residuals for both the moderated and unmoderated fixed-effect models. According to Drukker (2003) presence of serial correlation in linear panel-data models leads to biased standard errors and leads to less efficient coefficient estimates. Wooldridge (2002) recommends that clustering at the panel level produces consistent estimates of the standard errors leading to efficient estimates. To assess both models, the Woodridge test based on a null hypothesis of no serial correlation was used.

Table 4.13: Test of Cross Section Independence & Autocorrelation

Model	Pasaran CD test			Woodridge Test	
	Pesaran's test Score	Mean absolute value	P-Value	F Test Statistic	P-Value
Un-moderated	10.386	0.459	0.0000	F(1,94) = 16.74	0.0001
Moderated	10.412	0.453	0.0000	F(1,94) = 24.41	0.0000

The results of both the moderated and unmoderated models had a significantly higher mean absolute correlation (0.459 and 0.453) respectively and pr values of 0.000. Consequently, the null hypotheses of cross-sectional independence in both models were rejected. Similarly, Woodridge test statistic for both unmoderated and moderated model returned *p* values of less than 0.05 leading to rejection of both null hypotheses indicating that the idiosyncratic error term was correlated in both models. Where Cross-sectional dependence exists, Hoechle (2007) recommends the use of Driscoll and Kraay standard errors in place of standard errors. A strong advantage with Driscoll and Kraay standard errors is its ability to correct for any potential heteroscedastic, autocorrelation, and correlation between the panel groups. Consequently, Driscoll and Kraay's standard errors were used in both the moderated and unmoderated models in place of ordinary standard errors.

4.6.6. Test of Multicollinearity

Multicollinearity arises when two or more predictor variables are highly correlated in a regression model. Left unchecked, multicollinearity reduces the precision of coefficient estimates and weakens the explanatory power of the estimation model. Gujarati (2012) argues that the presence of multicollinearity results in coefficients with large and sensitive standard errors to small changes in data impairing both the precision and accuracy of coefficient estimates. Following the recommendations of Greene, (2012 Variance Inflation Factor (VIF) was used to test for multicollinearity. As a rule of the thumb, a VIF of 1 indicates no correlation; a value of between 1 and 5 denotes moderate correlation and a value above 5 indicates severe multicollinearity. VIF values presented in Table 4.14 range from 1.89 and 1.03 for the unmoderated model and between 4.53 and 1.64 for the moderated model, indicating acceptable tolerance levels of multicollinearity in the models.

Table 4.14. Multicollinearity Test

Variable|	**Variance Inflation Factor (VIF)**	
	Un Moderated Model	**Moderated Model**
Liquidity	1.03	1.66
Capital	1.21	2.15
Asset Quality	1.07	1.64
Investment	1.06	1.91
Size_Liquidity	-	4.53
Size_Capital	-	3.57
Size_Asset Quality	-	3.87
Size_ Investment	-	3.37
2012	1.68	1.68
2013	1.70	1.71
2014	1.72	1.75
2015	1.80	1.85
2016	1.89	1.97
Mean VIF	**1.46**	**2,43**

Test of Endogeneity

According to Gujarati (2012), endogeneity arises when regressors in a model are correlated with unique errors, an indication that independent variables have values that are determined by other variables within the model. Where endogeneity is present, the parameter estimates are both biased and inaccurate. Housman test, also referred to as model misspecification test has been used widely in determining whether fixed or random-effect model best fits panel data based on endogeneity. To test for the presence of an endogenous variable in a fixed-effect model, a null hypothesis postulating that there is no correlation between regressors and unique errors is tested. Hausman test Chi-square statistic results presented in Table 4.5 for both unmoderated (χ^2 =13.81, p = 0.0079) and moderated (χ^2 =34.34, p = 0.000) models had p-values of less than 0.05. Consequently, the null hypotheses of both models were rejected, an indication that regressors in the model were not significantly correlated with the error term.

4.7. Multivariate Analysis

4.7.1. Correlation between DTS Compliance Status and Efficiency Scores

The accuracy of the inferences derived from a regression analysis is influenced by the strength of relationships that exist between the selected independent variables and the predicted variable. Correlation analysis to establish the direction and the strength of the relationship does not only provide a basis for assessing the suitability of the independent variables but also sets out a framework for interpreting the results of the regression model. Being cognizant of the fact that compliance status is binary, a point-biserial correlation was used to assess the association between bias-corrected TE scores and the DTS compliance status of the four selected ratios. Table 4.6.1 presents correlation results.

Bias corrected Technical efficiency scores were found to be significantly negatively correlated (r_{bp} = - 0.288, $p < 0.05$) with DTS compliance with the set liquidity ratio, meaning that higher liquidity negatively affects DTS efficiency. Partly this could be attributed to high liquidly level maintained by a majority of DTS as was seen in the previous section 4.7.1. A negative correlation (r_{bp} = - 0.398, $p < 0.05$) was evident between Bias corrected TE score and capital ratio compliance status. While capital ratios may be intended to cushion members from losing their investments, higher capital ratio locks up funds that would otherwise be lent out or invested for increased returns, negatively affecting intermediation efficiencies. Compliance with the asset quality ratio was positively correlated with the DTS Technical efficiency, an indication that lower Loan loss provisions to the gross loan portfolio translate to better DTS technical efficiency. Meeting the established financial investment levels has a negative correlation (r_{bp} = -0.035, $p > 0.05$) with Technical efficiencies albeit at an insignificant level. Going by the principles of portfolio diversification, limited investment options may have set in compromising on capital allocation decisions among the DTSs.

Table 4.14: Point Biserial Correlation between DTS Compliance Status and Bias Corrected TE Scores

	Liquidity Ratio	Capital Adequacy	Asset Quality	Financial Investments
Bias Corrected TE- Score	-0.228^{**} (0.000)	-0.398^{**} (0.000)	0.231^{**} (0.000)	-0.035 (0.410)

Note: The figures in parenthesis are p - values

**. Correlation is significant at the 0.05 level (2-tailed).

4.8. Multivariate Analysis

Following the results of the model selection test, a fixed-effect model with a variable time effect was found to be the optimal model for both non-moderated and moderated estimation. The presence of hetero-scedasticity in both estimation models called for the use of hetero-scedastic robust standard errors also known as Huber/White or sandwich estimators in the place of ordinary standard errors. Determining the influence of compliance on DTS intermediation technical efficiencies was guided by testing the respective hypotheses as outline in section 1.4 of chapter one. The first part of this sub-section is dedicated to testing the first four hypotheses based on the non-moderated fixed effect estimation, while the second part is dedicated to testing the moderating effects of the DTS size on the unit's technical efficiency.

Where a binary coded independent variable is used, interpretation of the coefficients estimates should be about a base category/group. In both models, the four independent variables; Liquidity, capital, asset quality, and financial investment compliance, non-compliant DTSs were assigned a coded zero (0) and taken as the reference category while those that are compliant are assigned dummy code one (1). A fixed-effect regressions model results on which the first four hypotheses were based are presented in Table 4.8.1

Table 4.15. Fixed Effect Estimation Results for Non-moderated Model

BC EFF Scores	Coefficient	Drisc/Kraay Std Errors	t	P>|t|
Constant	0.5923	0.0229	25.91	0.000
Liquidity Compliance	-0.0241	0.0164	-1.47	0.145
Capital Compliance	-0.0663	0.0128	-5.16	0.000
Asset Qty compliance	-0.0062	0.0167	-0.37	0.710
Investment Compliance	-0.0722	0.0176	-4.1	0.000
YEAR				
2012	-0.0245	0.0088	-2.78	0.007
2013	-0.0559	0.0115	-4.86	0.000
2014	-0.0698	0.0145	-4.8	0.000
2015	-0.0848	0.0182	-4.67	0.000
2016	-0.0730	0.0200	-3.65	0.000

F (4, 94) = 21.26, P < 0.000. R^2 (within) = 0.2124, R^2 (Between) = 0.0493, R^2 (overall) = 0.1201

Note; Drisc/Kraay Standard Errors are used to correct hetero-scedasticity and cross-sectional dependence.

The fitted non-moderated model explained 21.24% of all the variations in technical efficiency score within the DTSs, 4.93% of the variances between DTSs and 12.01% of all variations across both units and time. With an F statistics of 21.26 ($p < 0.000$), the four compliance levels were found to significantly explain the variations in the DTS technical efficiency, a confirmation that the model was adequate. Subsequently, the estimation results presented in Table 4.8.1 provided a basis on which the combined influence of compliance with the four prudential regulations was assessed. To obtain the true influence of compliance on each of the individual prudential requirements on the Saccos efficiency, four fixed-effect models were estimated, a basis on which specific hypotheses were tested as discussed in the following subsections.

4.8.1. Compliance on Liquidity Ratio and Technical efficiency of DTS

The first objective of the study was to assess the influence of compliance on liquidity prudential requirements on the technical efficiency of DTSs in Kenya. The liquidity ratio was measured by the ratio of liquid assets to short-term liabilities and withdraw-able deposits. The resulting ratio was assessed against the prescribed minimum of 15% to identify DTSs that were compliant and assigned a dummy code (1) and those that were not complain coded as (0). To arrive at a statistical conclusion, the following null hypothesis that was tested;

HO_1: Compliance with Liquidity prudential requirements does not influence the technical efficiency of DTSs in Kenya

Being cognizant of the role liquidity management plays in the day-to-day decisions of SACCO managers, compliance with the set liquidity requirement ought to bear a strong influence on allocative efficiency. However, this was not evident in the current findings as seen in Table 4.8.2. Saccos that maintaining a liquidity ratio greater than the recommended 15% were on average 2.65% less efficient compared to these that were non-compliant. Intuitively this means that the greater the liquidity levels maintained by the DTS, the less technical efficient its intermediation role as a result of less optimal input allocation decisions. The strength of the coefficient was however not significant. With *p*-values greater than 0.05, the null hypothesis failed to be rejected, leading to a conclusion that the technical efficiency of DTSs with liquidity ratios greater than 15% was not significantly different from those that had lower liquidity ratios. This denotes that achieving or failure to meet the set liquidity compliance levels did not significantly influence the effectiveness with which DTS managers were utilizing their inputs in producing outputs.

Table 4.16. Fixed-Effects Regression Between Liquidity Compliance and SACCO Technical Efficiency

BC Eff Scores	Coef.	Robust Std. Err	t	P>|t|
Constant	.5163978	.0169636	30.44	0.000
Liquidity Compliance	- 0.02651	0.016809	-1.58	0.118
YEAR				
2012	-0.031	0.008641	-3.6	0.001
2013	-0.071	0.011508	-6.19	0.000
2014	-0.085	0.013942	-6.13	0.000
2015	-0.11107	0.016258	-6.83	0.000
2016	-0.10656	0.016431	-6.49	0.000

F (6, 94) = 9.27, P < 0.000. R^2 (within) = 0.2086, R^2 (Between) = 0.0499, R^2 (overall) = 0.0749

When the influence of complying with the other prudential requirements is controlled as seen in Table 4.8.1, maintaining a liquidity ratio greater than the recommended 15%, has a negative coefficient (-0.0241) that fails to attain statistical significance. This was an indication that DTS that achieved compliant were on average 2.41% less efficient compared to non-compliant DTS holding other factors constant, a slight improvement compared to when liquidity compliance acts alone.

The existence of a weak negative influence of liquidity compliance on technical efficiency concurs with the finding of Kamau (2016) where liquidity ratios of DTS extracted from financial statements between 2011 and 2014 were found to have a weak negative effect on financial intermediation efficiency. This was however contrary to most empirical evidence from the banking sector, the majority of whom have found higher liquidity ratios as efficiency-enhancing. For instance, Odunga, Nyamngweso, and Nkobe (2013) in assessing the ratio of liquid asset to deposits ratio among commercial banks in Kenya found a positive effect of liquidity levels on operating efficiency, Singh and Fida (2015) similarly reports significant positive effects of bank liquidity on efficiency among commercial banks in Oman.

The deviation of these findings from the conventional liquidity theory where a positive influence was expected between compliance with liquidity ratio and efficiency can be attributed to unique operating principles in cooperative and how DTSs have responded to the compliance call. Based on the observation of SASRA (2016), a perceived entitlement to loans, once a member has met minimal requirements, has consistently piled pressure on the liquidity levels of DTS, a position that has placed its managers with little or highly constrained control over-allocation of liquid resources as most of it is channeled to lending. Continued pressure from the regulator for all DTS to comply with the statutory ratio often accompanied with far-reaching penalties and threats of deregistration, may have forced DTS barely meet the minimum requirement, a position that is supported by evidence in Figure 4.8.1 where a majority of DTS has liquidity ratios bordering on the minimum compliance limit.

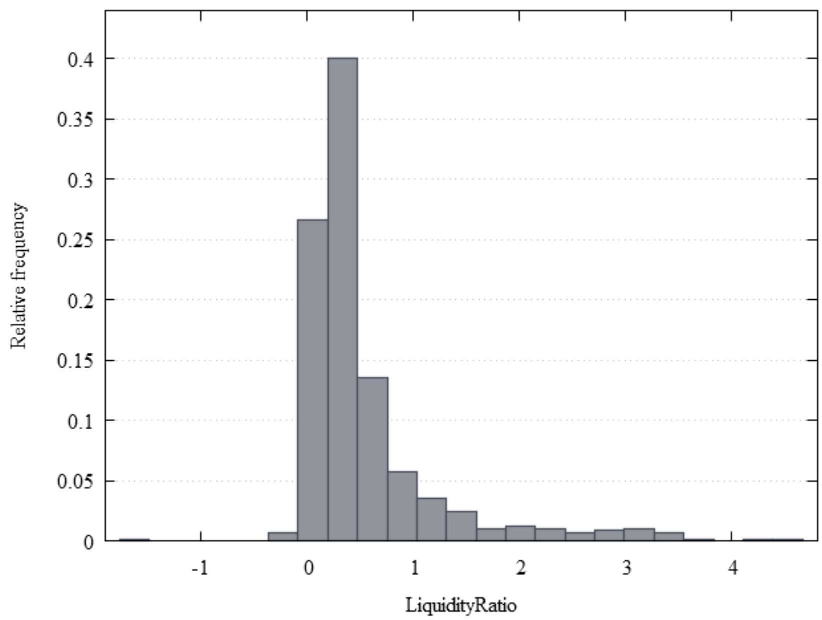


Figure 4.9. DTS Liquidity Ratio Distribution Density

Inevitably, liquidity management comes with a set of opposing costs whose optimality remains a challenge even in the much-developed conventional banking ((Elliots, 2014). The trade-off between the cost of maintaining liquidity and the opportunity cost of returns on foregone investment opportunities in exchange for meeting the statutory or desired liquidity levels is a balance that remains a challenge in all financial institutions. The adoption of PEARLS framework, championed by WOCCU as a foundation for SACCO regulations Kenya and the use of the framework recommends liquidity ratio, based on this findings raises, a question arises on the true optimality of the preset liquidity ratio and the justification of the component inputs/ items used in the computation of the ratio, matters that may call for a critical look on the current liquidity framework within the SACCO sector.

4.8.2. Capital Ratio Compliance and Efficiency

Capital adequacy continues to dominate most regulatory systems in modern financial systems globally. Despite the economic impact associated with adherence to capital adequacy standards, it continues to attract a significant amount of criticism from scholars questioning its rational and effectiveness. For instance, Barth, Caprio, and Levine (2006) in their study argue that in most countries, strong regulation and more specifically stringent or high capital adequacy standards did not improve bank efficiency calling for intensive scrutiny of its justification as a dominant financial regulatory tool.

In line with the justification of Mehran and Thakor (2011) of a positive relationship between capital ratios and bank efficiency, the current study postulated that compliance with the prudential capital ratio; set at a minimum 10% ratio of core capital to total assets by SASRA, will have a positive influence on technical efficiency of DTS. To arrive at a definitive conclusion on this relationship, the following null hypothesis was tested.

HO_1: Compliance with Capital prudential requirements does not influence Technical efficiency of DTS in Kenya

A fixed-effect model fitting compliance on capital adequacy on bias-corrected technical efficiency scores significantly was found to explain 26.4% variation within the sample, 12.92% variations between DTS and 13.13% variation overall. Contrary to the theories supporting capital adequacy and existing empirical evidence where a positive influence was expected, compliance with the minimum capital requirements ratio had a statistically significant negative influence on the technical efficiency of DTS.

