EFFICIENCY AND TOTAL FACTOR PRODUCTIVITY GROWTH OF SELECTED PUBLIC CHARTERED UNIVERSITIES IN KENYA

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K102/CTY/28010/2019

A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF ECONOMIC THEORY IN THE SCHOOL OF BUSINESS, ECONOMICS AND TOURISM IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ECONOMICS OF KENYATTA UNIVERSITY

JUNE, 2025

DECLARATION

CANDIDATE'S DECLARATION

This project is my original work and has not been presented for a degree in any other university or any other award.

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I confirm that the work reported in this project was carried out by the candidate under my supervision.

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DEDICATION

I dedicate this research study to my lovely wife and daughters Michelle and Faith.

ACKNOWLEDGEMENT

I wish to thank God for giving me good health. I would like also to express my gratitude to Dr. Paul Gachanja who supervised me for his invaluable guidance during the development of this research study. His unwavering commitment, support, positive criticism and encouragement has improved the standard and quality of this research project. I equally thank my colleagues at Kenyatta University, Nairobi City Campus for their stimulating discussions. Finally, I wish to thank my family for their encouragement and moral support.

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ABBREVIATIONS AND ACRONYMS

CRS: Constant Returns to Scale

CUE: Commission for University Education

DEA: Data Envelopment Analysis

DEAP: Data Envelopment Analysis Program

DMUs: Decision Making Units

DUC: Differentiated Unit Cost

HELB: Higher Education Loans Board

KUCCPS: Kenya Universities and Colleges Central Placement Service

TE: Technical Efficiency

TFP: Total Factor Productivity

UFB: Universities Funding Board

OPERATIONAL DEFINITION OF TERMS

Efficiency Measure of how well public universities use available inputs (resources) to produce maximum possible research and teaching outputs, given the available technology.

Technical Efficiency Ability of public universities to produce maximum possible output out of the available inputs given the available technology.

Productivity Ratio of outputs that public universities produce to the inputs that they use.

Total Factor Productivity Growth Improvement in the ability of public universities to transform inputs into outputs over time.

Inputs Resources public universities have to facilitate their main activities.

Outputs Teaching and research outputs of the public universities from the core activities.

ABSTRACT

University education is indispensable in the economic development of economies globally. It is offered by public owned and privately-owned universities. Unlike private universities, public universities get financed by governments which allocates funds for recurrent and development expenditure to facilitate them undertake their core activities which are research and teaching. These activities can only be attained as long as the institutions are provided with adequate resources which are necessary. The prudent use of these resources is necessary to ensure maximum utilization of the limited resources allocated to these universities. Despite of their importance, Kenyan public, these institutions continue to face huge funding gaps amidst increased administration costs and operational costs which have significantly affected their efficiency and their overall productivity over time. Many Kenyan public universities have huge pending bills which have continued to negatively affect their operations thereby impacting on their performance. The main problem studied is underfunding which is clear from decline in of the universities through the Differentiated Unit Cost model over time. The study aimed at assessing technical efficiency and total factor productivity growth of public universities in Kenya from 2017/2018 to 2021/2022 academic years when the university sector has been seriously hit by huge funding gaps and resource constraints. The specific objectives were to measure the Total Factor Productivity growth and technical efficiency levels of public chartered universities in Kenya as well as the determinants of technical efficiency. The study targeted 31 public universities which are fully fledged. Secondary data was obtained from the Decision-Making Units during the period under study. The study employed Malmquist Productivity Index in evaluating the total factor productivity growth and Data Envelopment Analysis in determining technical efficiency of the sampled public chartered universities using panel data covering five academic years from 2017/2018 to 2021/2022. Under the assumption of the variable returns to scale, this study found out that average TE scores for 31 Decision Making Units was 0.760. This implies that the public universities could have significantly improved their performance by 24% using the resources at their disposal during the period under study. Out of the 31 public universities only 12 public universities, 38.71% were found to be technically efficient having TE score of 1 under assumption of variable returns to scale. The Decision-Making Units recorded a mean Total Factor Productivity growth of 0.018. The results indicate that mean Total Factor Productivity growth was negative and declined by 98.2% during the period under study. From the Tobit regression analysis, employee cost negatively affected technical efficiency levels of public universities. All the other input and output variables besides employee costs positively influenced technical efficiency of the Decision-Making Units analyzed in the study. Therefore, the public chartered universities can increase their technical efficiency by increasing the number of undergraduate, master degrees and doctoral degrees graduates, amount of tuition income and government grants.

Keywords: Total Factor Productivity, Technical Efficiency, Decision Making Units

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

In an era where demand for university education in Kenya far outstrips available funding, public institutions face mounting pressure to deliver quality outcomes with ever-scarcer resources. The quest to maximize every shilling spent has never been more urgent, driving scholars and policymakers alike to scrutinize the efficiency and productivity of these universities as keystones of national development. Education which is anchored in Sustainable Development Goal 4 that primarily focuses on inclusive and equitable quality education and more importantly focusing on lifelong learning opportunities for all people is a fundamental pillar of sustainable growth and development. The contribution of education offered by the public universities plays a crucial role in achieving sustainable development (Odhiambo, 2018). Stakeholders in the education sector invest enormous resources in the provision of basic education and higher education so as to ensure that the citizens have equal access to education. Higher education institutions disseminate knowledge which is a public good. Therefore, universities contribute towards economic growth and development of countries by transferring knowledge to citizens who take part in the country's economic activities (Teichler, 2007). Further, Techler (2007) opined that higher education has a likelihood of enhancing economic activities since the skills and knowledge imparted on people enables them to create more opportunities for income generation.

Besides community service, the main activities which public universities are required to pursue are mainly teaching and undertaking research (Fussy, 2019; Van Schalkwyk, 2021). For public universities to achieve this, they ought to have sufficient resources to finance the core activities. However, these resources are limited and this calls for public universities to use the limited resources availed to them more prudently to produce the desired outputs. Stakeholders in the education sector more especially the government continue to implement strategies that

contribute towards improvement of efficiency and productivity of public universities with the main objective of ensuring that they are responsive to the technological advancements so that they produce the maximum possible output out of research and teaching activities given the available technology. Publicly owned universities are largely funded by public funds. It is therefore on this basis that the government is concerned on how efficient and productive public universities are in their operations. Allocation of limited public resources and their efficient use by public universities are closely linked. As a result, scholars focus on assessing the efficiency and productivity of these higher learning institutions. Therefore, it is paramount that public universities use resources allocated to them by the government in the most prudent, feasible and efficient manner to produce the desired outputs. Stakeholders in the education sector are concerned with both quality and quantity of human capital from the public universities (Ulewicz, 2017; Martin, 2018). It is therefore imperative for efficiency and productivity of public universities to be measured due to increased demand from stakeholders. Despite of the significance of university education, public universities in Kenya continue to face huge resource and funding gaps which continue to erode their overall efficiency and productivity (Wachira, 2018).

1.1.1 University Education in Kenya and Its Importance

The evolution of public universities in Kenya dates back to early 1951 when the British colonial government established Royal Technical College of East Africa which is now the University of Nairobi (Bailey, Cloete and Pillay, 2011). After Kenya attained its independence in 1963 demand for higher education by Kenyans continued to increase compelling the government to establish more universities (Kivati, 2017). Since then, the number of public universities in Kenya has continued to rise, with their number increasing from only 3 in early 1990s to 33 currently. Despite of this remarkable increase, Kenya's higher education sector continues to face many challenges that affect the overall quality of education provided by these institutions.

Admission of students into public universities is solely based on performance of the students in secondary education examinations. This is carried out by Kenya Universities and Colleges Central Placement Service (KUCCPS) (Otieno, 2024). The body determines the students who are placed in various universities including private universities on merit after they express their interest for university education. The students who miss out the opportunity of being sponsored by the government have an option of enrolling as self-sponsored students in any of the public universities after successful application or opt to join private universities. The academic programs offered by the universities are undergraduate programs and postgraduate programs in different disciplines such as in arts, social sciences, business, humanities, health sciences, engineering, medicine among others. Universities in Kenya are regulated by the Commission for University Education (CUE). It oversees the quality of education offered in universities by conducting regular inspections and audits of both private and public universities so as to ensure total compliance with university academic standards put in place.

Kenyan public universities receive grants from the government which is key in subsidizing tuition fees of government sponsored students. Government grants for a long time has been pegged on number of governments sponsored students in the public universities, programs offered and their levels, student load types, operation costs and infrastructure, staff cost and student-staff ratio using Differentiated Unit Cost (DUC) model (Universities Funding Board, UFB, 2023). This model was developed by the Universities Funding Board (UFB). The model has not been efficient in allocating adequate funds to universities. Needy students get loans which they use for upkeep from Higher Education Loans Board which they use in meeting their needs while on session and part of it paid directly to their respective institutions to cater for tuition fees.

University education in Kenya is vital for national development and individual advancement: it produces the skilled professionals—engineers, doctors, teachers, researchers, and

entrepreneurs—needed to drive economic growth, foster innovation, and address complex challenges such as public health, infrastructure, and environmental sustainability; it strengthens social cohesion by promoting critical thinking, civic engagement, and cultural exchange; it underpins Kenya's global competitiveness by generating research that informs policy and industry; and it serves as a powerful engine of social mobility, equipping students from diverse backgrounds with the knowledge, networks, and credentials to improve their livelihoods and uplift their communities.

1.1.2 Capitation Trend in Public Universities in Kenya

In order to support operations of public universities, the government through the Ministry of Education, Science and Technology finances their capital as well as recurrent expenditures every academic year. Table 1.1 shows the funding trend of public universities from 2017/2018 to 2022/2023 academic years.

Table 1.1 Public Universities Funding for Academic Years 2017/18 to 2022/23

Year	**2017/2018**	**2018/2019**	**2019/2020**	**2020/2021**	**2021/2022**	**2022/2023**
Amount	33,313,405,680.49	38,145,164,999.82	41,180,214,789	41,907,420,218.27	43,843,955,004	44,023,955,000
				(Currency: KES)		

Source: UFB, 2023

Table 1.1 above shows the amount of funding the public universities received during the period under study. Financing of the public universities has steadily increased from KES 33,313,405,680.49 in 2017/2018 academic year to KES 44,023,955,000 in 2022/2023 academic year. Despite of this trend, these institutions continue to face serious funding gaps which has significantly affected their overall performance. As established by Wachira (2018), government funding has a serious impact on operational efficiency of public universities. There has been a mismatch between funding needs of public universities vis-à-vis the grants received from the government. Funding of public universities has been done throughout the study period using DUC model has not been effective. The DUC percentage disbursed to universities has

continued to decline since it became effective in the financial year 2017/2018. The DUC model ought to cater for 80% of the total cost of the program and the remaining 20% borne by parents. However, this has not been the case. In 2017/2018 academic year, universities received 60.7% leaving a funding gap of 39.3% but this later significantly dropped to 48.11% in 2022/2023 leaving universities struggling with lack of adequate funds to run their operations (UFB, 2023). The following table, Table 1.2 shows the DUC percentage allocated to universities since 2017/2018 academic year to 2022/2023 academic year.

