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

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ABSTRACT

Purpose of the study: The study aimed at assessing efficiency and growth in productivity of public universities in Kenya from 2017/2018 to 2021/2022 academic years.

Problem statement: University education is critical in economic development. Public universities are funded by government. Despite of their importance, Kenyan public universities face huge funding gaps which have affected their efficiency and productivity over time.

Methodology: The study employed the Malmquist Index to evaluate total factor productivity growth of public chartered universities in Kenya. Additionally, a two-stage Data Envelopment Analysis was used to determine the technical efficiency of these institutions**.**

Findings: The study found out that average TE score of 31 DMUs was 0.760. Out of the 31 public universities only 11 public universities were found to be technically efficient. The DMUs recorded a mean TFP growth of 0.018 representing a decline by 98.2%. TFP change was driven more by technical progress. Employee cost negatively affected technical efficiency while other variables positively influenced efficiency.

Conclusion: The study concluded that the public universities experienced negative growth in total factor productivity and overall, they were technically inefficient.

Recommendations: The study recommends that public universities should strive to improve their performance by 24% without altering their current input levels, while the government should rationalize staffing and increase funding to address financial challenges. Policymakers should prioritize efficient resource allocation strategies and set targets for monitoring efficiency changes in universities over time. Additionally, universities should be encouraged to develop innovative ways of generating internal revenue to supplement their income, given the current financial constraints.

Keywords: *Total factor productivity, technical efficiency, decision making unit, data envelopment analysis, public chartered universities, Kenya*

INTRODUCTION

Education is a fundamental pillar of sustainable growth and development. The contribution of education offered by the public universities is inevitable towards the attainment of sustainable development of societies (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).

Besides community service, the main activities that public universities are required to pursue are primarily teaching and undertaking research (Teichler, 2007). For public universities to achieve this, they ought to have sufficient resources to finance these core activities. However, these resources are limited, calling for public universities to use the available resources more prudently to produce the desired outputs. Stakeholders in the education sector, especially the government, continue to implement strategies that contribute towards improving efficiency and productivity of public universities. The main objective is to ensure that they are responsive to technological advancements so that they produce the maximum possible output from research and teaching activities given the available technology (Odhiambo, 2018).

Publicly owned universities are largely funded by public funds. It is therefore on this basis that the government is concerned with how efficient and productive public universities are in their operations. The allocation of limited public resources and efficiency in their use by public universities are intertwined, compelling scholars to be concerned with the level of efficiency and productivity of these higher learning institutions (Wachira, 2018). 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 the quality and quantity of human capital from public universities. It is therefore imperative to measure the efficiency and productivity of public universities due to increased demand from stakeholders (Kithinji et al., 2023). Despite the significance of university education, public universities in Kenya continue to face huge resource and funding gaps which erode their overall efficiency and productivity (KIPPRA, 2022).

Capitation Trend in Public Universities in Kenya

To support the operations of public universities, the government, through the Ministry of Education, Science and Technology, finances both their capital and recurrent expenditures each academic year. Table 1 illustrates the funding trend for public universities from the 2017/2018 to 2022/2023 academic years.

Table 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

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 have 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 2 shows the DUC percentage allocated to universities since 2017/2018 academic year to 2022/2023 academic year.

Table 1: 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)

The 100% transition government policy for KCSE graduates resulted in some students being placed in private universities thereby denying public universities funding. This equally led to a significant drop in the amount of money generated by enrolling module II students in the public universities. 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.

Challenges facing Public Universities in Kenya

As established by Otiende et al. (2024), the performance of public universities in Kenya falls below expectations when compared to other countries. This underperformance stems from numerous challenges facing these institutions. Among the most significant issues are underfunding and substantial resource gaps, which continue to negatively impact their overall efficiency and productivity (Kithinji et al., 2023). The growth of public universities in Kenya since independence, coupled with increased student enrollment, has occurred without commensurate funding. Paradoxically, the establishment of new public universities in recent years has not been matched with adequate financial support for their operations (Osumba & Sang, 2021). Increased administration and operation costs, due to higher living expenses and a growing number of government-sponsored students, have further strained these institutions' performance. The situation is exacerbated by significant pending bills, currently estimated at about 63 billion Kenyan shillings, which many public universities are struggling to manage. The substantial debts owed to service providers, part-time lecturers, and various statutory bodies raise serious concerns about the efficiency and productivity of these institutions (KIPPRA, 2022).