Table 4.17. Fixed-effects Regression Between Capital adequacy requirement and SACCO Technical Efficiency

		Drisc/Kraay			
BC Eff Scores		Coef.	Std Errors	t	P>|t|
Constant		0.524498	0.01	50.86	0.000
Capital Ratio Compliance		-0.06247	0.0138497	-4.51	0.000
YEAR					
	2012	-0.0255	0.00858	-2.97	0.004
	2013	-0.0608	0.0114	-5.33	0.000
	2014	-0.0689	0.01422	-4.85	0.000
	2015	-0.0894	0.01735	-5.15	0.000
	2016	-0.0793	0.01917	-4.14	0.000

$F (6, 94) = 15.77$, $P < 0.000$. R^2 (within) = 0.2463, R^2 (Between) = 0.1292, R^2 (overall) = 0.1313

Results in Table 4.8.3 shows that DTSs maintaining core capital to total assets ratio greater than 10% on average was 6.25% ($p < 0.000$) less efficient than their non-compliant counterparts holding all other factors constant. With the test (t) statistic P-Values of less than 0.05, the null hypothesis was rejected, to infer that meeting or exceeding the set compliance ratio of 10% was an impediment to the ability of DTS management to optimally allocate their limited inputs in areas that would generate higher returns *ceteris paribus*. When compliance with other prudential requirements is put into consideration as seen in Figure 4.8.1, the strength of the coefficient remains relatively unchanged, an indication that the influence of complying with the stated capital adequacy ratio on the technical efficiency is independent of the degree of compliance with other prudential requirements.

The distribution of Capital adequacy ratios, contrary to those of the liquidity ratios, were relatively spread-out as seen in Figure 4.8, an indication that a significant proportion of

DTS faced less regulatory pressure to comply. This was equally supported by a strong increase in the number of DTSs that we're able to achieve compliance as a result of the coming into the full force of the Sacco Societies Act 2008 as seen in Figure 4.6.4. When compliance levels were compared before and after the compliance deadline of the end of 2014, as seen in Figure 4.8.2 and 4.8.3, there is a significant shift in the proportion of DTSs that achieved capital adequacy ratios greater than the statutory 10%.

The finding of Kariuki (2017) similarly reports a negative relationship between capital ratios and DTS efficiency, despite the *p*-values failure to attain statistical significance. On the contrary, Lari, Rono, and Nyangweso (2016) found that low capital adequacy ratios were associated with high inefficiency among DTS in Kenya. In the banking sector, Odunga et al (2013) found out that capital adequacy measures alone did not affect the operation efficiency of commercial banks in Kenya, a position that was contrary to the findings of Jackson and Fethi (2011) who reported a significantly negative relationship between capital adequacy and technical efficiency among Turkish commercial banks.

While the intent of capping the ratio of core capital to assets by the regulator was to facilitate risk sharing and reduce of shareholder’s moral hazard, maintaining the ratio beyond 10% could be counterproductive and efficiency dis-enhancing. The degree of regulatory scrutiny or pressure is often more on DTS that are non-compliant; those that barely meet the set minimum capital limits and less for highly capitalized entities that have shown consistency in compliance, (VanHoose, 2007). Consequently, managerial allocation decisions are more likely to be subject to a critical evaluation, robust and potentially efficiency-enhancing among non-compliant DTS, compared to those that comply.

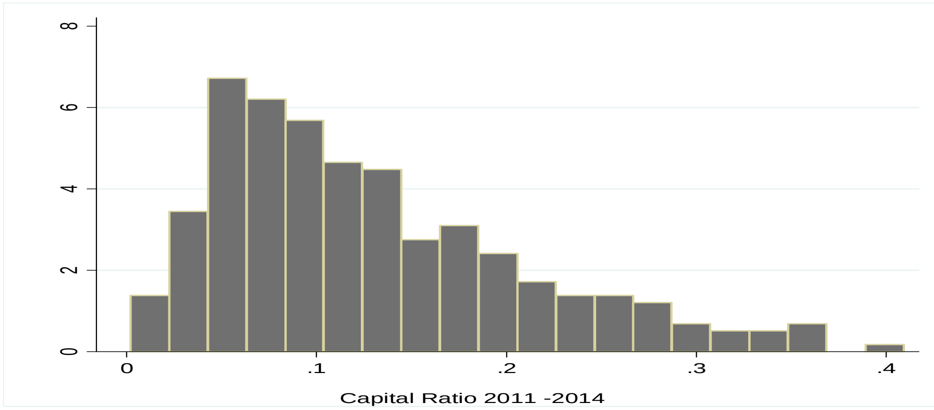


Figure 4.10. Distribution of Capital adequacy Ratios between 2011 -2014

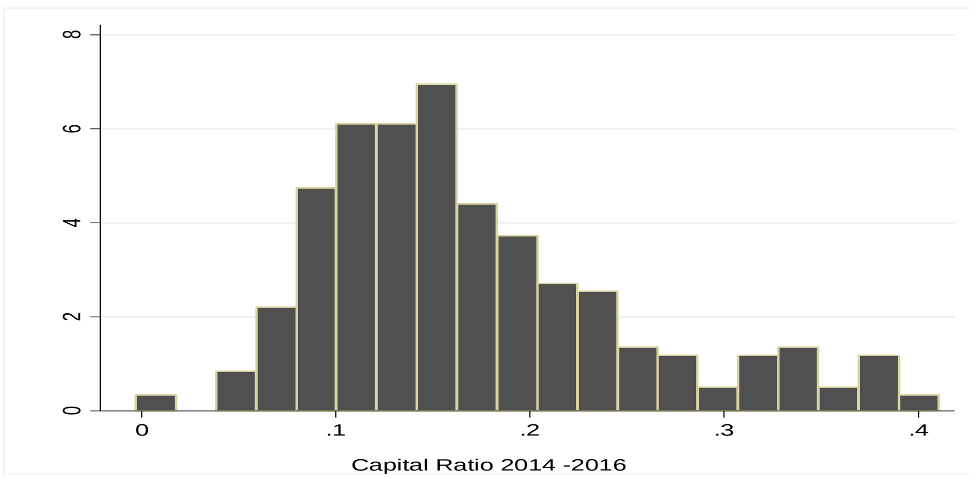


Figure 4.11. Distribution of DTS Capital Ratio between 2015 – 2016

4.8.3. Compliance on Asset Quality and Technical efficiency of DTS

Asset quality within the context of financial regulation is used broadly as an indicator of the potential losses likely to arise because of non-performing loans. Where inadequate measurement and monitoring exists, it is known to closely mirror a greater potential for bank failure. Whereas a credit portfolio of a lending institution will constitute both performing and non-performing loans, the latter is of key concern in the evaluation of asset quality. As a universal component of lending, default, or loan delinquency is inevitable and any related managerial decision will bear a direct influence on the overall allocative efficiency (Kariuki, 2016).

As part of the prudential requirements set out by SASRA, DTSs upon coming into effect of the Sacco Societies Act 2008, were required to make provisions of between 1% and 100% for different categories of loans based on default risk profiles. Specifically, DTSs are required to maintain a maximum ratio of 5% of their total loan provisions to the gross loans. It is expected that DTSs with lower loan loss provisions would benefit from additional liquidity and hence better efficiency. To assess the influence of complying with this requirement on technical efficiency, the following hypothesis was tested.

HO_3: Compliance with Asset quality ratio requirements do not influence the Technical efficiency of DTS in Kenya

Despite the fixed effect model fitting, DTSs' levels of compliance on asset quality on bias-corrected technical efficiency score achieving statistical significance, the proportion of the variances explained was significantly low. Variations explained within individual DTS accounted for 20.25% while 9.67% and 4.86% of the variation between panel units and overall were explained by the model.

Table 4.18. Fixed-effects Regression Between Asset Quality and SACCO Technical Efficiency

	Drisc/Kraay			
BC Eff Scores	**Coef.**	**Std Errors**	**t**	**P>|t|**
Constant	0.50389	0.0198	25.43	0.000
Asset Quality Compliance	-0.0104	0.018905	-0.55	0.584
YEAR				
2012	-0.0295	0.0086	-3.42	0.001
2013	-0.0719	0.0117	-6.13	0.000
2014	-0.0849	0.0142	-5.97	0.000
2015	-0.1147	0.0168	-6.82	0.000
2016	-0.1109	0.0182	-6.08	0.000

$F (6, 94) = 9.15$, $P < 0.000$. R^2 (within) = 0.2025, R^2 (Between) = 0.0967, R^2 (overall) = 0.0486

As seen in Table 4.8.3, Compliant DTSs maintaining a ratio of less than 5% of total loan provisions to total loans has a negative coefficient albeit its failure to attain statistical significance. While the fixed effect model was able to significantly explaining 20.25% of the variation within the panels and 9.67% of the variances between the different panels, the influence of meeting the set asset quality requirement was insignificant. When the DTS position in meeting the other three prudential requirements was taken into consideration, the influence of compliance with the set ratio still returned a negative (β = -0.0062) coefficient (as seen Figure 4.8.1), as previously established it strength remains insignificant. With the t-statistic *p*-values greater than 0.05, the null hypothesis failed to be rejected, an indication that DTSs that were compliant did not achieve on average significantly lower levels of efficiency than those that were not complaint holding all other factors constant. Consequently, maintaining a non-performing loan ratio to the total loans less than 5% does not significantly impede the manager’s ability to effectively allocate their inputs.

In the context of this study, compliance status denotes less provision, and archiving compliance should have been accompanied by better technical efficiency compared to DTSs that were non-compliant, a position that is contrary to the current findings. There is a wide consensus in empirical studies both in banking and non-banking institutions supporting the negative influence of higher non-performing loans on efficiency. For instance, Hussein and Karim (2010), Adeolu (2014), Kariuki (2017) and Jayaham and Mula (2014) found a negative influence of loan loss provision with varying significance levels on the efficiency of financial institutions. In the banking sector, Adai and Pu (2015) found a negative influence of loan delinquency on not only the profitability of banks but also interest income, making delinquency management a critical component of strategic decisions.

The most plausible reason could be attributed to the DTS credit-lending model anchored on the premise of guarantor-ship and deposits collateral, both of which cushions DTSs against bad loans (SASRA, 2016). With the majority of the DTS in compliance with this ratio as seen in Figure 4.8.3, stringent monitoring and control of lending risks may have been downgraded from among the critical decision processes of DTS managers, compromising on effective allocation of the resultant liquidity and consequently the technical efficiency of the DTS.

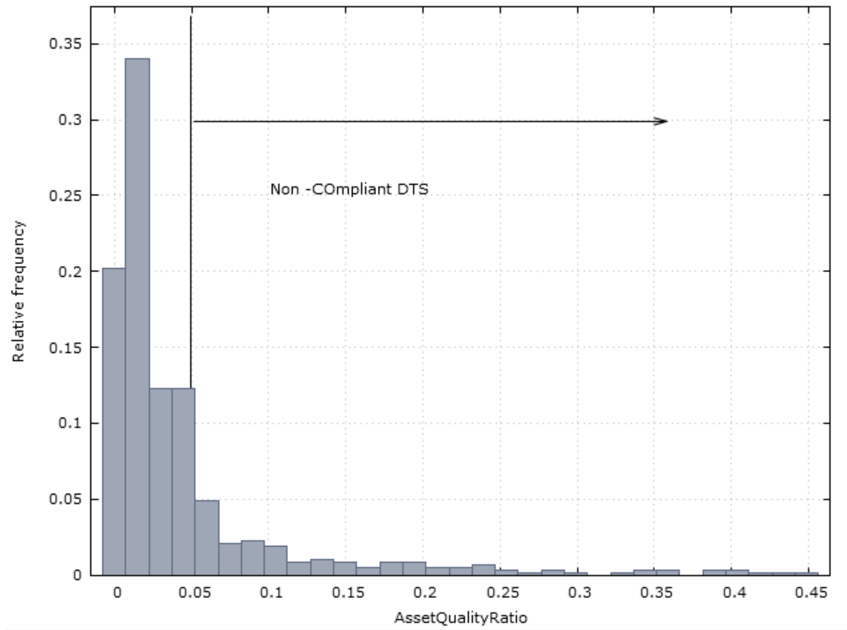


Figure 4.12. Distribution of Asset quality Ratio for compliant and non-Compliant DTS

4.8.4. Compliance with Investment Requirements and DTS Technical Efficiency

Maintaining sound financial investments by DTSs remains a key area of focus for SASRA as set out in Regulation 48 of the Regulations 2010, particularly for purposes of encouraging liquidity. Investments are an essential tool for diversifying income sources for financial institutions and provide a buffer when interest incomes are unfavorable. Where investments are relatively illiquid, they are a threat to effective DTS operations and efficiency. As part of the prudential requirements, SASRA requires all DTS to maintain a maximum of 5% of their investments in non-government backed securities. In assessing how this requirement has influenced the technical efficiency of DTSs in Kenya, the following hypothesis was tested.

> **HO_4: Compliance with financial investment requirements do not influence the Technical efficiency of DTSs in Kenya.**

A fixed-effect model fitting DTS compliance status and their bias-corrected technical efficiency were found to significantly explain 20.83% of the variations within DTS units and an insignificant variation between the panels. Maintaining a ratio of less than 5% of in financial investments to total deposits as seen in Table 4.8.3 returned a statistically significant coefficient (β = -0.06786) an indication that meeting the set ratio, leads to lower technical efficiency compared to DTSs that were non-compliant.

Table 4.19. Fixed-effects Regression Between investment requirement and SACCO Technical Efficiency

BC Eff Scores	Coef.	Drisc/Kraay Std Errors	t	P>|t|
Constant	0.533481	0.014661	36.39	0.000
Financial Investment Compliance	-0.06786	0.018548	-3.66	0.000
YEAR				
2012	-0.0273	0.0087	-3.13	0.002
2013	-0.0670	0.011	-5.880	0.000
2014	-0.0840	0.014	-5.930	0.000
2015	-0.1109	0.016	-6.850	0.000
2016	-0.1039	0.016	-6.490	0.000

F (6, 94) = 10.50, P < 0.000. R^2 (within) = 0.2383, R^2 (Between) = 0.0008, R^2 (overall) = 0.0434

When compliance with liquidity, capital adequacy, and asset quality ratios are introduced into the model, maintaining a ratio of less than 5% ratio in financial investments to total deposits remained significant negative but the negative influence increased marginally to β = - 0.0722, an indication that DTS that were compliant were 7.22 % less efficient on average than those that were not complaint holding all other factors constant. As seen in Table 4.8.1 and Table 4.8.3, the t-tests' *p*-values were less than 0.05, leading to the rejection of the null hypothesis and the recognition that compliant DTSs were less efficient than their non- compliant counterpart. The current findings concur with those found in Bilel and Abdelfattah (2013), Alhasn (2015), Kuruiki (2017), and Elyasiani and Wang (2012), all of whom found a negative relationship between low investments levels and intermediation inefficiency.

Compliance with the investment requirements in the current context indicates less diversification of investments in favor of liquidity. At lower levels of income diversification, financial intermediaries are better placed to exploit the benefits of economies of scope and provide core services at a lower per-unit cost Alhassan (2015). SASRA's capping of investments in non-government backed securities at 5% and with investments in government securities accounting for a paltry one 1% (SASRA 2016), a significant proportion of the DTS experience low levels of income diversification, a likely source of inefficiency, compared to DTS that hold a more diversified investment portfolio.

The proponents of the conglomeration hypothesis argue that diversification of banking activities ensures maximum managerial efforts are placed across different aspects of banking operations (Iskandar-Datta & McLaughlin, 2007; Gambacorta et al., 2014). If the current findings are to be seen from this perspective, then capping of investment levels especially on high return assets could impede managerial investment choices and their ability to allocate available resources effectively.

Additionally, the findings of Alhasn (2015) partially in support of the conglomeration hypothesis, provide a more concise explanation. Basing on his findings where bank asset diversification had a positive relationship with cost efficiency but a negative coefficient with profit efficiency, he cautions against concluding too soon. In his argument, profit efficiency accounts for efficiency on both cost and revenue sides, and hence the dominance of cost efficiency over revenue efficiency or vice versa determines the overall direction of the relationship. The introduction of the current ratios on investment regulation, if inherently has led to lower levels of income diversification, and then DTS are restricted in their ability to effectively exploit the inherent economies of scale, which would otherwise be an opportunity for improving their efficiency. This would, therefore, support the current findings.