Table 1.2 DUC percentage allocated to universities during the period under study

Financial Year	% DUC
2017/2018	60.70
2018/2019	66.40
2019/2020	60.70
2020/2021	53.77
2021/2022	49.51
2022/2023	48.11

Source: UFB (2023)

Table 1.2 shows the percentage under the DUC which the universities were funded during the period under study. As clearly shown, the DUC percentage has drastically declined. The DUC model was meant to fund 80% of the total cost of the program per student and the parents/guardians the remaining 20%. However, the trend shows an increasing funding gap through the period under study. The 100% transition government policy for KCSE graduates resulted in some students being placed in private universities thereby denying public universities funding. This meant that the students sponsored by the government joined private universities which implies that the monies meant for government students was remitted to the private universities where such students were placed. This equally led to a significant drop in the amount of money generated by enrolling module II students in the public universities. Regardless of the increasing funding trend as shown in Table 1.1, the target of 80% of the total cost of the program per student has never been realized since the start of the use of the Differentiated Unit Cost (DUC) model in allocating funds to the public universities as

demonstrated in Table 1.2. This has left the public universities underfunded. Besides the financial aspect, public chartered universities need other resources to meet their objectives such as human resource who include academic and non-academic staff, teaching and learning materials, infrastructure among other facilities. Non-financial resources in many public universities in Kenya are constrained by lack of enough money which can be used to incur them. Endless strikes by university dons and ever-increasing pending bills over the period under study, is a clear testament of the strain public universities experience in paying salaries and meeting their financial obligations due to underfunding.

Universities are graduating a lower-than-expected number of master degrees and doctorate degrees students (Mbogo et al., 2020). This implies that the expected teaching outputs are not in line with the expected ones. Moreover, the number of publications in refereed and non-refereed journals are quite low far from the expectation as a result of lack of adequate financial resources to fund research activities. Public universities produced 4,465 publications in 2017 with some universities producing zero research publication in some fields such as services and health (CUE, 2018). One of the main activities of public universities is to undertake research. Therefore, it is expected that every academic year all public universities publish research papers which is commensurate with the number of faculty and ranking. But notably, some universities lag behind in this area as a result of demoralized academic staff and lack of adequate finances that can be used to finance research activities by the university research fellows and professors in different fields. This has been necessitated by inadequate funding of the public universities by the government and insufficient internally generated income.

1.1.3 Challenges facing Public Universities in Kenya

As established by Otiende et al. (2024), the performance of public universities in Kenya is below expectations on the basis of comparisons with other countries. This has been occasioned

by many challenges which face these institutions. Among many other challenges that public universities in Kenya face, underfunding and huge resource gaps are the major challenges facing them. This continues to negatively impact their overall efficiency and productivity. Growth of public universities that Kenya has experienced since independence and increase in student enrollment both have taken place without commensurate funding. Paradoxically, establishment of public universities in the recent past has not in any way been matched with commensurate funding to support operations of the universities. Increased administration and operation costs due to higher costs of living and increased number of student enrolment in public universities sponsored by the government without commensurate funding has continued to negatively affect the performance of these institutions. The situation has further been worsened by huge pending bills that many public universities are struggling with which currently stands at about Kenyan shillings 63 billion. The huge debts that many of these public universities owe to service providers, part time lecturers and various statutory bodies raises serious concerns about how efficient they are and whether they are productive.

The model developed by UFB of financing public universities, DUC caters for only 80% of the unit costs. However, attaining the requisite 80% funding every academic year has never been attained which over time has negatively impacted financial sustainability of public universities. The DUC model has significantly reduced funding for large universities. It is worth noting that in 2018/2019 academic year the government financed public universities up to a tune of 66.4% only under the DUC model. However, this reduced to 48.11% in 2022/2023 academic year (KIPPRA, 2022). This has left the institutions with huge resource gaps making it very difficult to adequately finance its core activities.

Government sponsored student numbers have been increasing over time but DUC percentage has been drastically reducing as illustrated in Figure 1.1.

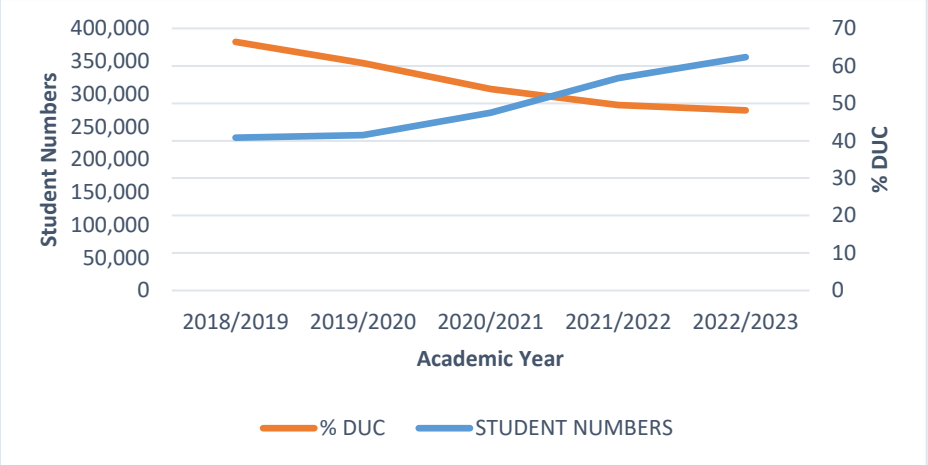

Figure 1.1 Relationship between student numbers and DUC Percentage

Source: UFB, 2024

Figure 1.1 shows the relationship between the number of students admitted to the public universities and the DUC percentage. Figure 1.1 shows a serious mismatch between the two. It shows that as the number of students admitted into the public universities increased as the DUC percentage declined. This represents the funding gap that existed in the public universities during the period under study. The underfunding of public universities that has been experienced since the inception and use of DUC model has fundamentally affected the overall efficiency and productivity of the universities. Besides decimal grants from the government, internally generated incomes have equally reduced. Number of Module II students who comprise self-sponsored students who join parallel programs which many universities depended upon to bridge the funding gap created by DUC model have drastically reduced. The admission of government sponsored students in private universities by KUCCPS has further denied public universities money. This study therefore aims to assess the efficiency and TFP growth of public universities to establish their efficiency and overall productivity during the study period when these public universities have seriously been hit by huge funding gaps.

Income streams in public chartered universities include: grants from the government which caters for the recurrent and development expenditure, grants from the development partners

and partner institutions which mostly includes research grants and finally appropriation-in-aid which comprises of the fees paid by students admitted into the universities. Besides the aforementioned income streams, public universities generate internal income which includes income generated from consultancies and admission of Module II students to supplement grants from the government. Universities budget on the income they expect to receive in the current financial year for recurrent and development expenditure. However, if the projected income is not realized, they are left with funding gap which affects their operations. Notably, since DUC was put into use in appropriating funds to public universities in the financial year 2017/2018, grants from the government have drastically reduced over the years. Income from consultancies, tuition fees paid in term of appropriation in aid and fees from module II students are not steady as they change from time to time hence, they cannot be depended on.

Public chartered universities are currently indebted up to a tune of KES 63 billion as at September 2023. These pending bills in the public universities have accrued for over a period of five to six years. The pending bills comprises of pension arrears which most universities were unable to pay, remittances to Kenya Revenue Authority, debt to suppliers of goods and services, cooperatives and SACCO contributions and loan deductions, remittances to NSSF and NHIF and debts owed to part-time lectures. Most public universities are operating deficit budgets whereby the actual budgeted expenditure overrun the income received by the universities. This situation has been necessitated by significant decrease in income from Module II students which many public chartered universities depend on to bridge the funding gaps, decrease in grants from the government and internally generated income from consultancies among others. Scaling down the number of lecturers, decrease in funding, increased administration cost and increased student enrolment rate are likely to negatively affect their overall efficiency and productivity. This is expected to hamper the core activities and more importantly quality of education. A study on efficiency and Total Factor Productivity

growth of public chartered universities is therefore necessary to assess how the funding gap has affected the efficiency and TFP of the universities during the study period.

Underfunding in Kenyan public universities undermines nearly every facet of their mission: dilapidated lecture halls and labs, chronic staff shortages and low morale among underpaid faculty, and overcrowded classrooms compromise teaching and practical learning; scant research budgets stifle publications and innovation; frequent strikes over unpaid allowances disrupt academic calendars; slipping global rankings erode prestige and deter talent; and reliance on higher fees for self-sponsored students widens access inequalities. Together, these pressures diminish graduate competitiveness, weaken knowledge production, and threaten social mobility—making predictable, strategic investment essential for safeguarding quality, equity, and sustainability in Kenya's higher education sector.

1.1.4 Reforms in Public Universities in Kenya Since Independence and Government Policies Related to Funding

Since independence in 1963, Kenyan public universities have moved from a fully state-funded model to a sophisticated, student-centered financing system. At each stage, the way institutions received and managed their funds altered the incentives for cost control, input utilization, and innovation. These changes are therefore critical to understanding trends in both technical efficiency (the effective use of labor, capital, and other resources) and Total Factor Productivity (the residual "catch-all" reflecting managerial improvements, technology adoption, and organizational learning). Under unconditional government block grants, universities faced little pressure to economize or innovate, as inputs (staffing levels, new buildings, and laboratory equipment) were approved centrally, and budgets rose or fell with annual appropriations. The introduction of tuition fees for government-sponsored students and the establishment of the Higher Education Loans Board (HELB) forced universities to admit self-sponsored cohorts and collect fees directly. This diversification exerted downward pressure on unit costs and

encouraged departments to optimize class sizes and mix of full-time versus adjunct faculty. The Universities Act 2012 introduced per-student grants tiered by program cost. Under this model, engineering and medical schools attracted higher capitation rates than humanities or social science departments. Institutions with large professional faculties saw their budgets grow more rapidly, but only if they maintained or expanded enrolment. This created strong incentives to rationalize low-cost programs and streamline administrative overhead. The latest reform channels government support directly to students based on a Means Testing Instrument (MTI), rather than as block grants to institutions. By delinking placement from funding, this framework compels universities to compete for self-sponsored students and to cultivate alternative revenue streams—research grants, short courses and consultancy. From an efficiency standpoint, the shift heightens pressure to optimize non-core operations (finance, estates, ICT), potentially raising technical efficiency scores.

1.2 Statement of the Problem

Many public universities in Kenya are facing financial constraints due to underfunding which has increased significantly amidst increased administration and operation costs over the years, which is the main problem of the study. Kithinji et al. (2022) noted that the financial performance of Kenyan public universities has been declining for a long period. This continues to undermine their ability to offer quality education and conduct research (Odhiambo, 2018). Underfunding negatively impacts the research outputs in public universities and quality of education offered which negatively affects national development.