The Differentiated Unit Cost (DUC) model, developed by the Universities Funding Board (UFB) for financing public universities, only covers 80% of the unit costs. However, even this target has never been fully met, negatively impacting the financial sustainability of public universities over time. The DUC model has significantly reduced funding for large universities. Notably, in the 2018/2019 academic year, the government financed public universities at only 66.4% under the DUC model, which further decreased to 48.11% in the 2022/2023 academic year (KIPPRA, 2022; UFB, 2023b). This reduction has left institutions with substantial resource gaps, making it extremely challenging to adequately finance their core activities (Wachira, 2018). Government sponsored student numbers have been increasing over time but DUC percentage has been drastically reducing as illustrated in Figure 1.

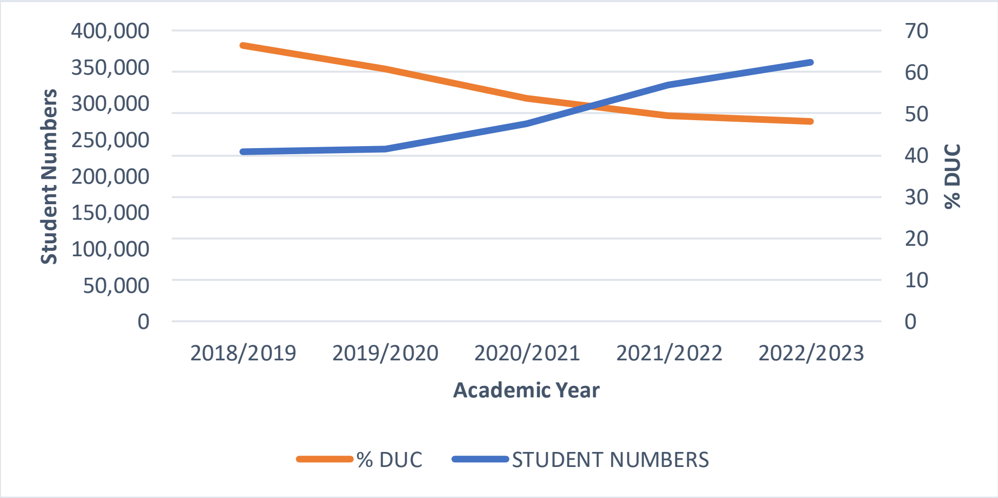

Figure 1: Relationship between student numbers and DUC Percentage

Source: UFB, 2024

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.

STATEMENT OF THE PROBLEM

Public chartered universities in Kenya are potential in producing desired outputs. However, there performance in terms of productivity and efficiency is not desirable. Many are facing financial constraints due to underfunding which has increased significantly amidst increased administration and operation costs over the years, more especially during the period under 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). This has necessitated many public universities to undertake cost-cutting measures such as merging schools and scaling down the number of lecturers (CUE, 2018).

The number of self-sponsored students has been declining steadily, leaving universities with diminished income to bridge the funding gap (Osumba and Sang, 2021). Moreover, pending bills continue to rise due to substantial budget deficits. Since the implementation of the Differentiated Unit Cost (DUC) model for allocating funds to universities, institutions have not been sufficiently funded. The DUC percentage allocated to universities has been drastically reducing, leaving many with significant funding shortfalls. Concurrently, the number of government-sponsored students admitted to public universities continues to rise without commensurate funding. Before the 2017/2018 academic year, many universities were performing well financially, as they obtained extra income by admitting Module II students into self-sponsored programs and generating revenue from satellite campuses.

However, reforms in higher education, such as the closure of satellite campuses that did not meet University Standards Guidelines for academic programs, the abolition of pre-university programs, and the admission of government-sponsored students into private universities, caused universities to lose considerable income. As the situation is unlikely to improve in the near future, public universities have no option but to embrace prudent ways of utilizing available resources and develop innovative methods of generating internal revenue to supplement their income. Given the current environment, public universities must find innovative approaches to maintain efficiency and productivity. Hence, the study examined the efficiency and total factor productivity growth of public chartered universities in Kenya during this period of significant financial challenges and reforms. By analyzing technical efficiency levels, determinants of efficiency, and total factor productivity growth, this research aimed to provide insights into how these institutions are performing and identify potential areas for improvement in resource utilization and productivity.

RESEARCH OBJECTIVES

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.

THEORETICAL REVIEW/ 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.

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:

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

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

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. The use of panel data allowed estimation of the technical progress and changes as it regards to TE over time.