4.9. Moderating Effects of Size Prudential Requirement and DTS Efficiency

In recognition that higher economies of scale, better market experience, diversification of customer base, and capability to mobilize resources varies with size, it would be expected that larger DTS would perform better than small DTSs. It was of interest in this study to examine if size moderates between DTS compliance on prudential ratios and the resulting technical efficiencies. To assess this preposition the following hypothesis was tested.

> **Ho_5: Sacco size has no significant moderating effects between prudential requirements compliance and the Technical efficiency of DTSs in Kenya.**

Several measures exist in an attempt to determine the size of a financial institution and firms in general. Market capitalization, revenues, total assets, and capital dominates the preference of both scholars and policymakers (Schildbach, 2017). While annual revenues are greatly considered to be the most optimum and accurate measure of size, its volatility, and dependence on the choice of the business model adopted by the institutions makes it ineffective. Market capitalization, as much as it is a true market valuation indicator, the efficiency of the market systems renders it inaccurate. Total assets, despite its shortcomings associated with the true valuation model, remains to be the preferred choice policymakers due to its consistency and stability across time and sectors (Schildbach, 2017).

The size of financial institutions, widely identified with its asset portfolio and total financial assets reported on the entity's financial statements has gained wide acceptance as a close proxy of size for banks and financial sector institutions. In this study, the total assets reported in the financial statements were used as a proxy of the individual DTS size. DTS with total assets greater than 1 million Kenya shillings were classified as large and coded One (1) and for interpretation, purposes assumed as a reference group. Those who reported total assets less than 1 million Kenya shilling were classified as small DTS and were assigned a code Zero.

Similar to the non-moderated model that was used in assessing the influence of the four prudential requirements, the moderated model considered time effect in its estimation due to the presence of different time intercepts as previously reported in section 4.8.2. The results of this estimation were as presented in Table 4.9.1. The effect of introducing DTS size as a moderator between DTS compliance status on the four prudential requirements and the technical efficiency failed to introduce any significant shift in the estimated coefficients of the original non-moderated model. Introducing DTS size and its interactions with the DTS compliance status into the estimation model improved variances in technical efficiency explained within the DTSs by 9.6%, between DTS by 3.58% and by 2.8% overall as compared with the unmoderated model, an indication that the model has a better fit than the un-moderated model.

Table 4.20. Moderated Model Estimation Results

	Drisc/Kraay			
BC EFF Scores	**Coefficients**	**Std Errors**	**t**	**P> |t|**
Constant	0.6125	0.0290	21.08	0.000
Liquidity Compliance	-0.0262	0.0239	-1.1	0.276
Capital Compliance	-0.0914	0.0187	-4.89	0.000
Asset Qty Compliance	-0.0222	0.0174	-1.28	0.204
Investment Compliance	-0.0737	0.0210	-3.51	0.001
DTS Size	-0.0232	0.0434	-0.54	0.593
DTS Size * Liquidity	-0.0017	0.0338	-0.05	0.959
DTS Size* Capital	0.0431	0.0226	1.91	0.059
DTS Size* Asset Qty	0.0294	0.0269	1.09	0.279
DTS Size *Investment	0.0043	0.0318	0.13	0.894
YEAR				
2012	-0.0248	0.0094	-2.63	0.010
2013	-0.0558	0.0118	-4.71	0.000
2014	-0.0722	0.0156	-4.64	0.000
2015	-0.0894	0.0183	-4.89	0.000
2016	-0.0811	0.0209	-3.87	0.000
F (14, 94) = 10.04, P -Value (F) = 0.000				
R^2 (Within) = 0.3060 R^2 (Between) = 0.0851 R^2 (overall) = 0.1482				

Note : DTS size is a binary : (1)Large DTS Total assets > 1 Billion(Kshs) , (0) Small DTS Total Assets < 1 Billion(Kshs). Year 2011 is taken as the base year. Robust Standard Errors are clustered SE to take care of hetero-scedasticity

The introduction of DTS size as a moderator and its interactions improved the strength of the fixed effect coefficients in all the four prudential requirements. The fitted model had 9.36% more variance explained compared to the non-moderated model. The variances explained by compliance with capital adequacy ratio increased by 2.51% , while maintaining delinquency loans below 5%, meeting the set liquidity and investment prudential ratios improved by 1.6%, 0.21% and 0.15% respectively. Except for compliance with investment requirements that returned an increased positive influence, compliance with the other requirements, when DTS was considered to lead to higher in-efficiency. The consideration of DTS size as a moderator did not introduce significant changes in the coefficients of all the four DTS compliance indicators, an indication that larger compliant DTS did not enjoy better technical efficiency than small DTS in compliance with all the four prudential ratios, *ceteris paribus*. This is a pointer to a possibility of the inability of growth in assets to enhance efficiency irrespective of DTS compliance status.

To arrive at a definitive conclusion on the moderating effect of DTS size, a null hypothesis equating all interaction coefficients to zero was tested. This is ideally tested through the assessment of the changes in the within R squared between the two models. As seen from Table 4.9.1, the F statistic testing the significance of changes in within R square returned a value of 1.30, with *p*-value exceeding the set significance level of 0.05, which led failure to reject the null hypothesis. This implies that DTS size does not significantly moderate between DTS compliance status and their inherent technical efficiency holding all other factors constant.

Table 4.21.Moderation Effect hypothesis test Results

Test Statistic	F Value	Prob > F
F(4, 94)	1.30	0.2756

While DTS size based on accumulated assets may be seen as a source of efficiency by the proponents of economies of scale theory, it is however evident that it does not significantly intervene in the relationship between regulation and input resource deployment effectiveness in the DTS context. Consequently, larger Saccos in Kenya do not enjoy better economies of scale to the extent that it is efficiency enhancing. From a regulatory perspective, subjecting all DTS irrespective of their size to a common regulatory framework would be justifiable based on the current findings. Additionally, this confirms the suitability of relative regulatory ratios that rates each DTS based at their levels as compared to ratios pegged on a fixed value.

The findings from this study, to a certain extent, lends support to Singh and Fida (2015), Passarosi and Weill (2013), and Lema (2017) who reports an insignificant influence of firm size on resulting firm efficiency. A strong negative influence however was reported in the findings of Adusei (2016). On the contrary, Kariuki (2017) and Kamau (2011) looking at DTS and Commercial banks in Kenya respectively found a strong positive influence of Size as measured by total asset on resulting technical efficiency, an indication that the influence of size on efficiency remains inconclusive.

4.10 Determination of the Optimal Model

To arrive at an optimal model, step-wise estimation based on an elimination approach was employed with the moderated estimation (Table 4.9.1) as the reference model (Model 1).

Table 4.22: Determination of the Optimum Model

	Model 1	Model 2	Model 3	Model 4
R^2 Within	0.3060	0.2954	0.2951	0.2894
R^2 Between	0.0851	0.0493	0.0579	0.0414
R^2 Overall	0.1482	0.1201	0.1260	0.1127
F Statistic	10.04	13.32	15.02	16.97
P-Value	<0.000	<0.000	<0.000	<0.000

Model 1: BC-Technical Efficiency Score, DTS Size, Capital Adequacy, Liquidity Requirement, Asset quality, and Investment Requirement.

Model 2: BC-Technical Efficiency Score, Capital Adequacy, Liquidity Requirement, and Investment Requirement.

Model 3: BC-Technical Efficiency Score, Capital Adequacy, and Investment Requirement.

The moderating variable, DTS size was found to be the least significant based on its p-Value and was the first to be dropped. As a moderator variable, all interaction terms were also eliminated in the estimation of the improved model. The resulting model (Model 2) lost 1.06% of its variations explained within panels, 3.58% of the variation between and 2.81% overall with the new model explaining 29.54% within variations in the efficiency of DTS.

The next prudential required to be removed from the model was compliance on Asset quality requirement given its *p*-value was greater than the 0.05 cut off significance level(Model 3). The new model lost a further 0.03% of the variation within the panel, 0.86% of the explained variations between and 0.59% overall. The last variable to be dropped was liquidity compliance. This led to a loss of 0.57% of the variation within panel explained, 1.65% of the variation between panels and 1.33% overall with the final model explaining 28.94% variations within (Model 4), leaving compliance on capital and investment requirement as the two prudential requirements that were significantly influencing technical efficiency of DTS in Kenya.

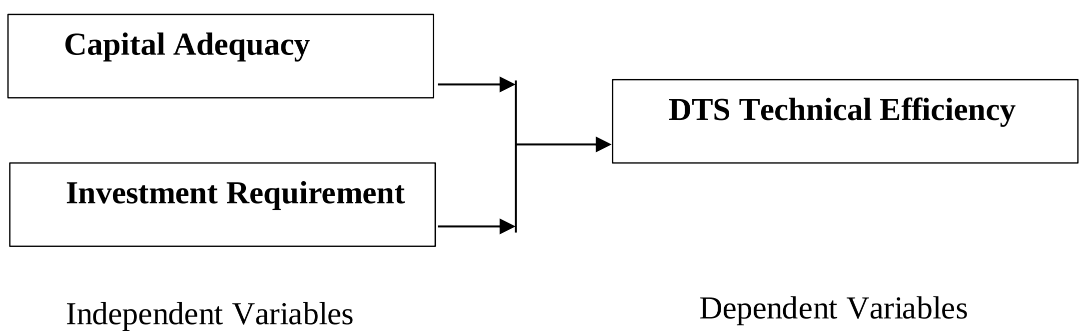


Figure 4.13. Conceptualized Optimum Model

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of key findings, derives conclusions and puts forward a number of recommendations in view of crystalizing the answers to the five specific research objectives and consequently revealing the influence of prudential requirements on the efficiency of DTSs in Kenya. The first section presents a summative view of the findings of each specific objective, while the second part of the chapter presents conclusions. Policy and research recommendations are outlined in the last section of the chapter.

5.2 Summary of Findings

The objective of this study was to assess the impact of prudential requirements on the technical efficiency of deposit-taking cooperative societies in Kenya. A two-stage analysis procedure using six years panel data was used to establish technical efficiency scores and assess the influence of prudential requirement compliance on biased corrected technical efficiency scores. A summary of findings from the study are presented in the following subsections.

5.2.1. Capital Adequacy Requirement and its influence on Efficiency

Despite the persistent increase in deposits, capital, labor costs, loans and investments of DTS over the six years reviewed in the study, the estimated technical efficiency was found to remain relatively unchanged except for 2012 and 2016 where the decline was experienced. Notably, the overall productivity change improved by 36.7% over the same period with improvement in efficiency associated with technological changes associated with the frontier shift seen as the main contributor. The mean technical efficiency of Large DTSs were found to be significantly higher than those of smaller DTS holding less than 1 billion shillings as of 2011, lending support to the workings of economies of scale principle in the sector.

Core capital, a measure of DTS's financial soundness increased progressively over the six years under review from the initial mean of 115 million shillings in 2011 to 539.8 million shillings in 2016, a 369% increase that was strongly attributed to the progressive attainment of the set capital requirement ratios by the regulator by a majority of DTSs. The mean annual ratio of core capital to total assets grew steadily over the six years from a low of 22% in 2011 to 28.7% in 2016, increasing the industry compliance levels from 60% in 2011 to 95% in 2016. However, this was also an indication that a significant number of DTS were maintaining relatively higher capital ratios than the prescribed 10% minimum. Contrary to the theories supporting capital adequacy and existing empirical evidence where a positive influence was expected, compliance with the minimum capital requirements ratio had a significant negative influence on the technical efficiency of DTS.

Based on the fixed effect estimation results, the null hypothesis set upon the premise that compliance with the capital ratio set out by SASRA does not influence the technical efficiency of DTS in Kenya was rejected. Intuitively, this meant that DTSs maintaining a core capital to total assets ratio greater than 10% on average were less efficient than their non-compliant counterparts holding all other factors constant. The current findings support the findings of Kariuki (2017) but in contradictions with the relationship reported in Odunga et al. (2013) and Lawi, Ronoh and Nyangweso(2016)

5.2.2. Liquidity Requirements and Efficiency of DTS

Liquid assets, a key indicator of how well the DTSs were in a position to meet their financial obligations as they fall due maintained a consistent growth from an average of 137.8 million shillings in 2011 to 318.2 million shillings in 2016, a 131 % increase. The ratio of liquid assets to total short-term liabilities similarly increasing from 0.42 in 2011 to a high of 0.54 in 2016 with a 10% drop in the 2013- 2014 period. With liquidity levels over and above the prescribed minimum levels of 15% indicating less liquidity risk exposure, however, this could also be a potential source of inefficiencies. The proportion of DTS achieving compliance increased from 69% in 2011 to 93% in 2016, a pointer to a working enforcement policy.

When the liquidity ratios were correlated with bias-corrected technical efficiency score, a significant negative correlation was found indicating that higher liquidity ratios were dis-efficiency enhancing. The results from a fixed effect estimation model indicate that maintaining a liquidity ratio greater than the recommended 15%, has a weak negative coefficient consequently, this meant that DTS that achieved compliant were on average less efficient compared to non-compliant DTS holding other factors constant. Failure to reject the null hypothesis was an indication that compliance with liquidity ratio did not influence the technical efficiencies of DTSs in Kenya. The findings affirm the important of effective liquidity management framework for the sectors that has faced liquidity challenges due to its unique operating model.

5.2.3 Asset Quality and Technical efficiency of DTS

The principle underlying the regulation of loan loss through provisioning is anchored on the need to minimize default rates and enhance prudent cash flow management. In a cooperative context where lending is a core activity, this ensures that members can access loans as and when they qualify. Despite the average gross loans growing consistently over the six years under review from a 133. Billions in 2011 to 2.59 billion in 2016, a 95% growth, the average loan loss provision declined in the first two years (2012 and 2013) to a low of 73.7 million shillings followed by a consistent increase from 2014 to 2016. The proportion of the total loan provision to gross loans; a ratio that was adopted in measuring asset quality grew from a low of 3% in 2011 surpassing the proposed maximum of 5% in 2013 and closing at a high of 11% in 2016.

As a result of the significant increase on loan provisions, the average compliance levels among the DTS dropped from 86% in 2011 to a low of 61% in 2016, an indication that a substantial number of DTS were falling out of compliance and a possible suboptimal credit management practices by DTSs. Contrary to theoretical expectations where higher asset quality ratio would potent lower efficiency as a result of more funds being tied up and not available for lending. The correlation between that biased corrected technical efficiency score and compliance with asset quality ratio was found to be positively correlated.

When this relationship was examined through a fixed effect estimation model, the resulting negative estimation coefficient failed to achieve statistical significance, and hence the null hypothesis postulating that compliance with asset quality requirement of 5% does not influence technical efficiencies of DTSs in Kenya failed to be rejected. This meant that DTS that complied with the maximum 5% loan loss provision to the total gross loans were less technically efficient compared to their non-compliant counterparts holding all other factors constant, a similar position reported in Hussein and Karim (2010), Adeolu (2014) and Kariuki (2017).

5.2.4. Investment Requirements and Technical Efficiency of DTS

Coming from a background of persistent misuse and abuse of investments by Sacco managers leading to pilferage of member funds, SASRA's objective of regulating investments undertaken by DTS was twofold; to promote prudent investment decisions and to enhance better liquidity. Financial investments made by DTSs over the six years under review saw a marginal growth from an average of 65.5 Million shillings in 2011 to 112.1 million shillings in 2016, representing a 71% growth over the six years. The ratio of financial investments to total deposits stagnated between 7-8% during the six years with the proportion of DTS meeting the set requirement increasing marginally from 57% in 2011 to 63% in 2016 with a significant drop in 2013 falling to a low of 57%.

A point biserial correlation between compliance status and bias-corrected Technical efficiency of DTS returned a negative coefficient that failed to attain statistical significance. Similarly, the results of the fixed effect estimation model returned a significant negative coefficient, an indication that compliant DTS were on average less efficient compared to their non-compliant counterparts. The null hypothesis postulating that compliance with the set financial investment requirement does not influence the technical efficiencies of DTS was consequently rejected. Broadly, this meant that DTS that maintained a ratio of less than 5% in financial investment to total deposits were less technically efficient than those that maintained the ratio above the prescribed 5% holding other factors constant. This support a similar conclusion arrived at by Elyasiani and Wang (2012), Bilel and Abdelfattah (2013), Alhasn (2015) and Kuruiki (2017).