The number of self-sponsored students has been declining and continues to decline leaving the universities with little income they could use to bridge the funding gap (Osumba and Sang, 2021). Moreover, pending bills continue to rise as a result of huge budget deficits. Since the commencement of the use of DUC model in allocating funds to universities, universities have not been sufficiently funded. The DUC percentage allocated to universities has been drastically

reducing leaving many universities with huge funding gap. Government sponsored students admitted to join public universities continues to rise without commensurate funding. Before 2017/2018 academic year, many universities were doing well since most of them obtained extra income by admitting Module II students into self-sponsored programs and getting more income from satellite campuses. However, the reforms undertaken in higher education such as closure of satellite campuses which did not meet University Standards Guidelines for academic programs, abolishing pre-university programs and admitting government sponsored students into private universities made universities lose considerable income. Since the situation is unlikely to improve soon, public universities have no option but to embrace prudent ways of utilizing resources available and coming up with innovative ways of generating internal revenues to supplement their income. Given the current environment, the public universities can develop innovative ways of remaining efficient and productive. Notably, studies on efficiency and productivity of public universities are non-existent in Kenya to the best of my knowledge yet it is imperative that they remain efficient and productive. Some studies in Kenya such as by Sulo et al. (2012), Nafukho, Wekullo and Muyia (2019), Oringo and Muia (2016), Atieno, Onyancha and Kwanya (2022) among others have focused on research productivity of public universities in Kenya which is only one aspect. The current research bridge the gap by measuring the technical efficiency and TFG growth of public universities in Kenya and determining the determinants of technical efficiency.

1.3 Research Questions

The research sought to address the following questions:

i. What is the Total Factor Productivity (TFP) growth of public chartered universities in Kenya?
ii. What are the technical efficiency levels of public chartered universities in Kenya?

iii. What are the determinants of technical efficiency levels in public chartered universities in Kenya?

1.4 Objectives of the Study

The main objective was to assess the technical efficiency and TFP growth of Kenyan public universities. The specific objectives are:

i. To measure Total Factor Productivity (TFP) growth of public chartered universities in Kenya.
ii. To measure technical efficiency levels of public chartered universities in Kenya.
iii. To identify determinants of technical efficiency in public chartered universities in Kenya.

1.5 Significance of the Study

Public universities are finance by the government. All Stakeholders in the education sector including the citizens are keen in ensuring accountability of public funds allocated to the public universities. This study contributes towards identifying and understanding how public universities are utilizing the resources allocated to them to produce maximum possible outputs. This enable stakeholders to identify areas where the limited resources can be optimized in order to improve overall efficiency and productivity of public universities. The study findings equally help in holding public universities accountable. The findings enable stakeholders to know how universities are performing. This enables the government of the day allocate resources efficiently based on the financing needs of the universities to enable them continue performing. Analysis of efficiency and TFP growth of public universities in Kenya enable them refine the policies they have in place that improve the quality of the outputs out of the research and teaching activities. The findings can equally be used as a benchmarking tool for performance. This will enable comparison of performance of public universities. Through this, efficient and inefficient public universities are identified.

The findings of this study could inform the design of a performance-based funding model that rewards universities for the effective and innovative use of their resources rather than mere enrolment figures. By allocating a portion of public grants in proportion to demonstrated improvements in institutional efficiency and productivity—and tying disbursements to clear performance management targets—policymakers can incentivize universities to streamline administrative processes, adopt cost-saving technologies, and foster cross-campus collaboration. Embedding robust monitoring and evaluation frameworks into the funding mechanism will ensure that resource allocations are regularly reviewed against key performance indicators, driving continuous improvement in teaching and research quality and directing support to the programs and practices that deliver the greatest impact. The findings could also guide the strategic alignment of resource allocation with national higher-education priorities through a performance management lens. Instead of uniform increases in staffing or infrastructure budgets, decision-makers might link incremental funding to objectives such as expanding high-demand academic offerings, enhancing postgraduate research capacity, and investing in digital learning platforms—each with associated performance targets and accountability measures. A flexible funding framework that adjusts support based on periodic performance assessments and evolving institutional needs will promote transparency, reinforce a culture of accountability, and bolster the long-term competitiveness and sustainability of Kenya's public universities.

This study will enrich the existing literature by providing a context-specific analysis of efficiency and productivity dynamics within Kenya's public universities, an area that has seen limited empirical scrutiny despite the sector's rapid expansion and recent funding reforms. By employing robust frontier and productivity measurement techniques—such as Data Envelopment Analysis and Malmquist indices—alongside regression analysis of funding components, the research offers fresh evidence on how different financing models affect both

technical efficiency and total factor productivity over time. This methodological integration not only advances empirical best practices for higher-education performance assessment but also generates comparative benchmarks that researchers can use to evaluate universities in other emerging-economy settings. Moreover, by linking efficiency and productivity outcomes to concrete policy shifts—ranging from cost-sharing and differentiated unit costs to the new student-centred funding model—the study sheds light on the causal pathways through which funding mechanisms shape institutional behavior and innovation. These insights close a critical knowledge gap on the interplay between financing and performance management in higher education, equipping policymakers and university leaders with evidence-based guidance on designing incentives that foster sustainable growth, quality enhancement, and equitable access.

1.6 Scope of the Study

The research focuses on public universities which are financed by public money. The study covered five years from 2017/2018 to 2021/2022. This study excluded public universities which were started after 2017. This is because funding data for these institutions is not available. Only 31 out of 33 public universities were studied. University constituent colleges were also not be considered in this study. The rationale for studying efficiency and TFP was to assess efficiency and productivity of universities over the last five academic years. Academic year 2017/2018 was chosen since it marked the commencement of the use DUC model in allocating funds to public chartered universities. The study period was also chosen since it corresponded to important changes in public funding. The study focused on the funding gaps which came up as a result of the DUC model and the effect they had technical efficiency and TFP growth of public universities in Kenya during the period under study.

1.7 Organization of the Study

Chapter one outlines the background of the study, problem statement, study objectives, research questions, importance and scope of the study. Chapter two presents review of

theoretical and empirical studies pertinent to this study. Chapter three outlines the methodology the study employs. Chapter four presents the findings from data analysis and finally chapter five presents the summary of the study, conclusion and recommendations.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The chapter presents pertinent theoretical literature review which the study is based on. The chapter also explores empirical literature of the previous research studies aimed at assessing efficiency and TFP of public universities. The last part of this chapter offers overview of reviewed literature.

2.2 Theoretical Literature

This section explores the classical production theory that the current study will be anchored on.

2.2.1 Classical Production Theory

The theory underpinning this study is based on classical production theory whereby firm's objective is to maximize their profit. Technical efficiency proposition of public university education emanates from theory of production (Myeki and Temoso, 2019). The production theory is used to explain how the public universities transform different inputs availed to them into different outputs. Public universities in this study are taken to be Decision Making Units (DMUs) which transform inputs into outputs. They aim to maximize their outputs subject to resource constraints. The theory of production highlights that the core objective of production units is to maximize outputs using available inputs (Levin and Milgrom, 2004). The authors Levin and Milgrom (2004) argued that public universities are financed by governments such as the public universities which impart knowledge and skills to individuals who later take part in the economic development activities in their countries. Therefore, the objectives of public universities are both social and economic in nature. The model will not follow the standard neoclassical production theory which assumes that the key objective of DMUs is to maximize profits and at the same minimizing production costs. However, this can be embraced in the case of public universities as they aim to maximize research and teaching outputs subject to the resources available.

The classical production function can be specified as shown below:

$Q_i = f(X_i)$ ……..……2.1

Where Q_i represents outputs and X_i represents the vector of inputs. The inputs constitute capital and labor.

Based on the theoretical underpinning of production theory, this research will use multiplicity of inputs and outputs. As established by Johnes and Tone (2017), the Data Envelopment Analysis (DEA) approach was important whereby more than one input are employed to produce more than one output and largely when market prices are not available. Consequently, the current study analyzed TE levels and TFP of public universities.

2.2.2 Total Factor Productivity

Productivity and change in productivity are critical in the measurement of performance of DMUs. Coelli et al. (1998) defined productivity as the movement in productivity performance of firms over time. TFP denotes changes of productivity in firms with multiplicity of inputs and outputs. TFP can be explained using production frontiers as illustrated by Coelli et al. (2005) whereby technical changes represent outward shift in technology along the curve of production possibility frontier whereas TE causes movement along the production possibility frontier curve. Malmquist DEA that can be used to analyze TFP and stochastic frontier analysis (SFA) are both grounded in the production theory. Figure 2.2 below illustrates the concept of TFP index.

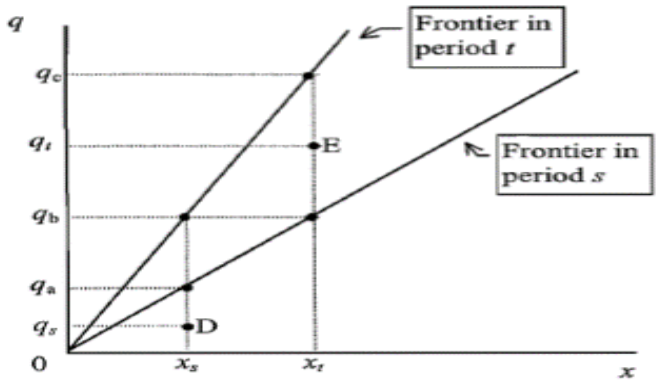

Figure 2.1 Malmquist TFP Index

Source: Coelli et al. (2005)

x and q are observed outputs and inputs respectively. The production technologies are represented by the frontiers in period t and s. For any firm producing at D in period t and Q in period s, the Malmquist Productivity Index can be calculated as the ratio of Farrel TE in period t to s. This can be expressed as:

$$Efficiency\ change\ = \frac{q_t/q_e}{q_s/q_a} \quad \text{.....2.2}$$

Technical change is a geometric mean which is represented by technology shift and evaluated at Xt and shift in technology evaluated at Xs. The technical change is given by:

$$Technical\ change = \left[\frac{q_t/q_b}{q_t/q_c} x\ \frac{q_s/q_a}{q_s/q_b}\right]^{0.5} \quad \text{.....2.3}$$

Efficiency change, also known as "catch-up," reflects whether a university has moved closer to or further from the best-practice frontier between two time periods—indicating improvements or declines in the ability to utilize available resources effectively. Technological change, on the other hand, measures shifts in the production frontier itself—capturing the effects of innovation, improved processes, or the adoption of more advanced technologies that enhance productivity across all units. Equation 2.2 combines both efficiency change and technical change. Malmquist TFP is deemed fit in the analysis since it captures sources of

productivity change that is efficiency and technical change. Malmquist TFP indices and its computation do not need specification of a priori as it regards to the nature of the production technology. Moreover, Malmquist TFP indices can be computed when the technology either exhibits Constant Returns to Scale (CRS) or Variable Returns to Scale (VRS). In the context of university performance, the catching-up effect and the frontier effect are key components derived from the Malmquist Productivity Index, used to understand the sources of productivity change over time. The catching-up effect, also known as efficiency change, reflects a university's ability to improve its use of existing resources relative to the best-performing institutions. If a university reduces waste, optimizes staff deployment, or improves administrative procedures without any change in technology, it is said to be "catching up" to the efficiency frontier. This means the university is becoming more effective at converting inputs (such as funding, staff, and infrastructure) into outputs (like graduates, publications, or innovations), even if the overall technological environment remains constant. The frontier effect, or technological change, refers to shifts in the best-practice frontier itself—meaning the most efficient universities are adopting new technologies, teaching methods, or management innovations that raise the benchmark for all others. When the frontier moves outward, it indicates that the entire sector is advancing in productivity potential due to these innovations. For example, a university implementing digital learning systems or automated administrative tools might push the frontier forward, setting a new standard for others to follow. Together, these effects help distinguish whether productivity gains at a university are the result of improving internal efficiency (catching up) or embracing broader innovations that redefine what high performance looks like (frontier effect).