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 uses 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 lie 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 were obtained using:

$$min_{\theta,\lambda}\theta$$

$$subject\ to$$

$$-q_i + Q\lambda \geq 0,$$

$$\theta x_i - X\lambda \geq 0, \quad \text{..} 3.2$$

$$\lambda \geq 0,$$

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:

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

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.

Model Specification: 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 technical efficiency scores on variables to assess their effect on efficiency.

EMPIRICAL REVIEW

Worthington and Lee (2008) assessed efficiency, technology, and TFP change of thirty-five universities in Australia over six years. The study used nonparametric frontier approaches to analyze data collected from the universities to determine their efficiency and productivity during the study period. The inputs used in the study were non-labour expenditure, non-academic staff, full-time equivalent academic staff, and student load in postgraduate and undergraduate programs. The outputs considered 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 was 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 were attributed to research productivity, which was largely linked to improvements in pure technical efficiency.

Bangi et al. (2014) assessed the efficiency and determinants of Tanzanian universities. In this study, the researchers employed DEA to examine the efficiency of Tanzanian universities and used a Tobit regression model to determine the impact of variables on the efficiency of sampled DMUs. 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 the Commission for Universities, university websites, Ministry of Education, and National Bureau of Statistics. The study employed three inputs: number of student enrollment, academic staff, and non-academic staff; and three outputs: 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 generating graduates using the resources available to them.

Kulshreshtha and Nayak (2015) assessed the 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 to measure the TEs of the sampled institutions. The inputs the study used included teaching and support staff, undergraduate, postgraduate and post-doctoral students, equipment and library stock, teaching materials, technical equipment, total expenditure on education, and grants from the central and state governments. The outputs used included student load in undergraduate courses, postgraduates, research grants 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. The average TE score using constant returns to scale DEA ranged from 0.987 in 2001/2002 to 0.992 in 2004/2005.

Myeki and Temoso (2019) assessed the efficiency of public universities in South Africa from 2009 to 2013. Panel data was used in this study. DEA was employed to estimate the TE of the sampled twenty-two public universities. The input variables used in the study included enrolled postgraduate students, enrolled undergraduate students, total budget expenditure, and the number of academic staff. The study used only two outputs: weighted graduates and weighted research output. The study established that the TE of the sampled public universities declined from 0.83 in 2009 to 0.78 in 2013. The study further established that research-intensive universities tended to be much more efficient compared to those universities which were professionally oriented.

Menga-Mokombi (2020) assessed the efficiency of higher institutions of learning using DEA in the Republic of Congo. The study covered a period of only one academic year, 2016/2017, using data from forty-nine private and public institutions in Congo. Input variables used in estimating efficiency levels were total expenditure, registrants, and number of academic staff whose last degree was a master's or doctorate. The output variables used in the study were success rate corresponding to students who completed different courses and students who completed undergraduate degrees. The findings 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 an effect on student success. It was also found that an increase in public expenditure on higher education improves the efficiency of DMUs and tax revenues over time.

Using the Data Envelopment Approach, Miranda and Gutiérrez (2021) assessed the technical efficiency of forty-two Peruvian public universities on the grounds that the main weakness of public universities in that country was deficiencies experienced in the quality of university education. The study used data from only one year, 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 input, which was total budget, and two outputs: enrolled students (comprising doctoral, postgraduate, and undergraduate students) and number of researchers placed in the Renacyt program. Findings showed that the overall TE was 0.568.

Andersson and Sund (2022) investigated productivity and TE of universities in the 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 the Nordic region for six years from 2011 to 2016. The study used inputs including teaching and research staff, number of undergraduate and graduate students, doctoral students, and office space, and four outputs including number of ECTS credits, PhD degrees awarded, and publications in scientific journals. The study found that the yearly average productivity change for the sampled higher education institutions was 0.4%. The study also established that the average inefficiency of the institutions under study was 10.1% for the entire period. Inefficiency scores were positively correlated with staff turnover. However, it did not consider other extraneous variables which affect efficiency.

Temoso and Myeki (2023) estimated productivity and efficiency of institutions of higher learning in South Africa using panel data spanning a period of eight years from twenty-two universities. The study employed the Färe-Primont index in measuring TFP. A feasible GLS 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 was 0.631. Much of this productivity growth was attributed to mix and scale efficiency changes, closely followed by technical efficiency change. In assessing productivity of twenty-two universities, the study employed five outputs and five inputs. The outputs were number of graduates in undergraduate, postgraduate, and doctoral programs, publications, and grants received. The inputs used were number of enrolled students in undergraduate and postgraduate courses, teaching staff, support staff, and other costs.