5.2.5. DTS Size, Prudential Requirement and DTS Efficiency

Total Assets, a close indicator of DTS size, more than doubled in six-years from an average of 1.59 billion shillings in 2011 to 3.38 billion shillings in 2016. By classifying DTS into two categories; Large (Total Assets > 1 billion Shillings) and small (Total Assets < 1 Billion shillings), the moderating effect of the size on the influence of complying with the four selected prudential ratios on the DTS technical efficiency did not introduce a significant change in the estimated coefficients. With DTS size moderating, the average technical efficiency of DTSs dropped by 2.51%, 1.6%, 0.21%, and 0.15% when a larger DTS remains compliant in their capital, asset quality, liquidity, and financial investment prudential requirements respectively, compared to a small DTS that has archived compliance. This meant that larger compliant DTS did not enjoy better technical efficiency than small DTS in compliance with all the four prudential ratios, *ceteris paribus*. The findings are in tandem with the findings of Passarori and Weill (2013) and Lema (2017) and contradict those reported by Kariuki (2017) and Kamau (2011).

5.3 Conclusions

The results from the analysis of the influence of prudential requirement on the efficiency of DTS in Kenya lead to several conclusions. First, the introduction of prudential requirements to guide the sector has facilitated growth in assets, deposit, increased lending, and capital accumulation as envisaged in the regulatory framework. However, this has not translated into a significant shift among DTS from their traditional investment portfolios into the less risky secured/ government-backed securities. With the significant increase in the loan book, default risk has also increased as indicated by a persistent increase in loan loss provisions made. Overall, the sector is evidently on the right growth trajectory but call for a close watch.

Secondly, the quality of the allocative decision of DTS managers as indicated by their efficiency has not experienced a significant change since the introduction of prudential requirements to guide the sector. A marginal improvement in technical efficiency was noted between 2013 and 2015 with pre-election years (2012 and 2016) showing efficiency decline, a pointer to a strong influence of political dynamics on the allocative decisions made by DTS managers. The source of the efficiency changes in the sector is mainly driven by changes in the technological front, with increased adoption of mobile banking in the sector as the most likely driver. Lending support to the applicability of the economies of scale theory in the sector, large DTS continues to achieve higher technical efficiencies than small DTSs based on their total assets.

Thirdly, DTS continues to posts mixed results on the levels of compliance with the prudential ratios. Since that introduction of the current regulatory framework by SASRA, there has been a significant growth in the number of DTS achieving the set liquidity and capital ratios. The opening up of Sacco membership to previously excluded groups and the push to increase minimum capital as outline in the new regulatory requirement is closely attributed to this growth. To the contrary, the number of DTS meeting the asset quality requirement has significantly declined while DTSs in compliance with the investment ratio has overtime remained changed.

Fourthly, compliance with the regulatory ratios set out by SASRA broadly points to a mixed influence on the allocative decisions of DTS managers. Maintaining liquidity ratios of greater than 15% and less than 5% in loan loss provision despite bearing a negative influence on the DTS efficiency remains insignificant. However, maintaining core capital to total assets ration greater than 8% and financial investments below 5% of total deposits bears a significant negative influence on the allocation decisions made by DTS managers leading to lower technical efficiencies. Conclusively this is an indication that compliance with the current regulatory framework by DTS is negatively affecting the resulting technical efficiency of DTS in Kenya.

Lastly, the adoption of industry-wide prudential regulations based on universal ratios is justified based on the current findings. The size of DTS bears an insignificant influence on the way the prudential requirements set out for DTS influences the resulting technical efficiency. Irrespective of size, DTS managers are facing similar input allocation decision challenges and large DTS do not enjoy the benefits of economies of scale. The allocative efficiency of managerial decisions within the DTS sector, therefore, is influenced by factors other than their size.

5.4 Contribution to Knowledge

The finding of this study extends on the existing literature on the relationship between prudential regulation and efficiency of deposit taking cooperative societies in three fronts. First, with only two countries in Africa: Kenya and South Africa having a legal regulatory framework for regulating cooperative societies, the current study expands on the limited research and opens up a frontier through comprehensive analysis of the relationship between prudential requirements and technical efficiency. Secondly, in advancement of the public interest theory, this study expands empirically the justification for extension of prudential regulation to include cooperative societies given their tremendous growth and influence on economic conditions in developing countries. Lastly, the study provides evidence to support the use of ratios in defining regulation in a manner that does not discriminate institutions based on size. Evidence from this study indicating an insignificant moderating effect of size in the relationship between regulation and efficiency lends support to the adoption of BASEL regulation for cooperative societies despite their unique operating principles.

5.5. Recommendations

The consistent increase in total assets, customer's deposits and gross loans since the introduction of the prudential requirements for the DTS sector point to a working regulatory framework. This largely validates the initial intention of establishing stability and growth that led to the introduction of the regulatory framework for Deposit-Taking Saccos. Despite this growth, the efficiency of DTS has remained relatively unchanged except for pre-election periods where the decline was evident. This calls for caution when the success of a regulatory framework is measured based on the performance in direct financial indicators. This hence calls for SASRA as the custodian and the implementing agency to not only assess and report sectorial performance beyond the changes in the sector's traditional financial measures and include changes in efficiency and productivity.

While the core intent in regulating capital and investment in the DTS sector is centered on protecting member's deposits, it should not impede growth and efficiency. Seen from the current findings, there is a likelihood of a conflict between the two objectives. The evidence of a significant negative influence of complying with the set capital and investment ratio on the efficiency of DTS is an indicator that the current ratios were impeding efficient allocation decisions among the DTS managers. This calls for a review by the regulator by critically re-examining the capital ratios in the interest of establishing the most optimal ratio that guarantees the safety of member's deposits while optimizing on growth and allocation efficiency.

Despite large DTS archiving better efficiency than small DTS based on total assets, the existence of an insignificant mediation effect of DTS size on the influence of meeting prudential requirements on the efficiency of DTS, reinforces the suitability of ratios as the preferred regulatory tool for Saccos. Given that the size of a DTS does not significantly enhance or impede input allocation decisions in a regulated framework, continued use of the same ratio approach by the regulator as the preferred regulatory tool for enhancing efficiency in the sector is recommended.

Going by the current findings, the negative influence of complying with the set liquidity and asset quality ratio on the efficiency of DTS points to a challenge of DTS holding excess current assets and impaired credit creation capabilities. While the strength of the influence on efficiency is statistically insignificant, balancing liquidity and demand for loans in the SACCO sector remains to be a challenge to most DTSs, a position that calls for close monitoring by both the regulator and the management of individual DTSs.

5.6. Areas for Further Research

The strength of the current findings can be extended in at least two ways. First, the use of only one ratio in each of the four regulatory areas leaves out a significant unexplained influence of the current regulatory framework. For instance, capital adequacy requirement as specified by SASRA is set out in four different ratios; the choice of one ratio may have limited the explanatory power of the analysis model used. A determination of the total influence based on all the regulatory ratios and limits will be more insightful. Secondly, with a bulk of the ratios currently in use in the DTS sector adopted from banking sector regulation, it would be insightful to study the optimality and potential limitations arising from individual ratios currently use in promoting efficiency in the sector.

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APPENDICES

Appendix I: Financial Data Collection Template

	Name of the SACCO……………………………………YEAR………………………		
	LIQUIDITY	Shs	Shs
1	Net Liquid Assets		
2	Total Deposits		
3	Total Short-term Liabilities		
4	Total Deposits+ Total Short-term Liabilities		
	Liquidity Ratio (1/4)		
ASSET CLASSIFICATION and PROVISIONING			
5	Total Loan Loss provision		
6	Gross Loan		
7	Total Loan provisions / Gross Loans		
	INVESTMENT REQUIREMENTS		
8	Quoted Financial Investments		
9	Unquoted financial investments		
10	Total Financial Investments (8+9)		
11	Financial Investments/Total Members Deposits (10/2)		
CAPITAL REQUIREMENTS			
12	Core Capital		
13	Core capital to Deposits Ratio (12/ 2)		
	EXPENSES		
14	Interest Expenses		

15	Other Expenses		
16	**Total Expenses (14 + 15)**		
	INCOMES		
17	Interest Income		
18	Other Incomes		
19	**Total Incomes (17 +18)**		
20	**Total Assets**		
21	▢ Less Than Kshs 1 Billion ▢ Over 1 KShs Billion		

Appendix II: List Of Registered Dts In Operations In 2011

Sn	Reg No	OLD NAME	CURRENT NAME
1	7315	ACO	AIRPORT SACCO
2	1981	AFYA SACCO	AFYA SACCO
3	2077	ASILI SACCO	ASILI SACCO
4	2349	BANDARI SACCO	BANDARI SACCO
5	5651	BARINGO FARMERS SACCO	SKYLINE SACCO
6	2549	BARINGO TEACHERS SACCO	BORESHA SACCO
7	3636	BORABU FARMERS TEA SACCO	VISION POINT SACCO
8	2876	BUNGOMA TEACHERS SACCO	NG'ARISHA SACCO
9	5932	BURETI SACCO	PATNA SACCO
10	2169	CHAI(KTDA)	CHAI SACCO
11	1920	CHEMILIL SACCO	JUMUIKA SACCO
12	6780	CHEPSOL TEA GROWERS SACCO	KIMBILIO DAIMA SACCO
13	2466	CHUNA SACCO	CHUNA SACCO
14	2466	CHUNA SACCO	CHUNA SACCO
15	2686	COMOCO SACCO	COMOCO SACCO
16	10068	DIOCESE OF MERU SACCO	CENTENARY SACCO
17	2633	EMBU TEACHERS SACCO	WINAS SACCO
18	10020	GITHUNGURI DAIRY	GITHUNGURI DAIRY SACCO
19	2641	GUSII MWALIMU	GUSII MWALIMU SACCO
20	1916	HARAMBEE SACCO	HARAMBEE SACCO
21	1991	HAZINA SACCO	HAZINA SACCO
22	2033	IMENTI	IMENTI SACCO
23	2843	IRIANYI TEA SACCO	KENYA ACHIEVERS SACCO
24	2044	JAMII	JAMII SACCO
25	9231	KAGWE CHRISTIAN SACCO	FARIJI SACCO
26	2738	KAKAMEGA TEACHERS SACCO	INVEST AND GROW (IG) SACCO
27	7591	KEIYO TEACHERS SACCO	PRIME-TIME SACCO
28	3468	KENPIPE SACCO	KENPIPE SACCO
29	2299	KENYA BANKERS	KENYA BANKERS SACCO
30	1615	KENYA CANNERS SACCO	AZIMA SACCO
31	2092	KENYA POLICE	KENYA POLICE SACCO
32	6336	KERICHO TEA SACCO	KENYA HIGHLANDS SACCO

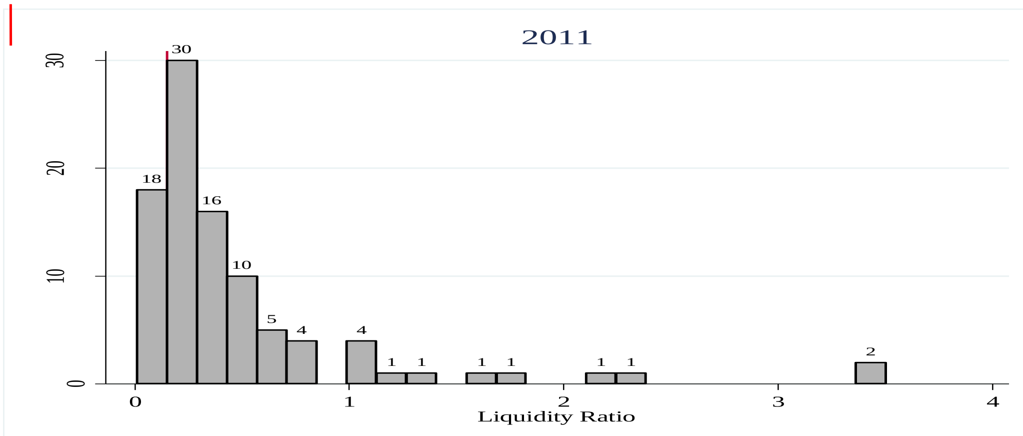
33	9111	KIAMBAA DAIRY SACCO	JOINAS SACCO
34	6447	KIAMBU TEA SACCO	TAI SACCO
35	2275	KIAMBU UNITY SACCO	K-UNITY SACCO
36	2255	KILIFI TEACHERS SACCO	IMARIKA SACCO
37	9208	KINGDOM	KINGDOM SACCO
38	2885	KIPSIGIS TEACHERS SACCO	IMARISHA SACCO
39	8379	KIRINYAGA DISTRICT FARMERS SACCO	FORTUNE SACCO
40	4107	KIRINYAGA TEA SACCO	BINGWA SACCO
41	2757	KISUMU TEACHERS SACCO	KITE SACCO
42	2480	KITUI TEACHERS	KITUI TEACHERS SACCO
43	3983	KMFRI	KEMFI SACCO
44	6569	KONOIN SACCO	K-PILLAR SACCO
45	7221	KURIA TEACHERS SACCO	STAKE KENYA SACCO
46	2467	LENGO	LENNGO SACCO
47	5937	MACADAMIA SACCO	JIJENGE SACCO
48	2664	MAGADI SACCO	MAGADI SACCO
49	7590	MARAKWET TEACHERS SACCO	SMART LIFE SACCO
50	2795	MARSABIT TEACHERS SACCO	BI-HIGH SACCO
51	9187	MATHIRA FARMERS SACCO	ENEA SACCO
52	5988	MATHIRA TEA SACCO	BARAKA SACCO
53	7320	MAUA METHODIST HOSPITAL SACCO	MMH SACCO
54	6825	MERU MWALIMU SACCO	SOLUTION SACCO
55	4918	MERU NORTH FARMERS SACCO	DHABITI SACCO
56	7178	MERU SOUTH FARMERS SACCO	SOUTHERN STAR SACCO
57	2638	METROPOLITAN	METROPOLITAN SACCO
58	1726	MOMBASA PORT	MOMBASA PORT SACCO
59	2484	MOMBASA TEACHERS SACCO SOCIETY	MAFANIKIO SACCO
60	2494	MUHIGIA SACCO SOCIETY	OLLIN SACCO
61	3109	MUMIAS OUTGROWERS SACCO	NITUNZE SACCO
62	6267	MUNGANIA TEA GROWERS	DAIMA SACCO
63	6760	MURAMATI SACCO	UNAITAS SACCO
64	2648	MURANGA TEACHERS SACCO	MENTOR SACCO
65	8056	MURATA SACCO	AMICA SACCO
66	2265	MWALIMU SACCO	MWALIMU NATIONAL
67	3047	MWITO	MWITO SACCO
68	2406	NACICO	NACICO SACCO