2.2.3 Technical Efficiency

Farrell (1957) defined efficiency as a means firms use in producing the maximum possible outputs given inputs. Coelli et al. (2005) stated that a technically efficient firm is the one

which operates on the production frontier and that which produces maximum possible outputs from combination of given inputs at their disposal. Firms which operate below the frontier are technically inefficient. Firms which are efficient still have a leeway of increasing their productivity by taking advantage of their scale economies. Technical inefficiency of firms is represented by QP which implies the amount by which firms can reduce their inputs without reducing their outputs as illustrated in Figure 2.2. Ratio QP/OP is the percentage by which available inputs of a firm can be reduced to attain technically efficient production.

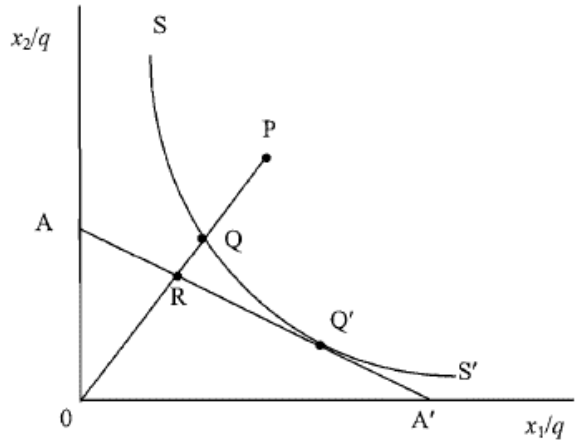

Figure *2.2* TE and allocative efficiency

Source: Coelli et al. (2005)

TE of firms is measured by ratio of TE = OQ/OP = 1 – QP/OP. AA' represents the isocost line which shows the minimum cost firms can incur to produce a unit output given a set of inputs.

2.4 Empirical Literature

A study carried out by Wachira (2018) explored the relationship between government financial support and how efficiently public universities utilize their resources. Wachira's work provides valuable insights by focusing primarily on the direct impact of funding levels on day-to-day operations, including administrative efficiency, procurement processes, and cost management strategies. The study concludes that consistent and adequate government funding contributes positively to operational efficiency by stabilizing core functions and reducing dependence on

unpredictable revenue sources such as student fees. However, there are several notable gaps in Wachira's research that the current study addresses. First, Wachira's study concentrates largely on operational efficiency without extending the analysis to technical efficiency or total factor productivity (TFP) growth, both of which are broader and more performance-oriented indicators that account for outputs relative to multiple inputs, not just cost control. Second, her methodology relies on descriptive and correlational analyses, which, while useful, do not employ frontier methods like Data Envelopment Analysis (DEA) or Malmquist productivity indices, tools better suited for measuring relative efficiency and productivity change over time. Third, Wachira's timeframe and data did not reflect the latest policy reforms, including the introduction of the student-centered funding model in 2023, which significantly altered the structure of university financing in Kenya. The current study filled these gaps by adopting advanced quantitative methods to evaluate both technical efficiency and TFP growth across public universities, offering a more comprehensive and dynamic assessment of performance. It also aligns efficiency analysis with key funding policy changes, making the findings more relevant for contemporary decision-making in Kenya's higher education sector.

Worthington and Lee (2008) assessed efficiency, technology and TFP change of thirty-five universities in Australia for six years. The study used nonparametric frontier approaches in analyzing data collected from the universities to determine how efficient and productivity they were during the period under study. The inputs used in the study were non-labour expenditure, non-academic staff, full-time equivalent academic and student load in postgraduate and undergraduate programs. The outputs considered in the study were completions in undergraduate, postgraduate and PhD programs, publications and industry grants. Productivity was decomposed into technological change and efficiency change using Malmquist indices. The study established that the average productivity growth of the universities under study to 3.3% yearly. However, much of the growth was attributed to technological change. The study

further established that most of the productivity gains in the sampled universities was attributed to research productivity which was largely linked to improvements in pure technical efficiency. Despite the study using sufficient data points in assessing the efficiency and productivity of Australian universities, the authors did not use control variables in their analysis. The current study bridges this gap by employing control variables that is age of the public universities to ensure that the findings of the analysis are reliable.

Bangi et al. (2014) assessed the efficiency and their determinants of Tanzanian universities. In this study, the researchers employed DEA in examining efficiency of Tanzanian universities and Tobit regression model in determining impact of variables on efficiency of DMUs sampled. They utilized panel data from 2008 to 2012 in the analysis using a sample of private and eight public universities. The data used was obtained from Commission for Universities, university websites, Ministry of Education, and National Bureau of Statistics. The study employed three inputs that is number of student enrolment, academic staff and non-academic staff and three outputs that is graduates, research papers and consultancies. The average efficiency score was reported to be 0.815 implying that sampled DMUs and colleges were 81.5% efficient and 18.5% inefficient. The study established that the sampled DMUs were efficient in generation of graduates using the resources availed to them. The major weakness of this study is that it did not take into consideration other extraneous factors/variables which may have notable effect on efficiency scores of DMUs. However, the study studied many factors which have significant effect on the overall efficiency and scale efficiency of universities. The current study bridged this gap by using extraneous variable that is age .

Kulshreshtha and Nayak (2015) assessed efficiency of eight learning institutions in India offering higher technical education using both the Data Envelopment Approach and Stochastic Frontier Approach employing panel data from 2001 to 2005. Output oriented and input oriented stochastic frontier functions and CRS DEA were used in measuring TEs of the sampled

institutions. The inputs the study used include teaching and support staff, undergraduate, post graduate and post-doctoral students, equipment and library stock, teaching materials, technical equipment, total expenditure on education, and grant from the central and state governments. The outputs the study used include student load in undergraduate courses, post-graduates, research grant and consultancies, student enrollments, qualifications completed and research outputs. The average technical efficiency score reported using both input-oriented and output-oriented SFA approaches ranged from 0.9896 in 2001/2002 to 0.8764 in 2004/2005. This indicates that the efficiency score of the sampled institutions significantly decreased during the period. Whereas, the average TE score using constant returns to scale DEA ranged from 0.987 in 2001/2002 to 0.992 in 2004/2005. This largely indicates that the efficiency score increased over time. The major weakness of this study is that it did not take into consideration other extraneous variables such as the size of the institutions and environmental factors which have significant effect on TE scores of DMUs. Equally, the study did not assess the determinants from among the variables used in the study to assess their effect on TE of sampled institutions over the period, a gap the current study bridged. However, the study assessed significant number of variables which have notable effects on the efficiency in learning institutions.

Visbal-Cadavid, Martínez-Gómez and Guijarro, (2017) assessed efficiency of Colombian state-owned universities using DEA approach. The study used one-year data from thirty-one public universities to assess the efficiency levels. The study used four inputs that is full-time equivalent faculty, administration staff expenditure, financial resources availed by government and revenue generated internally by respective universities and physical resources which include spaces and buildings. The outputs used in the determination of the efficiency scores are undergraduate students, postgraduate students, indexed journals, and students with the Saber PRO results in the upper quantile, articles in journals and mobility of faculty members represented by academic staff members participating in mobility programs. The output

variables measured the research and teaching activities of the universities. The outputs were chosen in a way that represents the quality of the graduates, performance of the universities in research activities and teaching activities. The findings show that overall scale efficiency of sampled universities to be 0.9418 implying that the institutions studied were 94.118% scale efficient and 0.5882% scale inefficient. The average TE reported was 0.8726 while the average pure TE was 0.9253. The major weakness of the study is that it did not take into consideration other extraneous factors/variables such as environmental variables and size of institutions which have effect on efficiency scores, a gap the current study bridged by using age as the control variables. Equally, this study used data from one academic year which means that trend in the changes in efficiency levels from year to another was not established to show how the efficiency of the sampled universities changed over time. Despite of these weaknesses, the study used slacks-based measure, models of Charnes, Cooper and Rhodes (CCR) and Banker, Charnes and Cooper (BCC) in assessing efficiency levels of sampled universities which gave the findings of the study credibility more especially in measuring the effect of the operational scale on each of the DMUs used in the study.

Using DEA, Drebee and Abdul Razak (2018) measured efficiency of various colleges at Al-Qadisiyah University located in Iraq for 2015/2016 only. Inputs used in this study include enrolled students, employees, and academic staff. The outputs used were published research papers and number of graduates with bachelor degrees. The findings from the study indicate that overall mean of TE to be 0.896 while the scale efficiency was 0.986 for output-oriented approach and 0.994 for input-oriented approach. The major weakness is that it used one DMU and data for only one academic year. The findings of this study cannot in any way be generalized. The current study bridged this gap by using a period of five years. Equally, effects of study variables have on efficiency of the respective colleges in the university of Al-Qadisiyah – Iraq were not established. However, the strength of the study lies in the use of both

input-oriented and output-oriented DEA in assessing scale efficiency which allows both pure TE and scale efficiency to be established.

Myeki and Temoso (2019) assessed efficiency of public universities in South African from 2009 to 2013. Panel data was used in this study. DEA was employed in estimating TE of the sampled twenty-two public universities. The input variables used in the study include enrolled postgraduate students, enrolled undergraduate students, total budget expenditure and the number of academic staffs. The study used only two outputs which are weighted graduates and weighted research output. The study established that TE of the sampled public universities declined to 0.78 in 2013 from 0.83 in 2009. The study further established that universities which were research-intensive tended to be much more efficient as compared to those universities which were professional-oriented. The major weakness of this study is that it did not go further to establish effects of study variables on efficiency levels of the respective universities. The research did not consider other extraneous factors that affect efficiency levels. Despite of these weaknesses, the study used twenty-two public universities with panel data covering a period of five years which increases significantly the reliability of the study findings.