RESEARCH METHODOLOGY

The study employed a longitudinal research design, which allows for the analysis of units over time, helping to identify changes (Wang et al., 2017). The research also adopted panel data, collecting information from the sampled decision-making units over five years, from 2017/2018 to 2021/2022. Data Envelopment Analysis (DEA) was used to estimate overall technical efficiency scores, while Malmquist DEA was employed to estimate Total Factor Productivity growth. A Tobit regression analysis was conducted using the overall technical efficiency scores as the dependent variable, with inputs and other control variables as independent variables, to assess their effect on efficiency. The application of DEA requires that chosen Decision Making Units (DMUs) be homogeneous and satisfy three criteria: first, the selected DMUs must have the same objectives and similar activities; second, they must use similar inputs to produce the same outputs; and finally, they must operate within similar environments (Dyson et al., 2001). The public chartered universities in this research study are homogeneous DMUs as they use similar inputs to produce similar outputs. Moreover, these universities operate in the same environment, have similar objectives, and undertake comparable activities.

RESULTS AND DISCUSSIONS

Descriptive Statistics of the Variables

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 exist in the public universities in Kenya. These variations are equally observed in the other variables. This analysis is presented in Table 3.

Table 3: 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

Empirical Results

Total Factor Productivity

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. 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.

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.

Table 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

Technical Efficiency Scores

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 12 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. 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.

Table 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

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.

Tobit Regression Results

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 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 6, 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.

CONCLUSION

The study concludes that higher education is a crucial sector for economic development, necessitating investments that yield maximum outputs contributing to economic progress. In addition, it is concluded that public chartered universities in Kenya experienced negative growth in total factor productivity during the study period. Besides, the research reveals that the mean technical efficiency score of the 31 public universities was 76.0%, indicating potential for a 24.0% increase in efficiency through full resource utilization. Also, the Malmquist DEA showed a mean TFP growth of 0.018, representing a significant 98.2% decline, highlighting the challenges faced by Kenyan public universities. Furthermore, the study determines that the decline in productivity can be attributed to changes in efficiency, scale efficiency, and pure efficiency. Moreover, the increasing technical efficiency change was insufficient to counteract the sharp TFP decline over the period under study.

In addition, the Tobit regression analysis reveals that employee costs negatively affected technical efficiency levels of public universities. Conversely, other input and output variables positively influenced technical efficiency. This implies that public universities can improve their overall technical efficiency by increasing the number of graduates at all levels, tuition income, and government grants. Also, it is noteworthy that the age of the DMUs had a positive influence on the efficiency levels of the analyzed institutions. Furthermore, only 11 universities were found to be efficient with a score of 1, while the remaining universities were inefficient. The study emphasizes that government capitation must be adequate to meet the needs of these institutions for improved performance and efficiency. In conclusion, this research provides valuable insights into the efficiency and productivity challenges facing Kenya's public university system, highlighting the need for improved resource allocation and management strategies.

RECOMMENDATIONS

The study recommends that public universities should improve their performance by 24% without altering their current input levels, as indicated by the output-oriented DEA and VRS analysis. In addition, it is recommended that the government should rationalize the number of academic and administrative staff, given the negative influence of employee costs on efficiency as revealed by the Tobit regression model. Besides, policymakers should prioritize strategies aimed at efficiently allocating resources to public universities to enable them to offer quality education. Also, the government policy should be geared towards increasing the number of academic staff to enhance efficiency.

Furthermore, it is recommended that all issues related to efficiency in the higher education sector should be adequately addressed to maximize the benefits of university education, given the declining or negative TFP growth observed over the study period. In addition, policymakers should set targets for the eleven efficient universities and monitor efficiency changes in these institutions over time. This approach should aim to ensure that adequate interventions are implemented to improve efficiency and productivity in the use of limited resources, with the goal of achieving improved productivity at zero additional costs. The study also recommends that the government should increase funding to public universities to address the significant financial challenges and resource gaps identified in the research. This increased support should be coupled with improved resource management strategies to enhance overall efficiency and productivity in the higher education sector.

REFERENCES

Andersson, C., & Sund, K. (2022). Technical Efficiency and Productivity of Higher Education Institutions in the Nordic Countries. *International Journal of Public Administration*, *45*(2), 107-120.

Atieno, A. V., Onyancha, O. B., & Kwanya, T. (2022). Trends, patterns and determinants of research productivity at the Technical University of Kenya. *Information Development*, *38*(1), 97-113.