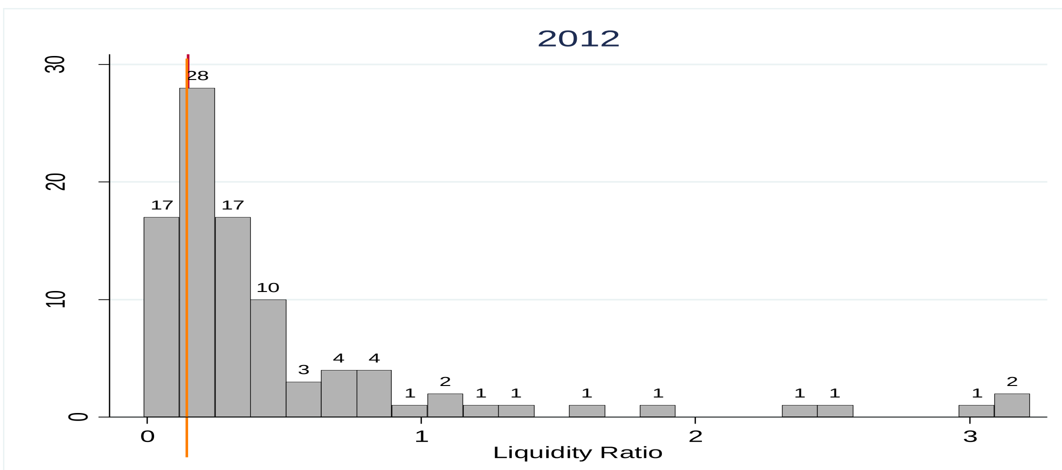
69	16919	NAKU	SHOPPERS SACCO
70	2675	NAKURU TEACHERS SACCO	COSMOPOLITAN SACCO
71	6061	NANDI HEKIMA	NANDI HEKIMA SACCO
72	10308	NAROK TEACHERS	NAROK TEACHERS SACCO
73	2386	NATION STAFF SACCO	NATION SACCO
74	2869	NDEGE CHAI	NDEGE CHAI SACCO
75	2196	NDOSHA	NDOSHA SACCO
76	5014	NITHI TEA SACCO	THAMANI SACCO
77	9233	NTIMINYAKIRU RURAL	NTIMINYAKIRU RURAL*
78	6917	NYAMBENE ARIMI	ARIMI SACCO
79	7593	NYAMIRA TEA FMRS	NYAMIRA TEA FMRS
80	2559	NYANDARUA TEACHERS SACCO	TOWER SACCO
81	8315	NYERI FARMERS SACCO	TAIFA SACCO
82	2567	NYERI TEACHERS SACCO	NEW-FORTIS SACCO
83	10120	ORTHODOX SACCO	MILIKI SACCO
84	9510	SAFARICOM	SAFARICOM SACCO
85	2102	SHERIA SACCO	SHERIA SACCO
86	2865	SIAYA TEACHERS SACCO	TARAJI SACCO
87	2678	SIMBA CHAI	SIMBA CHAI SACCO
88	7979	SIRAJI	SIRAJI SACCO
89	6570	SOT TEA SACCO	STEGRO SACCO
90	6128	SOTICO	SOTICO SACCO
91	6366	SOUTH IMENTI SACCO	YETU SACCO
92	2207	STIMA	STIMA SACCO
93	2185	SUKARI	SUKARI SACCO
94	2523	TAITA TAVETA TEACHERS	QWETU SACCO
95	2022	TEMBO	TEMBO SACCO
96	5676	TENHOS	TENHOS SACCO
97	6826	THARAKA NITHI SACCO	TRANS NATION SACCO
98	8012	THIKA DISTRICT TEACHERS SACCO	ORIENT SACCO
99	2660	TRANS NZOIA TEACHERS SACCO	TRANS-NATIONAL TIMES SACCO
100	2026	UKULIMA	UKULIMA SACCO
101	2375	UNITED NATIONS	UNITED NATIONS SACCO
102	6403	UNIVERSAL TRADERS	UNIVERSAL TRADERS SACCO

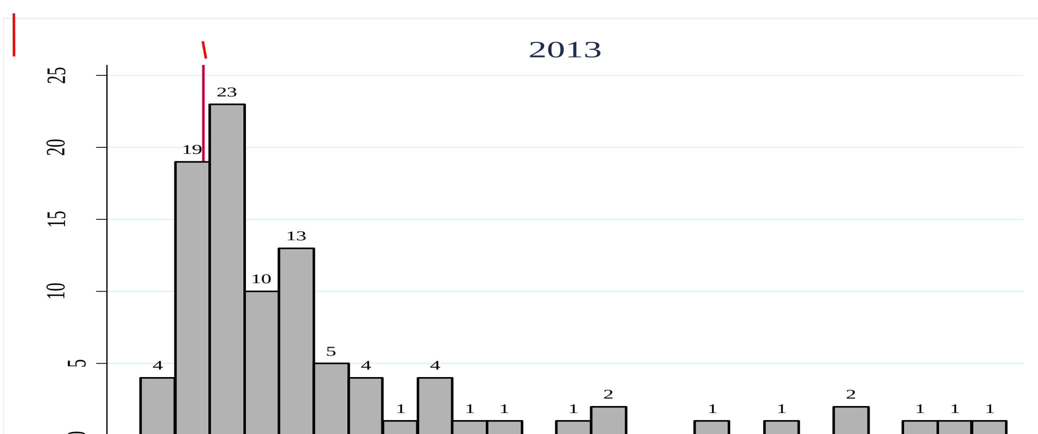
103	6433	WAKENYA PAMOJA	WAKENYA PAMOJA SACCO
104	10226	WAKULIMA DAIRY SACCO	WAKULIMA COMMERCIAL SACCO
105	3110	WANAANGA	WANAANGA SACCO
106	6531	WANANCHI NTG	WANANCHI SACCO
107	2700	WANANDEGE	WANANDEGE SACCO
108	2624	WARENG TEACHERS SACCO	THE NOBLE SACCO
109	3350	WASHA	WASHA SACCO
110	3302	WAUMINI	WAUMINI SACCO

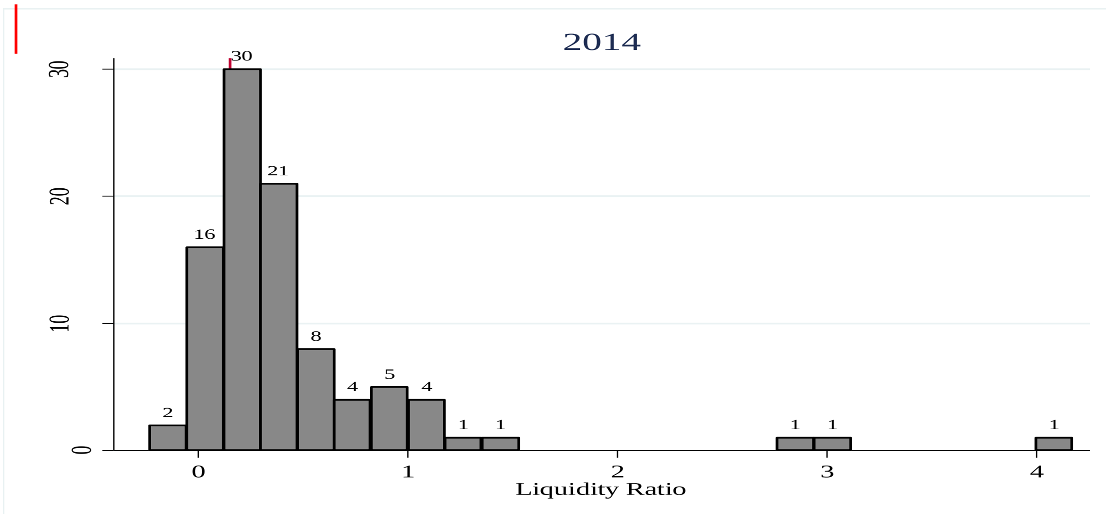
*license revoked in 2015 due to undercapitalization

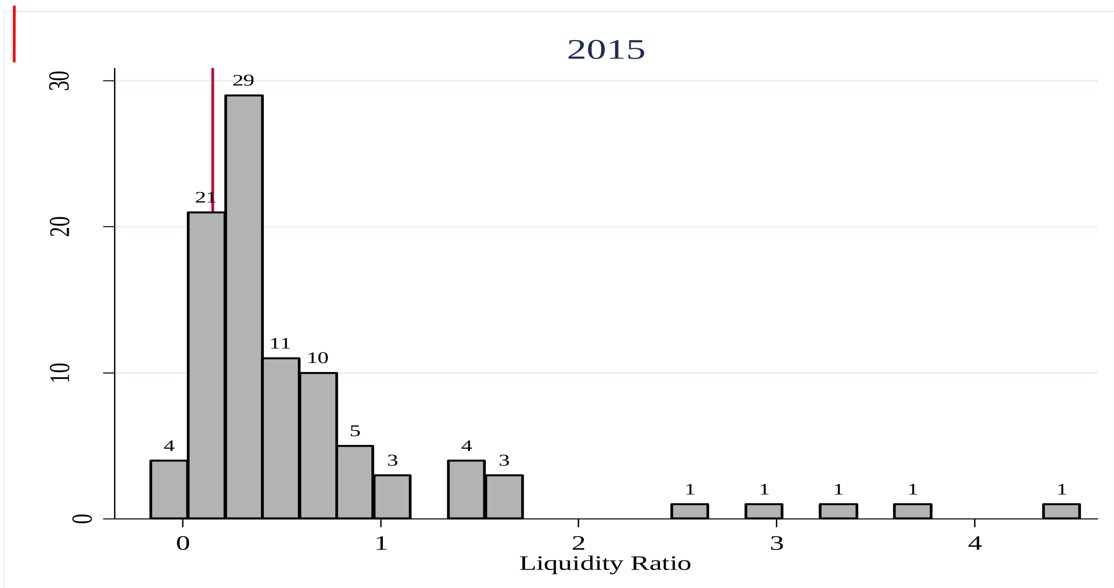
Appendix III : Distribution of DTS Based on Liquidity Ratio 2011-2016

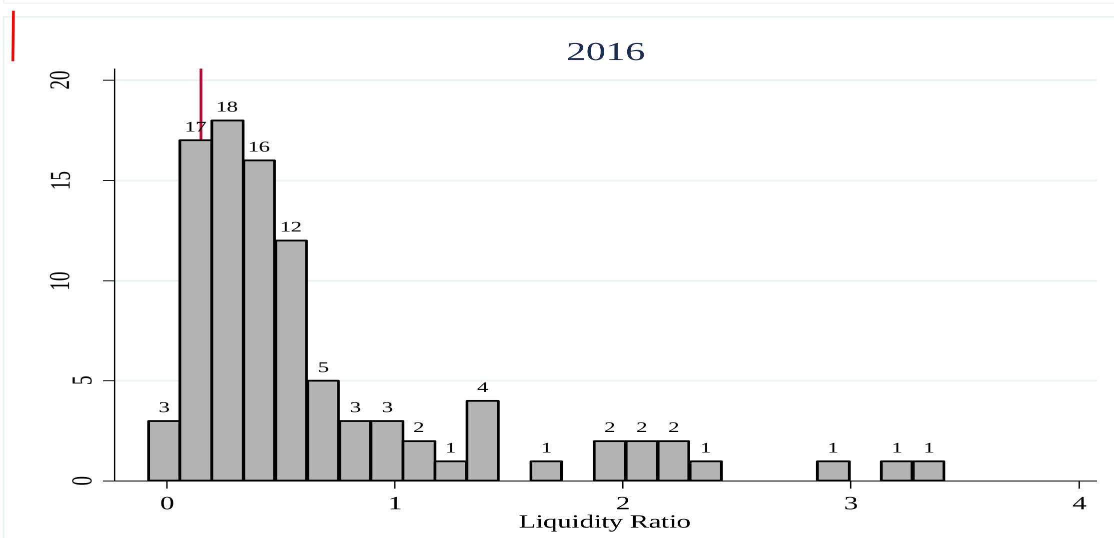




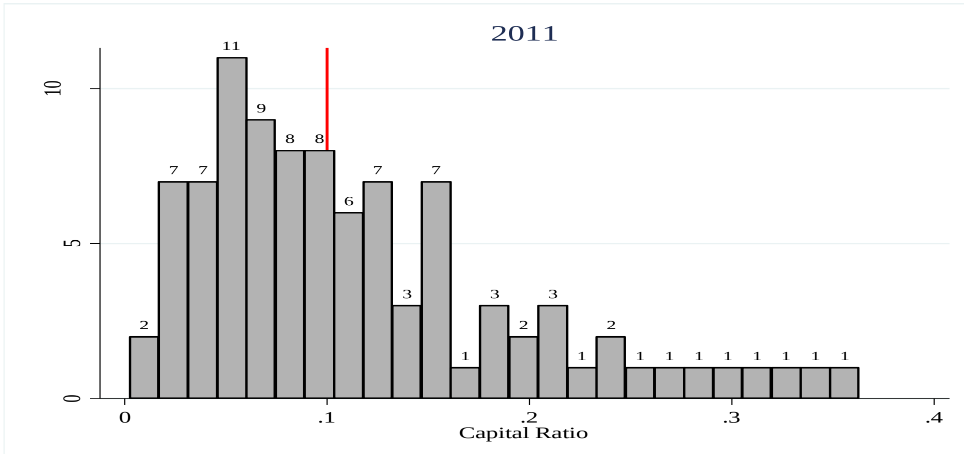


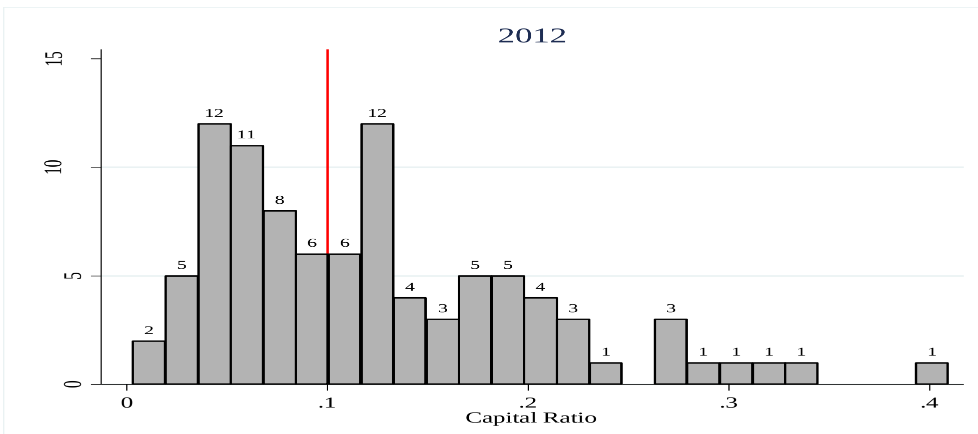

2014
30
20
10
0
2
16
30
21
8
4
5
4
1
1
1
1
1
0
1
2
3
4
Liquidity Ratio

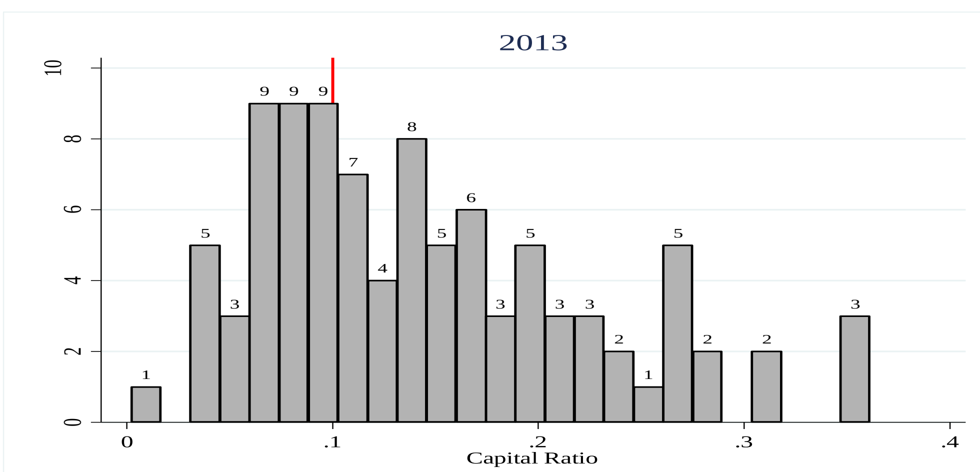

2015
30
20
10
0
4
21
29
11
10
5
3
4
3
1
1
1
1
1
0
1
2
3
4
Liquidity Ratio

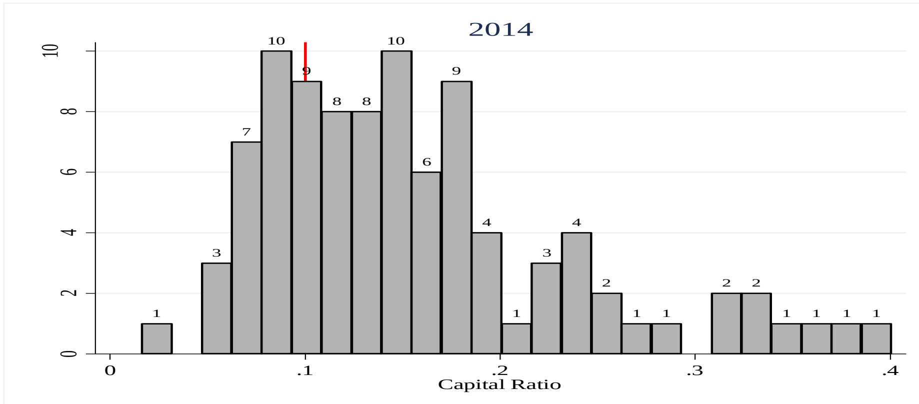

2016
20
15
10
5
0
3
17
18
16
12
5
3
3
2
1
4
1
2
2
2
1
1
1
1
0
1
2
3
4
Liquidity Ratio