Ngobi, Yawe and Dbumba-Ssentamu (2019a) used DEA to assess efficiency of state-owned universities operating in Africa. The study used fifteen universities sampled from different countries in Africa such as Kenya, South Africa, Tanzania, Ghana, among other countries. The study used seven input variables which include undergraduate enrolments, postgraduate enrollments up to the master degree level, total enrollments, doctoral enrollments, teaching, non-teaching and total staff. The outputs were the total yearly graduates from 2000 to 2007 and the total research outputs. The study assessed both CRS and VRS TE and SE of the sampled universities. The findings of the study showed post mean technical efficiencies for research-only, teaching –only and general models to be 0.971, 0.900 and 0.886 respectively. These findings indicate that African public universities are more efficient in the research functions as

compared to the teaching activities. The study established that change in productivity was linked use of technology in undertaking research and in teaching. The major weakness of the study it did not use universities from all the African countries implying that the institutions used was not representative. Despite of this weakness, the study considered the operating environment of the sampled universities which was adjusted to ascertain its effect on efficiency scores of African universities considered. This increases reliability of the research findings since the environmental variables have effect on relative efficiency levels. Moreover, Ngobi, Yawe and Dbumba-Ssentamu (2019b) investigated TFP of African public universities. The study used student enrolments and staffing levels as inputs and research outputs and graduates as outputs in estimating the TFP growth. In their study, they assessed the TFP growth of fifteen universities using Malmquist DEA approach. The study found out that public universities in Africa had TFP growth of 7.5% for general model, 0.7% for teaching-only model and 6.8%. Productivity growth was majorly brought about by research productivity gains as compared to gains in teaching productivity. The study also established that technological progress contributed significantly to research productivity in the sampled public universities in Africa. The current study deviated from these two studies as it studied public universities from Kenya. The current study studied technical efficiency and TFP growth together which gave the researcher an opportunity to make comparisons between efficiency levels of public universities and their level of productivity growth. The reviewed studies Ngobi, Yawe and Dbumba-Ssentamu (2019a) and Ngobi, Yawe and Dbumba-Ssentamu (2019b) did not look at the determinants of technical efficiency. The current study addressed this gap by assessing the determinants of technical efficiency.

Menga-Mokombi (2020) assessed efficiency of higher institutions of learning using DEA in the Republic of Congo. The study covered a period of only one academic year that is 2016/2017 using data from forty-nine private and public institutions in Congo. Input variables that the

study used in estimating efficiency levels are total expenditure, registrants and number of academic staffs whose last degree were masters and doctorate degrees. The output variables used in the study are success rate corresponding to students who have completed different courses and students who have completed undergraduate degrees. The findings from the study indicated that thirteen institutions were technically efficient with a success rate of 26.53%. The study also established that success rates, total budget, enrollment, classrooms, number of undergraduates and teachers had effect on success of students. It was also found out that increase in public expenditure on higher education improves efficiency of DMUs and tax revenues over time. The major weakness of this study is that it did not take into consideration other extraneous variables such as environmental factors, the age of the institution among others equally affected efficiency. The current study filled this research gap by using extraneous variables that is age of the public universities. The data used came from one academic year only making it impossible to establish the trend of efficiency in the sampled universities. Trend is important in studies since it acts as an indicator of how efficient DMUs are over a period of time.

Khan and Mazumder (2021) assessed efficiency of private and universities in Bangladesh using DEA. The study used twenty private universities and fifteen public universities using panel data from 2008 to 2018. The input variables the study used are the number of teachers, the number of non-academic staff and expenditure per student. The outputs used in the study are undergraduates, master graduates and the research funds. It established that the public universities sampled had technical efficiency scores ranging from 0.562 to 0.807 while the private universities had efficiency score of between 0.491 and 0.776 over the period of the study. The study further found out that only 33% of public institutions and 25% private which operated efficiently. It was further established that public universities had ability of producing between 1.24 and 1.78 times as much output as compared to the private universities which were

found to produce 1.28 to 2.04 of outputs given the same level of inputs. The study did not take into consideration the scale efficiencies as well as the pure technical efficiencies which would have been compared with the overall technical efficiency. This means that the study assumed that the sampled DMUs had CRS which may not be the case since the resources available to them are different. The current study bridged this study by employing VRS. The study used both private and public universities in assessing the comparative efficiency levels.

Using the Data Envelopment Approach, Miranda and Gutiérrez (2021) assessed the technical efficiency of forty-two Peruvian public universities on grounds that the main weakness of the public universities in that country was deficiencies that was experienced in the quality of university education. The study used data from one year only, 2016 which was obtained from the respective websites of the sampled universities as well as from *Superintendencia Nacional Educacion Superior Universataria.* The study used one output which is total budget and two outputs which are enrolled students comprising of doctoral, post graduate and undergraduate students enrolled and number of researchers placed in Renacyt program in determining TE of DMUs. Findings were overall TE was 0.568. The weakness of the study is that it used data from only one year which may not give reliable results on average efficiency of DMUs. The weakness of the study is that it used only input in determining the efficiency which may not give desirable results. This gap was bridged by this study as it used three inputs.

Using the Stochastic Frontier Analysis approach, D'Elia and Ferro (2021) assessed efficiency of higher learning institutions in Argentina by employing panel data covering nine years from 2005 to 2013. The study used four inputs in estimating the efficiency scores of the institutions which include faculty, students, financial resources and the environmental variables. The study used only one output which is the number of graduates. The current study bridged this gap by using two outputs that is teaching and research outputs. The findings were efficiency scores ranged from 0.8052 to 0.9514 on average for the entire period under study. The study

established 18% to 25% of inefficiency on average as it regards to the lost outcomes which comprises of the graduates.

Andersson and Sund (2022) investigated productivity and TE of the universities in Nordic region using Malmquist productivity index and DEA approach respectively. The study analyzed efficiency levels and TFP of sixty-eight institutions of higher learning in Nordic region for six years from 2011 to 2016. The study used the following inputs which include teaching and research staff, number of undergraduate and graduate and students, doctoral students and office space and four outputs which include number of ECTS credits, PhD degrees awarded and publications in scientific journals (Andersson and Sund, 2022). The study found out that the yearly average productivity change for the sampled higher education institutions to be 0.4%. The study also established that the average inefficiency of the institutions under study to be 10.1% for the entire period of study. Inefficiency scores were positively correlated with the turnover of staff. However, it did not consider other extraneous variables which affect efficiency. The current study bridged this gap by using two extraneous variables that is age of the public university.

Temoso and Myeki (2023) estimated productivity and efficiency of institutions of higher learning in South Africa using panel data spanning for a period of eight years from twenty-two universities. The study employed Fare-Primont index in measuring TFP. Fare-Primont index is prone to error when the panel data used is unbalanced. The current study deviated from this approach and used Malmquist productivity index since it is suitable for both balanced and unbalanced panel data. Feasible Generalized Least Squares model was used to establish the sources of efficiency and TFP changes. It was established that the average total factor productivity of the twenty universities sampled to be 0.631. Much of this productivity growth was attributed to mix and scale efficiency changes closely followed by technical efficiency change.

2.5 Overview of Literature

The review of the theoretical literature shows that the classical production theory can be applied in the current in assessing the efficiency levels and productivity of public universities. The classical production theory allows usage of many inputs and outputs. Many empirical research reviewed shows that efficiency in public universities can be evaluated by the use of the parametric (SFA) approach or non-parametric (DEA). However, many of the studies employed the non-parametric DEA in evaluating efficiency and productivity of DMUs. Two stage DEA is more preferred in many studies due to its non-parametric nature which to a large extent allows it to be applied in assessing efficiency in higher institutions of learning. There are many studies aimed at assessing efficiency and productivity of the public universities in many countries. However, in Kenya there are limited studies specifically assessing efficiency and productivity of public universities. Most of the studies concentrate on assessing efficiency of technical and vocational training institutions, primary and secondary schools.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

The research methodology which was employed in this research is presented in this chapter. The research design that was adopted, theoretical framework, definition of the variables and their measurement, study area, study population, sampling frame, instruments of research, data collection, data processing, analysis, ethical and logistical consideration are equally presented here.

3.2 Research Design

The study employed a longitudinal research design. This research design makes it possible for unit under analysis to be studied helping the identification of changes over time (Wang et al., 2017). The study also adopted panel data which involved collection of data from the sampled decision-making units over five years from 2017/2018 to 2021/2022. The study used DEA in estimating the overall technical efficiency scores and Malmquist DEA in estimating Total Factor Productivity growth. Tobit regression analysis was run using the overall technical efficiency scores as dependent variable and the inputs and other control variables as independent variables to assess their effect on efficiency. The application of DEA requires that DMUs chosen to be homogenous and satisfy three rules. First, the DMUs selected or the study must have same objectives and similar activities. Secondly, the DMUs must use similar inputs in producing same outputs and finally, the DMUs must operate within environments which are similar (Dyson et al., 2001). The public chartered universities in the research study are homogenous DMUs since they use inputs which are similar and produce outputs which are similar. Besides operating in the same environment, public universities in Kenya equally have similar objectives and undertake similar activities.

3.3 Theoretical Framework

The study was based on classical production theory which shows output changes due to changes in input variables. The production theory specifies how outputs change as inputs change given the technology employed. The study used the DEA technique as proposed by Farrell (1957) to compute the technical efficiencies of public universities under study and Malmquist DEA to compute TFP indices. Output oriented DEA was used to assess efficiency and productivity. The model allowed panel data to be used in estimating TFP changes (Mawson, Carlaw & Mclellan, 2003; Malmquist, 1953). TFP growth or change measures how productivity declines or grows over time.

3.3.1 Malmquist TFP Index

TFP was measured by Malmquist TFP index. The TFP indices are constructed through measurement of radial distances of observed vector of inputs and outputs relative to technology. TFP index was estimated as ratio of distance function of observations from the production frontier (Coelli et al., 1998). The Malmquist TFP index is specified as:

$$m_o(q_s, q_t, x_s, x_t) = \left[\frac{d_0^s(x_t,q_t)}{d_0^s(x_s,q_s)} x \frac{d_0^t(x_t,q_t)}{d_0^t(x_s,q_s)}\right]^{0.5} \quad \text{.....3.1}$$

Equation 3.1 addresses objective one. TFP index less than unit represents a decrease in TFP while more than one represents a positive TFP. The index can be decomposed into TE change and technological changes (Fare et al., 1994).

Efficiency change is given by $\frac{d_0^t(x_t,q_t)}{d_0^s(x_s,q_s)}$ 3.1.1

and technical change is given by $\left[\frac{d_0^s(x_t,q_t)}{d_0^t(x_s,q_s)} x \frac{d_0^s(x_t,q_t)}{d_0^t(x_s,q_s)}\right]^{0.5}$ .....3.1.2.

Equation 3.1 answered objective one.

Technical efficiency changes measures changes in efficiency of DMUs between the current period and the next period whereas technological change captures shift in the frontier

technology. Technological change encompasses innovation and the use of new technologies in the production processes. Technological changes allow DMUs to come up with innovative ways of remaining efficient and productive by utilizing the inputs available to them to produce the maximum possible outputs. Technical efficiency changes allow DMUs to make use of the already available resources that is capital, labour and any other economic inputs to increase the outputs they produce.