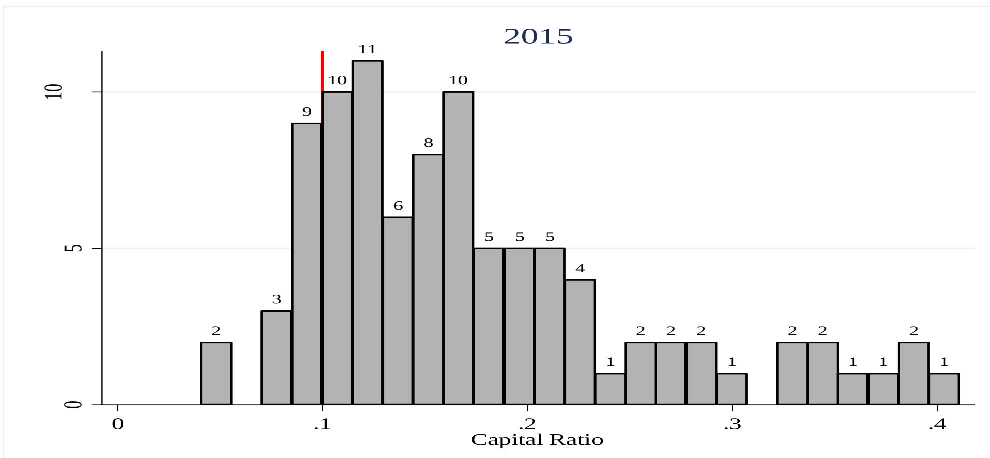
Apendix III : Distribution of DTS Based on Capital Ratios between 2011-2016

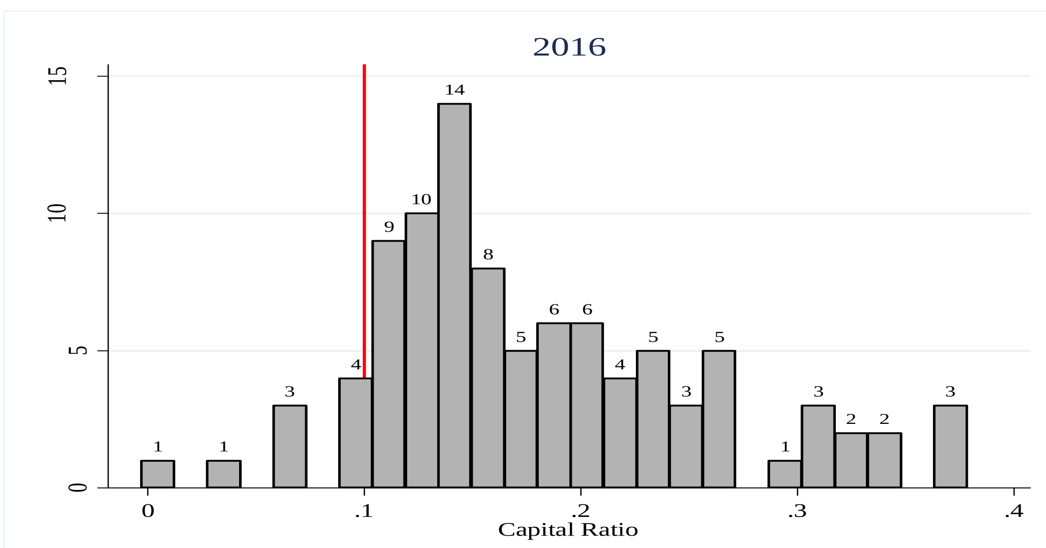




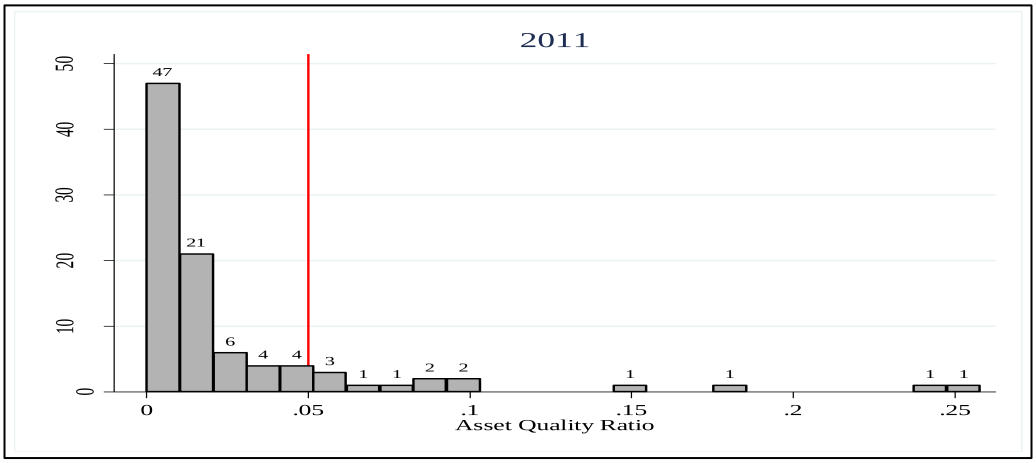


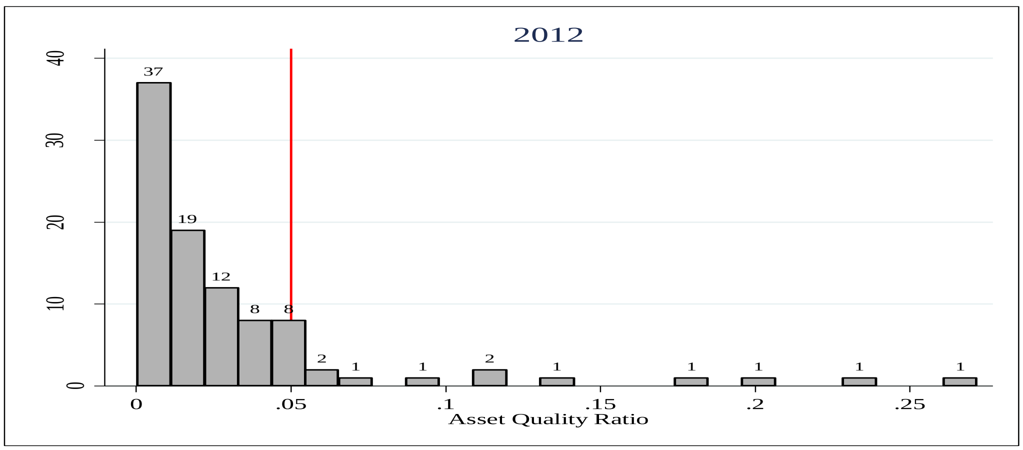

2014
0
2
4
6
8
10
1 3 7 10 9 8 8 10 6 9 4 1 3 4 2 1 1 2 2 1 1 1 1
0
.1
.2
.3
.4
Capital Ratio

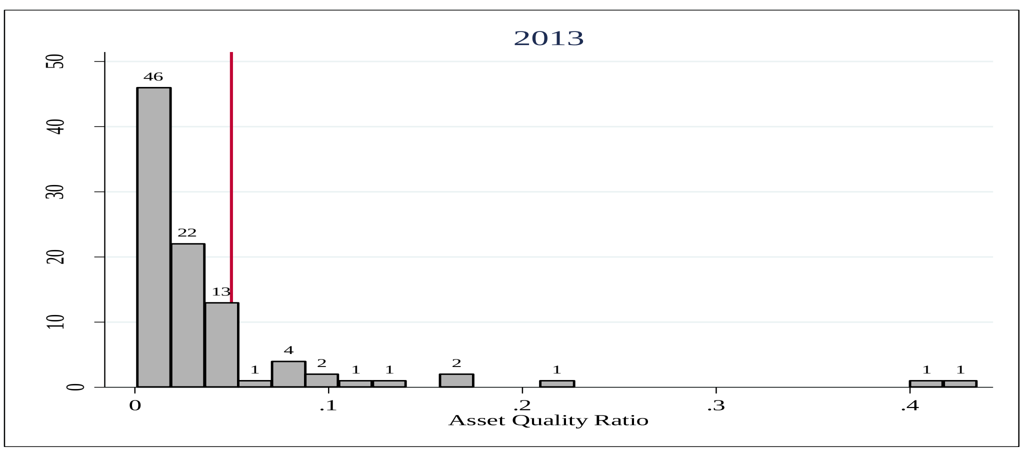

2015
0
5
10
2 3 9 10 11 6 8 10 5 5 5 4 1 2 2 2 1 2 2 1 1 2 1
0
.1
.2
.3
.4
Capital Ratio

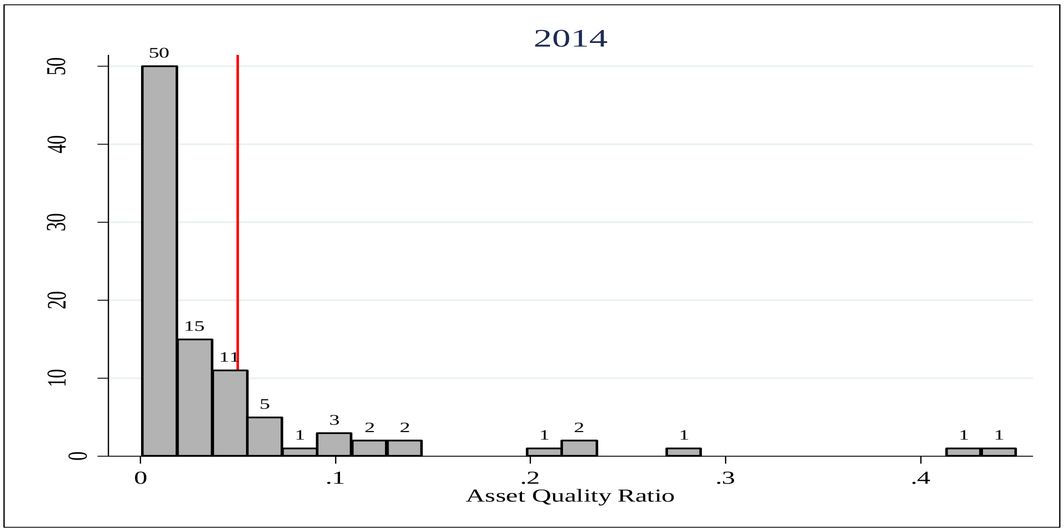

2016
0
5
10
15
1 1 3 4 9 10 14 8 5 6 6 4 5 3 5 1 3 2 2 3
0
.1
.2
.3
.4
Capital Ratio

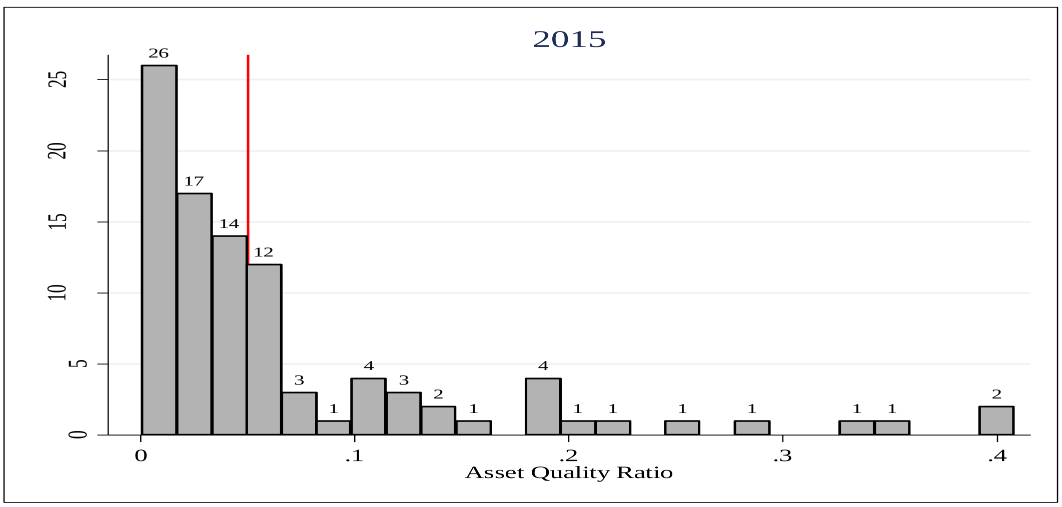
Appendix IV: Distribution of DTS Based on Asset Quality Ratio

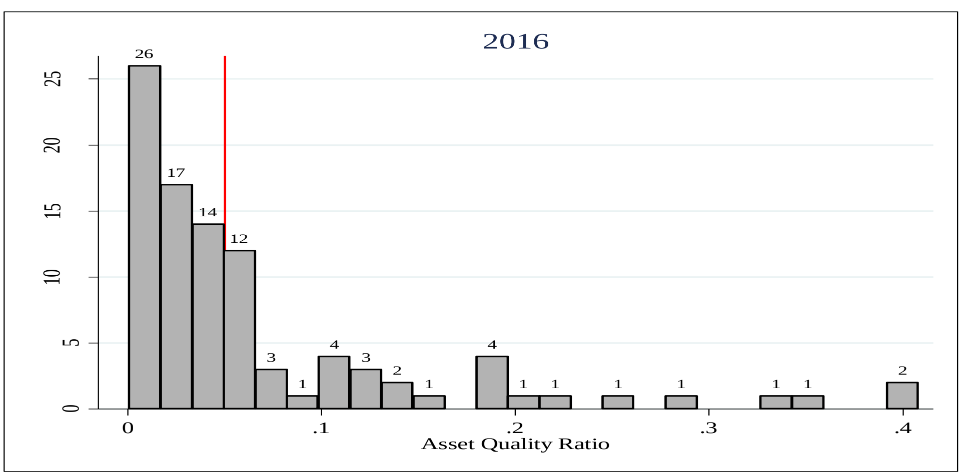




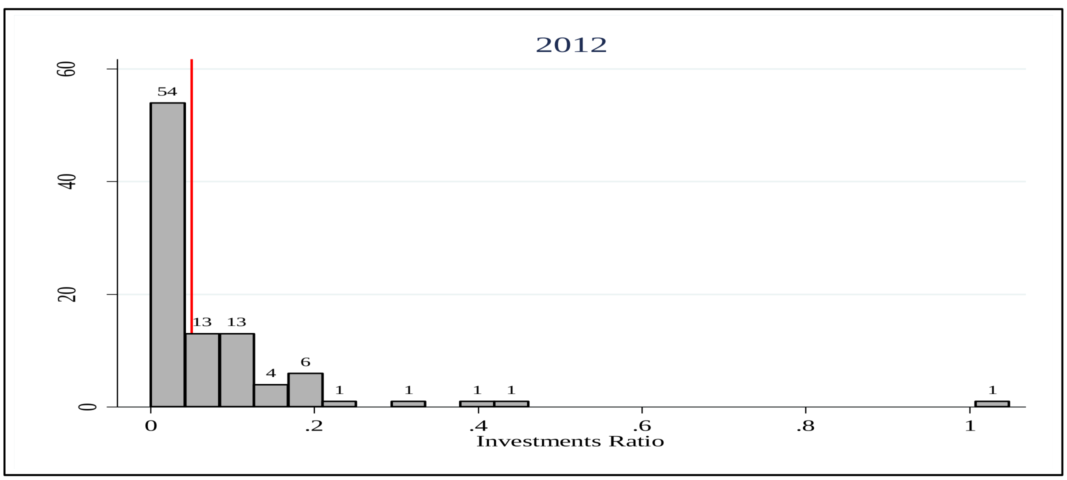


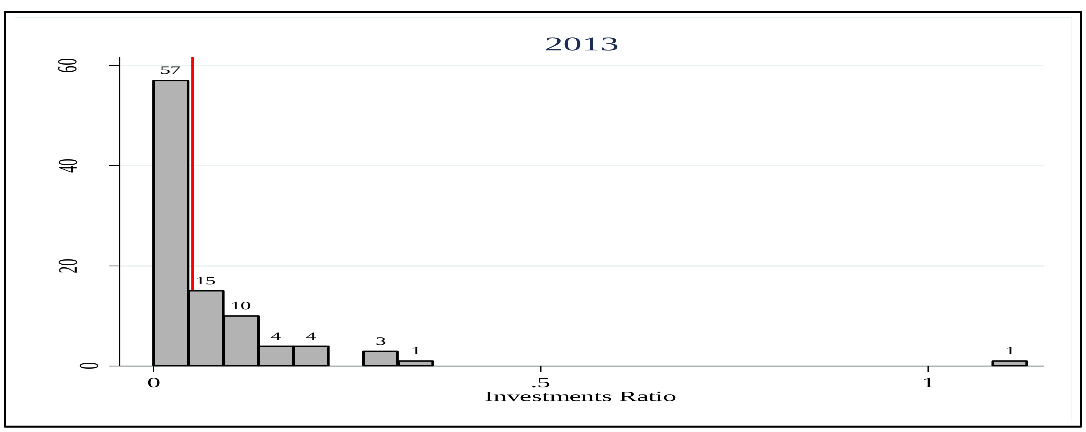

2014
0
10
20
30
40
50
50
15
11
5
1
3
2
2
1
2
1
1
1
0
.1
.2
.3
.4
Asset Quality Ratio

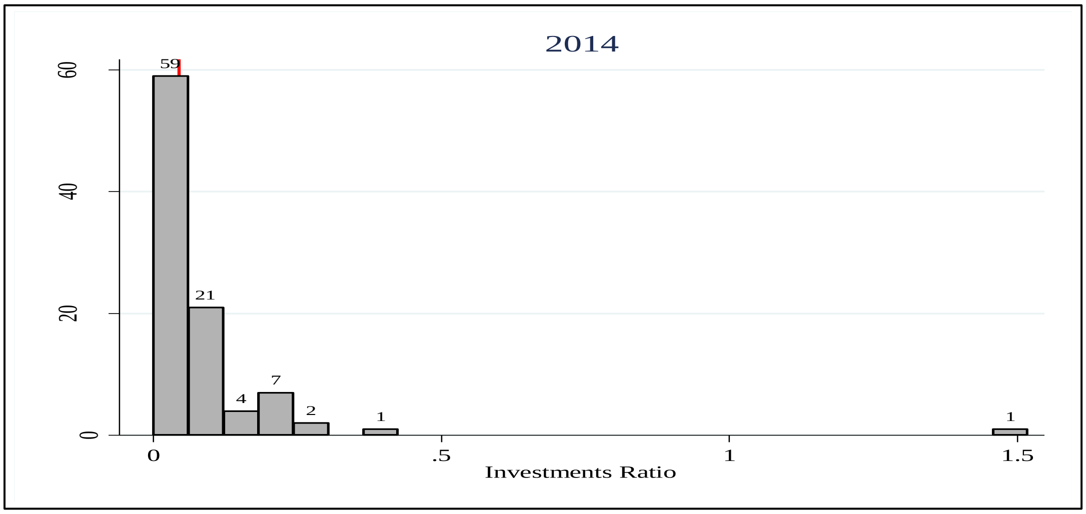

2015
0
5
10
15
20
25
26
17
14
12
3
1
4
3
2
1
4
1
1
1
1
1
1
2
0
.1
.2
.3
.4
Asset Quality Ratio

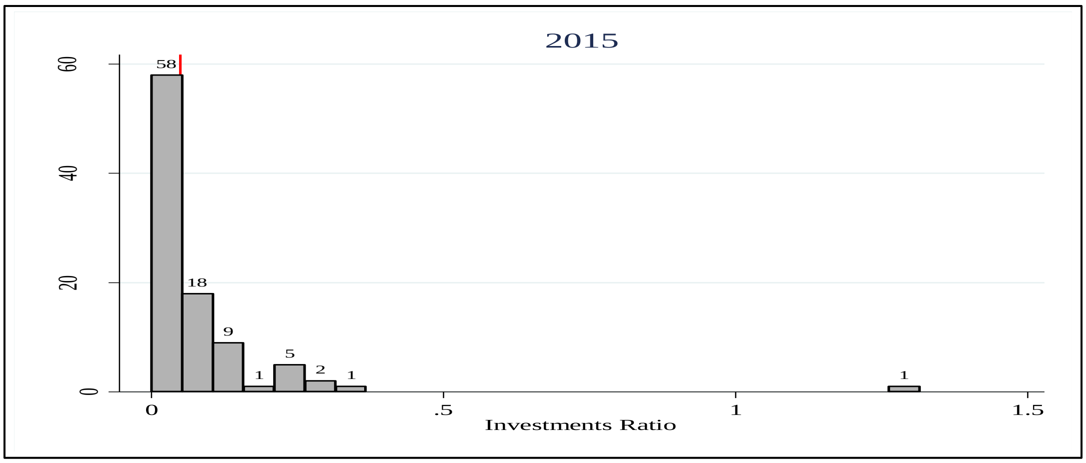

2016
0
5
10
15
20
25
26
17
14
12
3
1
4
3
2
1
4
1
1
1
1
1
1
2
0
.1
.2
.3
.4
Asset Quality Ratio

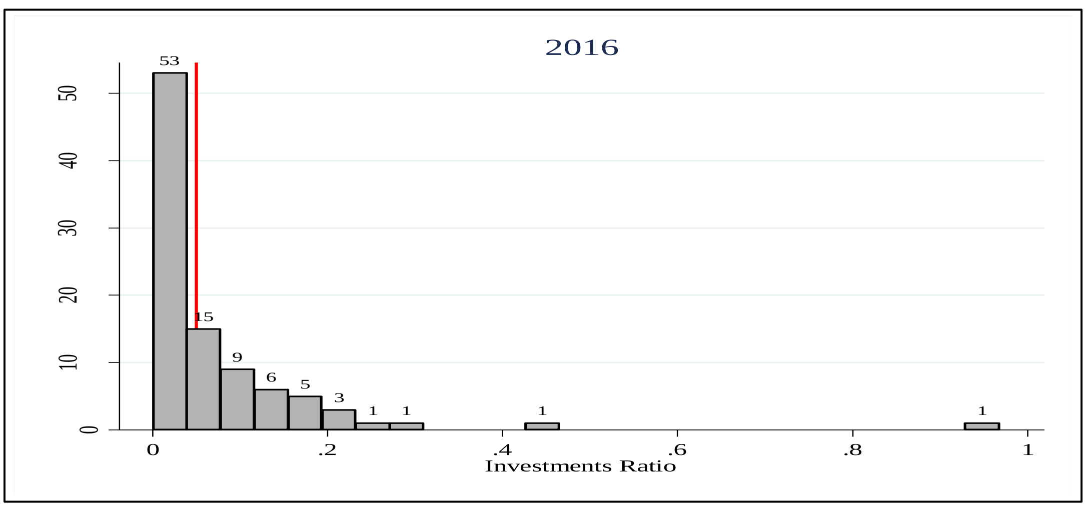
Appendix V: Distribution of DTS Based on Investment Ratios






2014
Investments Ratio
0
.5
1
1.5
0
20
40
60
59
21
4
7
2
1
1


2015
Investments Ratio
0
.5
1
1.5
0
20
40
60
58
18
9
1
5
2
1
1


2016
Investments Ratio
0
.2
.4
.6
.8
1
0
10
20
30
40
50
53
15
9
6
5
3
1
1
1
1

Appendix VI: Optimal Model Selection Results

MODEL 2

	Coefficient	*Drisc/Kraay Std Errors*	*t-ratio*	*p-value*	
Constant	0.592323	0.0228625	25.91	<0.0001	***
Liquidity Compliance	−0.0241325	0.0164139	−1.470	0.1448	
Capital Compliance	−0.0663438	0.0128482	−5.164	<0.0001	***
Asset Quality compliance	−0.00622393	0.0166731	−0.3733	0.7098	
Investment Compliance	−0.0722305	0.0176093	−4.102	<0.0001	***
2012	−0.0245190	0.00883151	−2.776	0.0066	***
2013	−0.0559443	0.0115159	−4.858	<0.0001	***
2014	−0.0697739	0.0145229	−4.804	<0.0001	***
2015	−0.0848051	0.0181666	−4.668	<0.0001	***
2016	−0.0729886	0.0200009	−3.649	0.0004	***

Mean dependent var	0.427244	S.D. dependent var	0.169881
Sum squared resid	3.330820	S.E. of regression	0.084544
LSDV R-squared	0.797161	Within R-squared	0.295431

Joint test on named regressors -
Test statistic: F(4, 94) = 10.3822
with p-value = P(F(4, 94) > 10.3822) = 5.23697e-007

Robust test for differing group intercepts -
Null hypothesis: The groups have a common intercept
Test statistic: Welch F(94, 161.7) = 32.31
with p-value = P(F(94, 161.7) > 32.31) = 1.35226e-071

Wald joint test on time dummies -
Null hypothesis: No time effects
Asymptotic test statistic: Chi-square(5) = 29.0953
with p-value = 2.22104e-005

MODEL 3

	Coefficient	*Drisc/Kraay Std Errors*	*t-ratio*	*p-value*	
Constant	0.587002	0.0199518	29.42	<0.0001	***
Liquidity Compliance	−0.0238760	0.0165790	−1.440	0.1532	
Capital Compliance	−0.0665857	0.0128056	−5.200	<0.0001	***
Investment Compliance	−0.0724840	0.0175907	−4.121	<0.0001	***
2012	−0.0244140	0.00881271	−2.770	0.0067	***
2013	−0.0554944	0.0113009	−4.911	<0.0001	***
2014	−0.0691778	0.0142858	−4.842	<0.0001	***
2015	−0.0837416	0.0175293	−4.777	<0.0001	***
2016	−0.0713044	0.0184830	−3.858	0.0002	***

Mean dependent var	0.427244	S.D. dependent var	0.169881
Sum squared resid	3.332515	S.E. of regression	0.084475
LSDV R-squared	0.797058	Within R-squared	0.295072

Joint test on named regressors -
Test statistic: F(3, 94) = 13.1582
with p-value = P(F(3, 94) > 13.1582) = 3.02743e-007

Robust test for differing group intercepts -
Null hypothesis: The groups have a common intercept
Test statistic: Welch F(94, 161.7) = 35.287
with p-value = P(F(94, 161.7) > 35.287) = 1.87148e-074

Wald joint test on time dummies -
Null hypothesis: No time effects
Asymptotic test statistic: Chi-square(5) = 29.2821
with p-value = 2.04117e-005

MODEL 4

	Coefficient	*Drisc/Kraay Std Errors*	*t-ratio*	*p-value*	
Constant	0.568270	0.0150860	37.67	<0.0001	***
Capital Compliance	−0.0667570	0.0129776	−5.144	<0.0001	***
Investment Compliance	−0.0734331	0.0175861	−4.176	<0.0001	***
2012	−0.0228653	0.00869987	−2.628	0.0100	**
2013	−0.0554056	0.0113735	−4.871	<0.0001	***
2014	−0.0678797	0.0144112	−4.710	<0.0001	***
2015	−0.0854061	0.0174826	−4.885	<0.0001	***
2016	−0.0726731	0.0187600	−3.874	0.0002	***

Mean dependent var	0.427244	S.D. dependent var	0.169881
Sum squared resid	3.359541	S.E. of regression	0.084726
LSDV R-squared	0.795412	Within R-squared	0.289355

Joint test on named regressors -
Test statistic: F(2, 94) = 18.2486
with p-value = P(F(2, 94) > 18.2486) = 2.01262e-007

Robust test for differing group intercepts -
Null hypothesis: The groups have a common intercept
Test statistic: Welch F(94, 161.7) = 37.9227
with p-value = P(F(94, 161.7) > 37.9227) = 8.36044e-077

Wald joint test on time dummies -
Null hypothesis: No time effects
Asymptotic test statistic: Chi-square (5) = 29.9241
with p-value = 1.52644e-005

Appendix VII: List of Deposit Taking Saccos and Their Efficiency Scores

SACCO NAME	2011			2012			2013			2014			2015			2016		
	BC vrste	**vrste**	**crste**	**BC vrste**	**vrste**	**crste**	**BC vrste**	**vrste**	**crste**	**BC vrste**	**vrste**	**crste**	**BC vrste**	**vrste**	**crste**	**BC vrste**	**vrste**	**crste**
AFYA SACCO	0.724	1.000	1.000	0.676	1.000	1.000	0.668	1.000	1.000	0.544	1.000	1.000	0.365	1.000	1.000	0.727	1.000	1.000
AIRPORTS SACCO	0.706	0.989	0.989	0.379	0.555	0.378	0.387	0.679	0.598	0.329	0.692	0.615	0.311	0.762	0.757	0.303	0.462	0.378
ASILI SACCO	0.285	0.580	0.580	0.283	0.543	0.282	0.315	0.446	0.606	0.289	0.587	0.571	0.262	0.677	0.650	0.241	0.293	0.282
BANDARI SACCO	0.604	0.887	0.887	0.627	1.000	0.902	0.706	0.912	0.966	0.686	0.930	0.924	0.712	1.000	1.000	0.685	0.936	0.902
BARAKA SACCO	0.245	0.162	0.162	0.217	0.304	0.096	0.199	0.326	0.182	0.211	0.368	0.229	0.195	0.497	0.482	0.176	0.269	0.096
BIASHARA SACCO	0.554	0.867	0.867	0.558	1.000	0.186	0.193	0.468	0.422	0.173	0.443	0.411	0.157	0.645	0.610	0.154	0.216	0.186
BINGWA SACCO	0.152	0.311	0.311	0.138	0.311	0.237	0.170	0.406	0.356	0.285	0.472	0.459	0.313	0.818	0.702	0.304	0.444	0.237
BORESHA SACCO	0.332	0.475	0.475	0.232	0.440	0.255	0.278	0.611	0.582	0.326	0.603	0.602	0.337	0.951	0.782	0.402	0.682	0.255
CAPITAL SACCO	0.280	0.378	0.378	0.297	0.469	0.229	0.224	0.572	0.438	0.277	0.680	0.649	0.186	0.584	0.530	0.159	0.254	0.229
CENTENARY SACCO	0.618	0.685	0.685	0.406	0.697	0.284	0.301	0.751	0.500	0.328	0.691	0.591	0.288	0.722	0.697	0.258	0.416	0.284
CHAI SACCO	0.338	0.484	0.484	0.329	0.549	0.415	0.327	0.739	0.639	0.304	0.681	0.675	0.408	0.957	0.909	0.376	0.517	0.415
COSMOPOLITAN SACCO	0.677	0.842	0.842	0.656	0.862	0.664	0.651	1.000	0.939	0.596	0.907	0.906	0.565	1.000	0.960	0.590	0.896	0.664
DAIMA SACCO	0.262	0.476	0.476	0.233	0.465	0.200	0.203	0.374	0.385	0.213	0.414	0.413	0.201	0.482	0.467	0.155	0.257	0.200
DHABITI SACCO S	0.581	0.770	0.770	0.824	1.000	0.164	0.404	0.703	0.380	0.351	0.551	0.459	0.227	0.676	0.664	0.164	0.242	0.164
DIMKES SACCO	0.565	0.716	0.716	0.511	0.738	0.374	0.510	1.000	0.798	0.346	0.674	0.619	0.304	0.833	0.795	0.258	0.391	0.374
EGERTON SACCO	0.592	0.754	0.754	0.403	0.685	0.397	0.331	0.505	0.651	0.258	0.564	0.551	0.372	0.753	0.738	0.324	0.453	0.397
ELGON TEACHERS SACCO	0.472	0.382	0.382	0.466	0.632	0.236	0.352	0.490	0.334	0.376	0.607	0.382	0.367	0.662	0.484	0.354	0.756	0.236