3.3.2 Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) was introduced by Charnes, Cooper and Rhoders (1978) closely borrowing from Farrell (1957). It is a non-parametric technique which use linear programming in comparing DMUs which handles many inputs and outputs. DEA classifies the DMUs into efficient and inefficient. The efficiency scores in the DEA model strictly lies between 0 and 1. The maximum score of 1 implies maximum efficiency while any score that is less than one to a minimum of 0 implies that the DMU is inefficient. DMUs have either constant returns to scale or DRS or IRS. This depends on whether the DMU is input-oriented or output oriented. The models used to measure the efficiency of DMUs can be with CRS or even VRS which are oriented at minimizing the inputs used and/or maximizing outputs (Charnes et al., 1978). DEA is preferred since it can combine many inputs and outputs to measure efficiency of DMUs without requiring any specification as it regards to a priori of weights. The DEA model also allowed the evaluation of relative efficiency of DMUs.

Efficiency scores was obtained using:

$$
\begin{aligned}
&min_{\theta,\lambda}\theta \\
&subject\ to \\
&\qquad -q_i + Q\lambda \geq 0, \\
&\qquad \theta x_i - X\lambda \geq 0, \qquad \text{……3.2} \\
&\qquad \lambda \geq 0,
\end{aligned}
$$

Where θ - scalar and λ - I x 1 vector of constants. Value of θ obtained represents TE of i-th firms which is between 0 and 1 with θ =1 indicating a technically efficient firm and value less than 1 but greater than or equal to zero representing technically inefficient firms.

DEA allowed for the determination of TE of universities in every academic year. Technical efficiency is ratio of sum of weighted outputs to weighted sum of inputs as shown below:

$$TE_i = \frac{\sum_r \mu_{ri} Q_{ri}}{\sum_s v_{si} X_{si}} \quad \text{……………………………………………………………… } 3.3$$

Where Q_{ri} is output r and X_{si} is input s. Equation 3.3 was subject to two constraints that is none of the DMUs obtained an efficiency score of more than 1 or less than 0 and that the input and output variables used should be non-negative. Equation 3.3 answered objective two.

3.4 Model Specification

3.4.1 Tobit Regression Model

This is a non-linear model was put forward by James Tobin with the aim of describing the relationships between dependent variable, Y_i which is non-negative and independent variables X_i's. Tobit regression model has extensively been used in the previous studies in estimating relationships between dependent variables and independent variables in different fields including the education sector. The Tobit regression is a truncated model and hence largely preferred more especially when dependent variable lies in specified limits such as efficiency scores which are bounded between 0 and 1 (Garza-Garcia, 2012; Lovell et al., 1995).

The second DEA stage involved regressing the technical efficiency scores on variables to assess their effect on efficiency. Tobit regression model assumes the following form;

$$TE_{it} = X_{it}\beta + e_{it} \quad \text{……………………………………………………………...} 3.4$$

Where TE_{it} is the efficiency scores –technical efficiency of the ith DMU (public chartered universities) at period t, X_{it} is determinants of efficiency of the ith DMUs at period t, β is the vector of parameters estimated in the model and e_i is error term.

Tobit regression model used to estimate determinants of efficiency in public universities is specified as given below:

$$TE_{it} = \beta_0 + \beta_1 EC_{it} + \beta_2 GF_{it} + \beta_3 TI_{it} + \beta_4 UND_{it} + \beta_5 MG_{it} + \beta_6 PHD_{it} + \beta_7 AG_{it} + e_{it} \quad \text{.....3.5}$$

Where;

TE_{it} - technical efficiency score.

EC_{it} – Salaries paid to full-time academic staff and non-academic staff.

GF_{it} - government capitation grants.

TI_{it} – Tuition income.

UND_{it} - undergraduate students.

MS_{it} - Masters students.

PhD_{it} - Doctoral students.

AG_{it} - age.

e_{it} - the error term which is normally distributed with zero mean and constant variance.

β_1, β_2 , β_3, β_4, β_5, β_6 and β_7 are the coefficients to be estimated that is employee cost, government funding, number of graduates from undergraduate programs, number of graduates from the masters and doctoral degree programs and age respectively.

Thereafter, the marginal effects from the model were estimated to establish impact of independent variables on TE of public universities. Equation 3.5 answered objective three.

3.5 Definition and Measurement of Variables

Table 3.1 Definition and Measurement of Variables

Variable	Definition	Measurement
	Input Variables	
Employee Cost	Amount of salaries paid employees	Salaries paid to all employees
Government Capitation Grants	comprises of funding universities get from the ex-chequer	Amount of money per academic year allocated to the public universities by the government
Tuition Income	Amount of tuition fees paid by students and their parents/sponsors/guardians	Measured by the amount of tuition fees deposited into the accounts of universities
	Output Variables	
Teaching Output i. Number of Undergraduate Students awarded degrees	students who have qualified and graduated with bachelor degrees	Measured by number of students who have successfully graduated from the undergraduate programs
Research Output i. Number of Postgraduate Students (Masters level and PhD level) awarded degrees	number of students with postgraduate degrees including the master degrees and PhD degrees from the public universities	Measured by number of students who have successfully graduated from the postgraduate programs that is both master and PhD programs throughout the period under study
	Control Variable	
Age	Is the number of years a university has been operating	Measured by year the university started operating officially

Source: Author

3.6 Study Area

The study was conducted Kenya. Kenya has a national government and county governments where the sampled public universities in this study are located.

3.7 Target Population

The study targets chartered public universities only operating in Kenya. The number of public universities targeted in study were 31 excluding those which were not operational by 2017/2018 and university constituent colleges which were not full-fledged universities. Therefore, a census approach will be adopted in this study.

3.8 Sampling Frame

Total population sampling technique was used in this study where the whole population was studied (Etikan, Musa and Alkassim, 2016). The National Defence University and Open University of Kenya was excluded from the study since they started operating after 2021 hence no data was available from 2017 to 2020. Equally, constituent colleges of public universities for instance Tharaka University College, Turkana University College, Koitalele Samoei University College, among others were excluded since they were not fully-fledged public universities.

3.9 Research Instruments

The current study gathered quantitative data from the sampled public universities. Secondary data will be gathered from the websites of the public universities and their audited financial statements, Commission for University Education and University Funding Board.

3.10 Data Collection Procedure

Secondary data was collected from the websites of the sampled public chartered universities, audited financial reports, Commission for University Education and Universities Funding Board.

3.11 Data Processing and Analysis

The quantitative data that was collected was analyzed using Data Envelopment Analysis Program (DEAP) whereby efficiencies and TFP indices of the sampled DMUs will be computed. Thereafter, Tobit regression was run to determine the determinants of technical efficiency using STATA version 17.0.

3.12 Logistical and Ethical Considerations

Collection and subsequent storage of data was meticulously handled to ensure highest level of integrity and confidentiality. The information that was obtained from the sampled universities

will be treated confidential since they involve sensitive issues. Prior to undertaking the research study, ethical approval was sought from the relevant authority which ensured adherence to various ethical standards.

3.13 Diagnostic Tests

3.13.1 Normality Test

This was carried out to determine if data used in the study was drawn from normally distributed population. It is undertaken to verify normality of data used in studies. Further, normality tests determine whether or not the data set have normal distribution and if the data is normally distributed. Normality was tested using the Shapiro-Wilk test since it is more appropriate for samples which are less than 50 (Mishra et al., 2019). In the event the data collected was found to deviate from normality, the cure was checking for any outliers and removing them from the data and carrying out non-parametric regression which does not require normality of data.

3.13.2 Multicollinearity

Multicollinearity occurs when explanatory variables in regression models are correlated. The problem of multicollinearity among the independent variables can to lead to results in a study which are skewed and hence less reliable reducing the precision of the coefficients estimated in a regression model. Multicollinearity makes it impossible or rather hard to clearly determine how independent variables impact dependent variable. Multicollinearity test in this study was done using VIF. The problem of multicollinearity was solved by removing the highly correlated variables.

3.13.3 Heteroscedasticity Test

Error terms must be normally distributed and have constant variance. When this assumption is violated the problem of heteroscedasticity arises which implies that the estimator is no long best linear unbiased estimator. This means that regression predictions made will be inefficient,

inconsistent and biased. Breusch-Pagan test was used in this study to test for the presence of heteroscedasticity. If the problem of heteroscedasticity if established, the data was log transformed.

CHAPTER FOUR: EMPIRICAL FINDINGS

4.1 Introduction

This chapter presents empirical findings of analysis of efficiency and productivity of 31 public chartered universities in Kenya under constant returns to scale. The analysis presents findings of the DEA-based Malmquist which examines the TFP of the DMUs during the period under analysis. Analysis was then done for a period of five years from 2017/2018 to 2021/2022 academic years whereby technical efficiency scores of one indicates that the DMUs are efficient and technical efficiency scores of less than unit indicates inefficiency levels. The study aimed at assessing the TFP growth and technical efficiency levels of public universities and the determinants of technical efficiency.

4.2 Descriptive Statistics of the Variables

The following table shows the descriptive statistics of the variables used in the study.

Table 4.1: Descriptive Statistics for the Study Variables

Variable	Obs	Mean	Std. dev.	Min	Max
UNDERGRADU~D	155	2199.832	2008.669	0	10845
MASTERSDEG~D	155	157.1097	427.4842	0	2559
DOCTORALDE~D	155	20.89032	37.00449	0	166
EMPLOYEECOST	155	1.86e+09	2.10e+09	2.46e+08	1.18e+10
GOVERNMENT~K	155	1.23e+09	1.05e+09	2.15e+08	5.59e+09
TUITIONINC~E |	155	8.22e+08	1.09e+09	7.18e+07	6.01e+09

Source: Author

The study analyzed 31 public chartered universities in Kenya over a period of five years (155 observations). It was observed that the average number of graduates annually in undergraduate, masters and PhD programs were 2199.832, 157.1097and 20.89032 respectively. It was observed that the minimum number of students graduating with undergraduate degrees was zero while the highest was 10,845 students. Equally, for the masters and PhD programs the least was observed to be zero to a maximum of 2,559 and 166 students respectively. This largely illustrates wide variations which exists in the public universities in Kenya. These variations are equally observed in the other variables. This analysis is presented in Table 4.1.

4.3 Diagnostic Tests Results

4.3.1 Normality Test Results

The p-value for Shapiro-Wilk test for all the variables was established to be greater than 0.05. This implies that the variables used in this study were normally distributed. Technical efficiency scores which are truncated scores from DEA analysis and age which was used a moderating variable were equally normally distributed. All the W-values were close to one indicating that that the data used in the study was normally distributed.