ENEA SACCO	0.509	0.247	0.247	0.398	0.553	0.096	0.367	0.580	0.182	0.298	1.000	0.166	0.293	1.000	0.239	0.233	0.397	0.096
FARIJI SACCO	0.416	0.288	0.288	0.453	1.000	0.195	0.494	1.000	0.694	0.550	1.000	0.627	0.407	0.872	0.598	0.376	0.615	0.195
FORTUNE SACCO	0.124	0.253	0.253	0.085	0.170	0.161	0.105	0.310	0.214	0.151	0.362	0.353	0.135	0.789	0.683	0.146	0.241	0.161
GITHUNGURI SACCO	0.521	0.894	0.894	0.555	1.000	0.215	0.347	1.000	0.726	0.418	1.000	0.908	0.179	0.597	0.590	0.186	0.238	0.215
HARAMBEE SACCO	0.719	0.991	0.991	0.662	1.000	0.321	0.528	1.000	0.757	0.594	1.000	0.800	0.309	0.581	0.513	0.416	0.695	0.321
HAZINA SACCO	0.755	0.897	0.897	0.657	0.832	0.473	0.633	0.904	0.850	0.603	1.000	0.816	0.483	0.977	0.823	0.518	0.645	0.473
IMARISHA SACCO	0.507	0.668	0.668	0.551	0.759	0.295	0.544	0.951	0.847	0.532	0.963	0.958	0.516	0.894	0.816	0.445	0.706	0.295
IMENTI SACCO	0.404	0.460	0.460	0.394	0.562	0.198	0.325	0.536	0.379	0.358	0.623	0.445	0.265	0.576	0.512	0.238	0.460	0.198
JAMII SACCO	0.503	0.868	0.868	0.421	0.806	0.438	0.382	0.683	0.756	0.393	0.733	0.731	0.410	0.751	0.733	0.446	0.581	0.438
K- UNITY SACCO	0.279	0.975	0.975	0.200	0.491	0.209	0.194	1.000	0.483	0.180	1.000	0.594	0.150	0.370	0.355	0.163	0.244	0.209
INVEST & GROW SACCO	0.565	0.875	0.875	0.541	0.890	0.773	0.598	0.833	0.869	0.646	0.842	0.838	0.704	1.000	0.864	0.744	0.996	0.773
KENPIPE SACCO	0.630	0.959	0.959	0.478	0.824	0.438	0.463	0.689	0.779	0.421	0.727	0.717	0.424	0.767	0.767	0.384	0.453	0.438
KENVERSITY SACCO	0.593	0.786	0.786	0.516	0.712	0.646	0.713	1.000	1.000	0.601	1.000	1.000	0.523	0.922	0.916	0.551	0.690	0.646
KENYA ACHIEVAS SACCO	0.285	0.366	0.366	0.273	1.000	0.175	0.163	0.330	0.144	0.202	1.000	0.204	0.187	0.470	0.438	0.160	0.252	0.175
KENYA BANKERS	0.495	0.599	0.599	0.455	0.583	0.329	0.385	0.533	0.563	0.390	0.589	0.566	0.354	0.653	0.605	0.390	0.562	0.329
KENYA CANNERS	0.447	0.697	0.697	0.407	0.671	0.547	0.403	0.639	0.653	0.415	0.735	0.691	0.425	0.708	0.675	0.468	0.652	0.547
KENYA HIGHLANDS SACCO	0.146	0.273	0.273	0.137	0.275	0.109	0.132	0.267	0.286	0.121	0.306	0.294	0.094	0.430	0.378	0.091	0.120	0.109
KENYA POLICE SACCO	0.634	0.797	0.797	0.631	1.000	0.569	0.707	1.000	1.000	0.667	1.000	1.000	0.707	1.000	0.852	0.660	1.000	0.569
JOINAS SACCO	0.834	0.480	0.480	0.788	1.000	0.277	0.649	1.000	0.672	0.500	0.906	0.625	0.367	0.782	0.677	0.315	0.725	0.277
IMARIKA SACCO	0.389	0.604	0.604	0.360	0.632	0.314	0.366	0.580	0.590	0.334	0.529	0.529	0.376	0.748	0.727	0.463	0.704	0.314
KINGDOM SACCO	0.400	0.493	0.493	0.371	0.581	0.472	0.340	0.741	0.639	0.240	0.623	0.568	0.349	0.709	0.707	0.391	0.514	0.472
KIPSIGIS EDIS SACCO	0.756	0.791	0.791	0.703	1.000	0.261	0.658	1.000	0.695	0.566	1.000	0.583	0.532	1.000	0.749	0.474	1.000	0.261
KITE SACCO	0.489	0.665	0.665	0.462	0.610	0.380	0.483	0.663	0.774	0.435	0.643	0.590	0.381	0.671	0.650	0.336	0.478	0.380
K- PILLAR SACCO	0.328	0.410	0.410	0.379	0.543	0.144	0.347	0.549	0.387	0.358	0.628	0.446	0.253	0.596	0.523	0.191	0.395	0.144
LENGO SACCO	0.699	0.704	0.704	0.691	1.000	0.184	0.474	0.879	0.245	0.422	0.692	0.301	0.384	0.736	0.526	0.341	0.624	0.184

MAGEREZA SACCO	0.431	0.568	0.568	0.407	0.556	0.394	0.458	1.000	0.878	0.452	1.000	1.000	0.385	0.608	0.602	0.399	0.556	0.394
MAISHA BORA SACCO	0.681	1.000	1.000	0.733	1.000	0.909	0.790	1.000	1.000	0.752	1.000	1.000	0.700	1.000	1.000	0.661	0.966	0.909
BI HIGH SACCO	0.657	1.000	1.000	0.518	1.000	0.835	0.412	0.694	0.616	0.444	1.000	0.660	0.554	1.000	1.000	0.499	1.000	0.835
MENTOR SACCO	0.653	1.000	1.000	0.572	1.000	0.500	0.475	0.707	0.763	0.487	0.772	0.772	0.453	0.778	0.750	0.529	0.702	0.500
METROPOLITAN SACCO	0.683	0.908	0.908	0.642	0.915	0.392	0.563	0.995	0.859	0.657	0.969	0.886	0.566	1.000	0.977	0.633	1.000	0.392
MMH SACCO	0.267	0.287	0.287	0.267	0.386	0.309	0.346	0.585	0.528	0.362	0.646	0.554	0.338	0.684	0.653	0.307	0.477	0.309
MOMBASA PORT SACCO	0.555	1.000	1.000	0.433	0.867	1.000	0.443	1.000	0.854	0.514	1.000	0.958	0.793	1.000	1.000	0.694	1.000	1.000
MAFANIKIO SACCO	0.315	0.540	0.540	0.359	0.653	0.304	0.317	0.517	0.589	0.268	0.550	0.495	0.256	0.620	0.589	0.282	0.403	0.304
MUDETE TEA G. SACCO	0.822	0.443	0.443	0.540	1.000	0.341	0.339	0.558	0.310	0.332	0.608	0.340	0.289	0.503	0.321	0.347	0.706	0.341
MUHIGIA SACCO (OLLIN)	0.763	1.000	1.000	0.772	1.000	0.447	0.741	1.000	1.000	0.701	1.000	1.000	0.332	0.774	0.739	0.443	0.572	0.447
MWALIMU NATIONAL	0.718	1.000	1.000	0.661	1.000	1.000	0.486	1.000	0.642	0.481	1.000	0.552	0.715	1.000	0.931	0.669	1.000	1.000
MWITO SACCO	0.453	0.622	0.622	0.506	0.655	0.348	0.465	0.746	0.749	0.406	0.828	0.763	0.294	0.808	0.784	0.293	0.365	0.348
NAFAKA SACCO	0.405	0.469	0.469	0.327	0.512	0.228	0.234	0.596	0.368	0.257	0.600	0.511	0.219	0.718	0.713	0.213	0.376	0.228
NAKU SACCO	0.417	0.664	0.664	0.521	0.709	0.427	0.354	0.578	0.644	0.332	0.635	0.618	0.377	0.762	0.745	0.371	0.427	0.427
NANDI HEKIMA SACCO	0.359	0.346	0.346	0.355	0.573	0.423	0.401	0.756	0.637	0.514	1.000	1.000	0.501	1.000	1.000	0.545	0.921	0.423
NAROK TEACHERS	0.649	1.000	1.000	0.492	0.862	0.426	0.482	0.754	0.818	0.528	1.000	0.912	0.451	0.997	0.993	0.313	0.584	0.426
NASSEFU SACCO	0.379	0.684	0.684	0.400	0.738	0.351	0.310	0.571	0.629	0.259	0.618	0.599	0.270	0.793	0.781	0.297	0.366	0.351
NATION SACCO	0.636	0.835	0.835	0.442	0.596	0.458	0.474	0.842	0.824	0.488	0.914	0.889	0.408	0.849	0.841	0.404	0.486	0.458
NDOSHA SACCO	0.414	0.435	0.435	0.422	0.566	0.289	0.365	0.557	0.414	0.383	0.697	0.493	0.384	0.845	0.708	0.331	0.696	0.289
NG’ARISHA SACCO	0.301	0.491	0.491	0.357	0.504	0.313	0.260	0.475	0.492	0.222	0.532	0.518	0.271	0.765	0.732	0.230	0.315	0.313
NITUNZE	0.308	0.605	0.605	0.183	0.260	0.185	0.168	0.266	0.231	0.211	0.338	0.281	0.181	0.588	0.572	0.177	0.277	0.185
NYAMBENE ARIMI SACCO	0.362	0.269	0.269	0.309	0.441	0.111	0.295	0.479	0.292	0.306	0.521	0.352	0.252	0.524	0.463	0.221	0.328	0.111
NYAMIRA TEA FARMERS	0.331	0.361	0.361	0.298	0.462	0.255	0.274	0.581	0.404	0.398	0.694	0.632	0.334	0.581	0.530	0.299	0.511	0.255
NEW FORTIES SACCO	0.598	1.000	1.000	0.569	1.000	0.608	0.648	1.000	1.000	0.673	1.000	1.000	0.635	0.898	0.888	0.587	0.872	0.608
ORIENT SACCO	0.678	0.866	0.866	0.771	1.000	1.000	0.557	1.000	0.981	0.450	1.000	0.950	0.396	1.000	1.000	0.665	1.000	1.000

ORTHODOX SACCO	0.721	0.506	0.506	0.669	0.950	0.147	0.668	1.000	0.336	0.599	1.000	0.318	0.721	1.000	0.790	0.736	1.000	0.147
PUAN SACCO	0.337	0.489	0.489	0.332	0.581	0.307	0.287	0.539	0.482	0.362	0.745	0.585	0.345	0.789	0.686	0.308	0.689	0.307
SAFARICOM SACCO	0.790	1.000	1.000	0.632	0.859	0.565	0.671	1.000	1.000	0.605	1.000	1.000	0.532	0.960	0.905	0.493	0.623	0.565
SHERIA SACCO	0.592	0.765	0.765	0.696	0.894	0.419	0.618	0.877	0.900	0.437	0.750	0.722	0.521	0.801	0.797	0.495	0.604	0.419
SIMBA CHAI SACCO	0.574	0.889	0.889	0.561	0.904	0.521	0.575	0.827	0.939	0.491	0.903	0.861	0.402	0.863	0.854	0.482	0.603	0.521
SIRAJI SACCO	0.561	0.445	0.445	0.525	0.703	0.338	0.386	0.818	0.430	0.343	0.676	0.486	0.466	1.000	0.693	0.356	0.711	0.338
SKYLINE SACCO	0.365	0.420	0.420	0.252	0.401	0.338	0.280	1.000	0.461	0.095	1.000	0.120	0.231	0.663	0.633	0.243	0.347	0.338
STIMA SACCO	0.566	0.746	0.746	0.548	0.761	0.465	0.543	1.000	0.762	0.528	1.000	0.797	0.445	1.000	0.770	0.583	1.000	0.465
SUKARI SACCO	0.311	0.443	0.443	0.298	0.456	0.581	0.281	0.435	0.501	0.204	0.479	0.461	0.292	0.725	0.686	0.392	0.586	0.581
TAIFA SACCO	0.177	0.376	0.376	0.121	0.285	0.217	0.133	0.336	0.322	0.135	0.341	0.328	0.135	0.486	0.444	0.163	0.278	0.217
QWETU ACCO	0.408	0.584	0.584	0.372	0.534	1.000	0.276	0.599	0.593	0.260	0.601	0.589	0.666	1.000	1.000	0.641	1.000	1.000
TARAJI SACCO	0.322	0.490	0.490	0.385	0.723	0.253	0.219	0.397	0.286	0.199	0.399	0.221	0.201	0.401	0.339	0.251	0.496	0.253
TEMBO SACCO	0.724	1.000	1.000	0.705	1.000	0.741	0.541	0.903	0.857	0.578	0.947	0.919	0.594	0.876	0.850	0.555	0.839	0.741
TEMBO SACCO	0.458	0.340	0.340	0.399	0.519	1.000	0.474	0.677	0.447	0.438	0.799	0.372	0.265	0.603	0.537	0.717	1.000	1.000
TRANS-NATIONAL TIMES	0.464	0.708	0.708	0.373	0.617	0.421	0.520	1.000	1.000	0.291	1.000	0.850	0.295	0.612	0.607	0.323	0.462	0.421
UKRISTO NA UFANISI	0.530	0.475	0.475	0.555	0.840	0.539	0.400	0.655	0.625	0.322	0.658	0.624	0.465	0.959	0.944	0.470	0.565	0.539
UKULIMA SACCO	0.380	0.493	0.493	0.462	0.607	0.354	0.645	1.000	1.000	0.626	1.000	1.000	0.364	0.808	0.747	0.376	0.741	0.354
UN SACCO	0.809	0.942	0.942	0.811	1.000	0.475	0.733	1.000	0.937	0.536	1.000	0.839	0.485	1.000	0.724	0.478	0.605	0.475
UNAITAS SACCO	0.182	0.361	0.361	0.307	1.000	0.195	0.353	1.000	0.446	0.394	0.678	0.388	0.479	0.951	0.757	0.391	0.752	0.195
WAKENYA PAMOJA SACCO	0.446	0.891	0.891	0.620	1.000	0.324	0.298	1.000	0.521	0.679	1.000	1.000	0.267	0.777	0.769	0.207	0.337	0.324
WAKULIMA SACCO	0.827	0.530	0.530	0.788	1.000	0.520	0.735	1.000	1.000	0.727	1.000	1.000	0.380	0.684	0.637	0.369	0.616	0.520
WANAANGA SACCO	0.561	0.731	0.731	0.618	1.000	0.445	0.532	1.000	0.782	0.499	0.891	0.809	0.419	0.749	0.748	0.388	0.499	0.445
WANANCHI SACCO	0.404	1.000	1.000	0.335	1.000	0.581	0.284	0.566	0.950	0.256	0.653	0.653	0.328	0.814	0.755	0.299	0.584	0.581
WANANDEGE SACCO	0.268	0.357	0.357	0.220	0.346	0.268	0.204	0.423	0.370	0.202	0.425	0.416	0.195	0.564	0.525	0.198	0.282	0.268
WARENG TEACHERS SACCO	0.346	0.575	0.575	0.363	0.664	0.403	0.403	0.746	0.775	0.395	0.863	0.856	0.355	0.780	0.762	0.330	0.410	0.403

WASHA SACCO	0.641	0.779	0.779	0.667	1.000	0.249	0.547	1.000	0.687	0.459	1.000	0.691	0.415	1.000	0.670	0.309	0.966	0.249
WAUMINI SACCO	0.491	0.681	0.681	0.473	0.678	0.431	0.431	1.000	0.665	0.716	1.000	1.000	0.430	0.891	0.852	0.444	0.577	0.431
WINAS SACCO	0.513	0.875	0.875	0.475	0.984	0.482	0.534	1.000	0.943	0.493	0.987	0.938	0.458	0.834	0.833	0.579	0.711	0.482

Appendix VIII: Distribution of DTS Technical Efficiency Scores

Year	Class	Frequency	Percent	Cumulative Percent
2011	< 0.250	2	2.11%	2.11%
	0.25 – 0.500	33	34.74%	36.84%
	0.50 – 0.75	23	24.21%	61.05%
	>0.75	37	38.95%	100.00%
	Total	**95**	**100.00%**	
2012	< 0.250	1	1.05%	1.05%
	0.25 – 0.500	15	15.79%	16.84%
	0.50 – 0.75	35	36.84%	53.68%
	>0.75	44	46.32%	100.00%
	Total	**95**	**100.00%**	
2013	< 0.250	0	0%	0%
	0.25 – 0.500	16	16.84%	16.84%
	0.50 – 0.75	33	34.74%	51.58%
	>0.75	46	48.42%	100.00%
	Total	95	100.00%	
2014	< 0.250	0	0%	0%
	0.25 – 0.500	11	11.58%	11.58%
	0.50 – 0.75	37	38.95%	50.53%
	>0.75	47	49.47%	100.00%
	Total	95	100.00%	
2015	< 0.250	0	0%	0%
	0.25 – 0.500	7	7.37%	7.37%
	0.50 – 0.75	31	32.63%	40.00%
	>0.75	57	60.00%	100.00%
	Total	95	100.00%	
2016	< 0.250	6	6.32%	6.32%
	0.25 – 0.500	33	34.74%	41.05%
	0.50 – 0.75	34	35.79%	76.84%
	>0.75	22	23.16%	100.00%
	Total	95	100.00%	