Table 4. 2 Shapiro–Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
lnte	31	0.78393	7.038	4.043	0.00003
lnun	31	0.97071	0.954	-0.097	0.53872
lnms	31	0.95319	1.525	0.874	0.19107
lnphd	28	0.97536	0.744	-0.609	0.72874
lnec	31	0.93334	2.171	1.606	0.05410
lngf	31	0.97808	0.714	-0.698	0.75726
lnti	31	0.93231	2.205	1.638	0.05070
lnag	31	0.87034	4.223	2.985	0.00142

Source: Author

4.3.2. Multicollinearity Test Results

The Variance Inflation Factor was employed in this study to examine the level of multicollinearity among variables. As outlined by Kalnins and Praitis (2023), a VIF value that is greater than 10 signals existence of some multicollinearity. Table 4.3 presents the VIF results which indicates multicollinearity was not present in the variables used.

Table 4.3 Variance Inflation Factor

Variable	VIF	1/VIF
lnec	17.45	0.057307
lngf	11.92	0.083893
lnti	8.69	0.115075
lnun	7.34	0.13624
lnphd	7.07	0.141443
lnms	6.09	0.164204
lnag	3.77	0.265252
Mean VIF	8.904286	

Source: Author

4.3.3 Heteroscedasticity Test Results

To test for the presence of heteroscedasticity, the study employed Breusch-Pagan test to establish if the data was largely homoscedastic.

hettest

Breusch–Pagan/Cook–Weisberg test for heteroskedasticity

Assumption: Normal error terms

Variable: Fitted values of te

H0: Constant variance

chi2(1) = 3.31

Prob > chi2 = 0.0687

From the Breusch-Pagan test results the p-value is greater than 0.05 significance level. Hence, it is concluded that heteroscedasticity was not present in the data.

4.4 Empirical Results

4.4.1 Total Factor Productivity

The objective of this study was to determine the TFP growth of the public universities during the period under study. To measure the TFP growth in the DMUs during the period under study, Malmquist Productivity Indices were computed using Malmquist DEA. Overall mean results from the analysis have revealed a trend of productivity in public universities that is of great concern during the period under study as presented in Table 4.2.

Table 4.4: Malmquist Productivity Indexes Summary of the Annual Means

No	DMU	effch	techch	pech	sech	tfpch
1	University of Nairobi	1.033	0.790	1.027	1.004	0.816
2	Moi University	0.915	0.811	0.930	0.984	0.742
3	Kenyatta University	0.876	0.760	0.890	0.984	0.666
4	Egerton University	1.025	0.867	0.981	1.045	0.889
5	Maseno University	0.859	0.778	0.816	1.053	0.668
6	JKUAT	1.022	0.807	1.029	0.993	0.824
7	Technical University of Mombasa	0.893	0.855	0.923	0.967	0.763
8	Masinde Muliro University	0.844	0.800	0.987	0.854	0.675
9	Dedan Kimathi University	0.987	0.839	1.096	0.901	0.828
10	Chuka University	0.559	0.855	0.923	0.967	0.763
11	Laikipia University	0.732	0.802	0.880	0.831	0.587
12	South Eastern Kenya University	0.833	0.827	1.046	0.796	0.689
13	Kisii University	0.907	0.856	1.006	0.901	0.776
14	Multimedia University of Kenya	0.000	0.230	0.000	****	0.000
15	University of Kabianga	0.917	0.801	0.949	0.967	0.735
16	Karatina University	1.083	0.879	1.066	1.016	0.952
17	Meru University	1.060	1.016	1.053	1.007	1.078
18	Kirinyaga University	1.140	0.957	1.134	1.006	1.091
19	Pwani University	0.981	0.926	0.996	0.985	0.909
20	Murang'a University	1.263	0.976	1.249	1.011	1.233
21	Machakos University	1.149	1.087	1.132	1.016	1.249
22	University of Eldoret	0.883	0.846	0.967	0.913	0.747
23	Kibabii University	1.015	****	1.041	0.976	****
24	Maasai Mara University	0.916	0.893	0.929	0.985	0.817
25	Co-operative University of Kenya	1.129	0.896	1.129	1.000	1.011
26	Rongo University	0.000	****	0.000	0.000	0.000
27	Technical University of Kenya	0.722	0.808	0.780	0.925	0.583
28	Garissa University	0.735	0.853	0.798	0.921	0.626
29	Jaramogi Oginga Odinga University	0.847	0.862	0.853	0.993	0.729
30	Taita Taveta University	0.957	0.906	0.955	1.002	0.867
31	University of Embu	0.993	0.994	0.997	0.996	0.987
	Mean	**0.002**	**8.831**	**0.003**	**0.616**	**0.018**

Source: Author

Mean efficiency change (effch) is 0.002. This represents staggering decline in efficiency by 99.8% across the public chartered universities. This significant decline suggests that many public universities during the period under study were unable to fully optimize the resources available to them. This could have been as a result of various challenges which hindered the abilities of the universities to operate effectively. The declining efficiency implies that the public universities were producing significantly less outputs than expected which is a good indicator of decreasing operational performance. Moreover, the average technological change (techch) of 8.831 reflects 83.1% increase which implies that the public universities kept pace with the technological advancements as equally established by Viverita and Wibowo (2007) and Worthington and Lee (2008).

The mean TFP growth of the public universities in Kenya was 0.018. The results indicates that mean TFP growth was negative and declined by 98.2% which shows how the public universities in Kenya struggled during the period under study. Despite of the substantial average technical efficiency change (techch) of 8.831 which implies that a number of universities adjusted their operations successfully towards an optimal scale, the improvement was not enough to offset overall negative trends in technological progress and efficiency.

4.4.2 Technical Efficiency Scores

The objective of this study was to determine the TE levels of public universities which this section answered.

Table 4.5 Efficiency Scores

No	DMU	crste	vrste	scale	
1	University of Nairobi	0.565	0.800	0.706	drs
2	Moi University	0.631	1.000	0.631	drs
3	Kenyatta University	0.633	1.000	0.633	drs
4	Egerton University	0.468	0.814	0.576	drs
5	Maseno University	0.529	1.000	0.529	drs
6	JKUAT	0.969	1.000	0.969	irs
7	Technical University of Mombasa	1.000	1.000	1.000	-
8	Masinde Muliro University	1.000	1.000	1.000	-
9	Dedan Kimathi University	0.815	0.916	0.890	drs
10	Chuka University	0.864	1.000	0.864	drs
11	Laikipia University	0.762	0.809	0.941	drs
12	South Eastern Kenya University	0.691	0.801	0.863	drs
13	Kisii University	0.528	0.712	0.742	drs
14	Multimedia University of Kenya	0.512	0.694	0.737	drs
15	University of Kabianga	0.935	1.000	0.935	drs
16	Karatina University	0.252	0.256	0.986	drs
17	Meru University	0.330	0.333	0.989	drs
18	Kirinyaga University	1.000	1.000	1.000	-
19	Pwani University	1.000	1.000	1.000	-
20	Murang'a University	0.771	0.936	0.824	drs
21	Machakos University	0.621	0.627	0.990	drs
22	University of Eldoret	1.000	1.000	1.000	-
23	Kibabii University	0.600	0.609	0.984	drs
24	Maasai Mara University	0.599	0.622	0.963	drs
25	Co-operative University of Kenya	0.560	0.568	0.985	drs
26	Rongo University	0.454	0.621	0.732	drs
27	Technical University of Kenya	0.383	0.412	0.930	drs
28	Garissa University	0.195	0.248	0.788	drs
29	Jaramogi Oginga Odinga University	0.498	0.531	0.938	drs
30	Taita Taveta University	0.181	0.238	0.762	drs
31	University of Embu	1.000	1.000	1.000	-
	Mean	**0.656**	**0.760**	**0.867**	

Source: Author

Data analysis was done using DEAP version 2.1 to obtain VRS technical efficiency scores (Coelli, 1996). The program was run under output orientation two stage DEA for 31 DMUs over a period of five years from 2017/2018 academic year to 2021/2022 academic year. Under the assumption of the variable returns to scale, this study found out that average TE scores for 31 DMUs to be 0.760. This implies that the public universities could have significantly improved their performance by 24% using the resources at their disposal during the period under study. Out of the 31 public universities only 11 public universities, 38.71% were found to be technically efficient having TE score of 1 under assumption of variable returns to scale. This implies that they operated efficiently when gauged with their respective peers. These findings are in tandem with the findings in the study carried out by Ngobi, Yawe and Dbumba-Ssentamu (2019a) and Ngobi, Yawe and Dbumba-Ssentamu (2019b). Twenty public universities were found to be technically inefficient since they had scores less than one. The average scale efficiency of the public universities was found to be 0.867. This means that they had 13.3% unused capacity which otherwise could have enabled the DMUs analyzed to perform much better than they did during the period under study. The public universities had 13.3% possibility to attain their optimal size.

Twenty-five universities which represent 80.64% of the public universities studied in this research had decreasing returns to scale. This implies that for the universities to increase their inputs they have to increase their inputs. It is worth noting that only one university which had increasing returns to scale and only five universities which had constant returns to scale.

4.4.3 Tobit Regression Results

The objective of this study was to determine the determinants of technical efficiency. Tobit regression model was used to find out the factors which affected technical efficiency of public universities. Recognition of the drivers of efficiency enables the DMUs which are inefficient

to focus on the factors which can enable them become efficient. The Tobit regression model used was as follows:

$$TE_{it} = \beta_0 + \beta_1 EC_{it} + \beta_2 GF_{it} + \beta_3 TI_{it} + \beta_4 UND_{it} + \beta_5 MG_{it} + \beta_6 PHD_{it} + \beta_7 AG_{it} + e_{it}$$

The dependent variable in the model is technical efficiency scores whereas the input and output variables were treated as explanatory variables. Positive coefficient of the explanatory variables implies an increase in efficiency while negative coefficients imply inverse relationship of the explanatory variables with the explained variable at 5% significance levels. Significant p-values range from 1% to 5%.

Table 4.6 Tobit Regression Results

Tobit Regression					Number of obs	= 31
					Uncensored	= 31
Limits:	Lower = -inf				Left-censored	= 0
	Upper = +inf				Right-censored	= 0
					LR chi2(4)	= 9.91
					Prob > chi2	= 0.0420
Log likelihood = 3.2802618					Pseudo R2	= 2.9599
te	**Coefficient**	**Std. err.**	**t**	**P>|t|**	**[95% conf.**	**interval]**
un	.0000705	.000081	0.87	0.392	-.0000957	.0002367
ms	7.94e-06	.0003628	0.02	0.983	-.0007364	.0007523
phd	.0023787	.0031361	0.76	0.455	-.0040561	.0088136
ec	-1.34e-10	1.51e-10	-0.89	0.381	-4.44e-10	1.75e-10
gf	3.94e-11	2.24e-10	0.18	0.862	-4.21e-10	5.00e-10
ti	1.74e-11	2.90e-10	0.06	0.953	-5.78e-10	6.13e-10
ag	.0092607	.0068645	1.35	0.189	-.004824	.0233455
cons	.5900887	.0861302	6.85	0.000	.4133641	.7668132
var(e.te)	.0473823	.0120351			.0281369	.0797913

Source: Author

From Table 4.2, employee cost negatively affected technical efficiency levels of public universities. All the other input and output variables besides employee costs positively influenced technical efficiency of the DMUs analyzed in the study. Therefore, the public chartered universities can increase their technical efficiency by increasing the number of undergraduate, master degrees and PhD degrees graduates, amount of tuition income and government grants. This means that the universities must put in place strategies which are

aimed raising the number of students who graduate from these institutions annually at undergraduate, masters and doctoral levels. Equally, the universities must find a mechanism of negotiating for increased government grants besides increasing the internally generated incomes in form of appropriation-in-aid that is tuition income which is basically determined by the number of students they admit into their various programs. Notably, the age of the DMUs equally had a positive influence on the efficiency level of the DMUs analyzed. The findings of the regression model show that all the variables used in the model are insignificant since the p-values of the variables are out of the accepted range of between 0.01 and 0.05 level of significance. This implies that regardless of the effect they have on efficiency, they are not significant. Therefore, this means that the individual variables may not such strong individual effect on efficiency. The p-value of the Tobit regression model fell below 0.05. This implies the regression model is statistically significant at 5% significance level. All other variables held constant, the efficiency of the DMUs will be 0. 5900887. Variance of the error term is equal to 0.0473823 with a standard error of 0.0120351. This suggests there are some levels of variability in unobserved variables which influence technical efficiency across the DMUs analyzed in the study.

4.5 Summary of Study Findings

The main objective was to assess the technical efficiency and TFP growth of Kenyan public universities. The specific objectives are: i) to measure Total Factor Productivity (TFP) growth of public chartered universities in Kenya; ii) to measure technical efficiency levels of public chartered universities in Kenya; and iii) to identify determinants of technical efficiency in public chartered universities in Kenya. The study found that Total Factor Productivity (TFP) growth among public chartered universities in Kenya declined significantly during the period under review, with an overall decrease of 98.2%. This drop was primarily driven by technological regress, indicating that universities were not effectively adopting innovations or

enhancing their production capabilities over time. Despite this decline in productivity, technical efficiency levels remained relatively stable, with an average efficiency score of 0.760. This means that, on average, the universities were operating 24% below their potential efficiency frontier, suggesting substantial room for improving how resources are utilized to achieve maximum output. In identifying the determinants of technical efficiency, the study found that tuition income, government grants, and the number of graduates at the undergraduate, master's, and doctoral levels had a significant and positive effect on efficiency. These variables enhanced universities' capacity to translate inputs into educational outputs. On the other hand, employee costs had a significant negative effect on efficiency, indicating that rising salary expenditures, when not accompanied by proportional output increases, contributed to inefficiencies. These findings highlight the critical need for Kenyan public universities to improve innovation uptake, optimize resource use, and align funding structures with performance outcomes to enhance overall institutional productivity.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Introduction

The chapter provides the summary, conclusion and various policy implications which arose the analysis of efficiency and productivity of public chartered universities in Kenya. It equally identifies the potential areas where further research in the future can be carried on.

5.2 Summary of the Study

The aim of the research was to assess technical efficiency and total factor productivity growth of public chartered universities in Kenya. To accomplish this aim, this study analyzed 31 public chartered universities for a period of five years from 2017/18 to 2021/2022. The higher education sector in Kenya is expected to take a center stage in the economic growth and development of the economy. This sector was selected based on the many challenges that continue to cripple the operations of the public universities in Kenya as a result of resource constraints. The sector was seriously hit by huge funding gaps which significantly affected the financial sustainability of the public universities more especially during the period under study. The study examined the technical efficiency of the public universities and their total factor productivity growth for a period of five years when these universities experienced huge funding gaps. The DEA was used to compute the efficiency scores and Malmquist indices which were used in measuring the TFP growth. Since the universities had limited resources, output-oriented DEA model was opted for.

The first objective was to assess the TFP growth of public universities in Kenya. The DMUs recorded a mean TFP growth of 0.018. The results indicate that mean TFP growth was negative and declined by 98.2% during the period under study. This demonstrates how the productivity of public universities changed during the period under study. The negative growth in the productivity was attributed to efficiency change, pure efficiency changes and scale efficiency

change. The positive growth in technical efficiency change was not enough to counter the negative productivity growth. It is evident that the TFP change was largely driven more by technical progress as compared to efficiency changes. The second objective was to determine the technical efficiency levels of public universities. The results revealed that only 11 public universities were technically efficient as compared to 20 remaining DMUs which were found to be technically inefficient.

5.3 Conclusions

Higher education is an important sector in the economic development of countries. Therefore, it is very necessary that investments in the higher education attain the maximum possible outputs which directly and indirectly contribute towards economic progress of such economies. The study analyzed efficiency and TFP growth of public chartered universities in Kenya. This study sought to assess the technical efficiency levels and determine the determinants of efficiency. It equally sought to assess the TFP growth in the selected DMUs over a period of five years. Employee costs, government grants and tuition income were used as input variables while the number of graduands in undergraduate, masters and doctoral levels were used as output variables. Age was used as the control variable in regression analysis.

Demand for university education today has significantly increased globally. Considerably huge investments in the higher education sector have been made in the higher education sector in Kenya in effort to ensure that the high demand for higher education among the Kenyans is met. However, these investments are considerably low. Many public universities decry low funding which does not meet their needs. Assessment of efficiency and productivity in higher education sector is largely critical so as to ensure that needs of the people are met but more importantly to ensure that the limited resources allocated to these universities are utilized efficiently to achieve the expected results.

This study employed DEA in the assessment of technical efficiency of public universities and Malmquist DEA in the assessment of productivity. Using DEA and largely assuming variable returns to scale, the mean technical efficiency score of the 31 public universities was 76.0%. This indicates that on average, if the public universities fully utilize the resources availed to them, their efficiency levels will rise by 24.0%. Malmquist DEA showed that the mean TFP growth of the public universities in Kenya was 0.018. The results indicates that mean TFP growth was negative and declined by 98.2% which shows how the public universities in Kenya struggled during the period under study. This study concludes that the DMUs under analysis, public chartered universities experienced negative growth in total factor productivity. The decline in productivity can be attributed to efficiency change, scale efficiency changes and pure efficiency change. The increasing technical efficiency change was not enough to counter the sharply declining TFP over the period under study. After independence in Kenya, the number of universities set up by the government rapidly increased. Given the increase, it is not surprising to find out that only one university which was subject to increasing returns to scale, five of them experienced constant returns to scale while the rest had decreasing returns to scale. Analysis of the Tobit regression model shows that employee cost negatively affected technical efficiency levels of public universities. All the other input and output variables besides employee costs positively influenced the technical efficiency of the universities analyzed in this study. This implies that the public universities can increase their overall technical efficiency by increasing the number of undergraduates, master degrees and doctoral degrees graduates, amount of tuition income and government grants. Notably, the age of the DMUs equally had a positive influence on the efficiency level of the DMUs analyzed. It is important to note that capitation from the government must be adequate to meet the needs of the

universities. 11 universities were found to be efficient having a score of 1 while the other remaining universities were inefficient.

5.4 Policy Implications

This study has demonstrated that many public universities studied are inefficient and unproductive. The Data Envelopment Analysis helps in determining the magnitude by which the inputs and outputs can be varied to enable the universities which are inefficient become efficient. Since this study employed an output-oriented DEA and VRS the public universities can improve performance by 24% without any alterations to the current level of their inputs. From the Tobit regression model, employee cost had a negative influence on efficiency. Therefore, this calls rationalization of the number of academic staff and administrative staff. Government policy should therefore be geared towards increasing funding to these public universities. Based on the findings from this study, the policymakers must prioritize strategies aimed efficiently allocating resources to public universities to enable them offer quality education.

The declining or negative TFP growth in the public universities over the study period is a major challenge to the governments and its efforts to improve equity and access to university education. This therefore calls for need to adequately address all the issues which are related to efficiency for higher education sector to largely maximize the benefits of university education. Since eleven universities are efficient and operate in an environment similar to the other universities, policy makers must set targets for these universities and monitor efficiency changes in these institutions over time with a view of ensuring that adequate interventions which are aimed at improving efficiency and productivity in use of the limited resources and improved productivity at zero additional costs.

5.5 Contribution to Knowledge

The findings of this study contribute immensely to the current body of knowledge in more diverse ways. Firstly, the study offers a more comprehensive analysis of the levels of efficiency particularly in the public universities in Kenya which to a large extent underexplored. The analysis utilized DEA which is more applicable to learning institutions in assessing efficiency of the Decision-Making Units. By applying this technique, this study sheds more light on how the limited resources allocated to the public universities influence the performance of these institutions thereby largely contributing to the discourse on efficiency in public universities in Kenya and around the world. The study advances Malmquist DEA in measuring productivity within the contexts of publicly owned universities. By incorporating both input variables and output variables which are specific to university sector in Kenya, the study provides important understanding of total factor productivity dynamics which can serve as model in similar studies in other countries more especially developing countries in Africa and the other parts of the world. By identifying the determinants which contribute to efficiency, the study informs strategies which can be used in enhancing the maximum utilization of the limited resources that can ultimately help in boosting the productivity of the public universities and overall quality of education that they offer to the people.

5.6 Areas of Further Research

This study left out constituent colleges and universities which were established after 2017/2018 academic year. The study equally considered public universities leaving out private universities despite of the government sponsored students being placed in the private universities. Future studies can opt to include both private and public universities so as to assess comparative efficiency in private and public universities. The study included three inputs and three outputs leaving out many other inputs and outputs such as research publications, consultancy income

among others. Future studies can increase the number of study variables to ensure that efficiency and productivity of these institutions are comprehensively analyzed without leaving out any important variable which otherwise may affect the efficiency and productivity levels. The study used output-oriented DEA and Malmquist DEA. Future studies can use a mix of the methods available such as input-oriented DEA, stochastic frontier analysis among other methods to fully assess the TE and TFP growth of public universities.

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Appendices

Appendix I: Public Chartered Universities

1	University of Nairobi	1970
2	Moi University	1984
3	Kenyatta University	1985
4	Egerton University	1988
5	Maseno University	1991
6	Jomo Kenyatta University of Agriculture and Technology	1994
7	Technical University of Mombasa	2007
8	Masinde Muliro University of Science and Technology	2007
9	Dedan Kimathi University of Technology	2012
10	Chuka University	2012
11	Laikipia University	2013
12	South Eastern Kenya University	2013
13	Kisii University	2013
14	Multimedia University of Kenya	2013
15	University of Kabianga	2013
16	Karatina University	2013
17	Meru University of Science and Technology	2013
18	Kirinyaga University	2016
19	Pwani University	2013
20	Murang'a University of Technology	2016
21	Machakos University	2016
22	University of Eldoret	2013
23	Kibabii University	2015

24	Maasai Mara University	2009
25	The Co-operative University of Kenya	2016
26	Rongo University	2016
27	Technical University of Kenya	2013
28	Garissa University	2017
29	Jaramogi Oginga Odinga University of Science and Technology	2013
30	Taita Taveta University	2016
31	University of Embu	2016

Source: (UFB, 2023)