Bailey, T., Cloete, N., & Pillay, P. (2011). Universities and economic development in Africa case study: Kenya and University of Nairobi.

Bangi, Y., Sahay, A., NCR, G. N., & Pradesh, U. (2014). Efficiency assessment of the Tanzanian universities. *Journal of Education and Practice*, *5*(14), 130-143.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision-making units. *European journal of operational research*, *2*(6), 429-444.

Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., & Battese, G. E. (2005). *An introduction to efficiency and productivity analysis*. Springer science & business media.

Coelli, T., Rao, P.D.S., O'Donnell, C. and Battese, G.E. (1998). An *introduction to efficiency and productivity* analysis. Second edition. Newyork: Springer Science.

Commission for University Education, CUE, (2018). 2017-2018 University Statistics. Retrieved from: https://www.cue.or.ke/index.php?option=com_phocadownload&view=category&id=18:universities-data-0-3&Itemid=187. Accessed on 29th October 2023 at 4:24 PM.

D'Elia, V., & Ferro, G. (2021). Efficiency in public higher education: A stochastic frontier analysis considering heterogeneity. *Economic Analysis Review*, *36*(2), 21-51.

Drebee, H. A., & Abdul Razak, N. A. (2018). Measuring the efficiency of colleges at the University of al-qadisiyah-Iraq: A data envelopment analysis approach. *Jurnal Ekonomi Malaysia*, *52*(3), 153-166.

Dyson, R. G., Allen, R., Camanho, A. S., Podinovski, V. V., Sarrico, C. S., & Shale, E. A. (2001). Pitfalls and protocols in DEA. *European Journal of operational research*, *132*(2), 245-259.

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American journal of theoretical and applied statistics*, *5*(1), 1-4.

Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the royal statistical society: series A (General)*, *120*(3), 253-281.

Garza-García, J. G. (2012). Determinants of bank efficiency in Mexico: A two-stage analysis. *Applied Economics Letters*, *19*(17), 1679-1682.

Johnes, G., & Tone, K. (2017). The efficiency of higher education institutions in England revisited: comparing alternative measures. *Tertiary Education and Management*, *23*, 191-205.

Kalnins, A., & Praitis H. K. (2023). The VIF score. What is it good for? Absolutely nothing. Organizational research methods, 10944281231216381.

KIPPRA (2022): Improving the performance of public universities in delivering higher education in Kenya. Retrieved from: https://kippra.or.ke/improving-the-performance-of-public-universities-in-delivering-higher-education-in-kenya/#:~:text=As%20a%20result%2C%20public%20universities,%2C%20health%20insurance%2C%20and%20taxes. Accessed on 22th October, 2023 at 3:23 PM.

Kithinji, M. M., Wephukulu, J. M., Gekara, M., & Mwanzia, M. (2023). Cash management and financial performance of public universities in Kenya. *Reviewed Journal International of Business Management [ISSN 2663-127X]*, *4*(1), 41-59.

Kivati, G. (2017). The Role of Kenya's formal higher education in sustainable development within the context of globalization. *Handbook of Theory and Practice of Sustainable Development in Higher Education: Volume 2*, 17-33.

Kulshreshtha, P., & Nayak, T. K. (2015). Efficiency of higher technical educational institutions in India. *Archives of Business Research*, *3*(1).

Levin, J., & Milgrom, P. (2004). Introduction to choice theory Available from internet: http://web. stanford. edu/∼ jdlevin. *Econ20202*.

Lovell, C. A. K., Walters, L. C. and Wood, L. L. (1995) Stratified models of education production using modified DEA and regression analysis, in Data Envelopment Analysis: Theory, Methodologies and Applications, (Eds) A. Charnes, W. W. Cooper, A. Y. Lewin and L. M. Seiford, Kluwer, Boston, 329–52.

Malmquist, S. (1953). Index numbers and indifference curves. Trabajos de Estatistica, 4 (1), 209-242.

Marire, J. (2020). Analysis of Changes in Total Factor Productivity for Academic Departments of Historically Privileged Small University in South Africa. European Journal of Business and Management, 12, 10-24.

Mawson, P., Carlaw, K. I., & McLellan, N. (2003). *Productivity measurement: Alternative approaches and estimates* (No. 03/12). New Zealand Treasury Working Paper.

Menga-Mokombi, R. I. (2020). Efficiency of Higher Education in the Republic of the Congo. *Journal of Economics*, *8*(4), 18-27.

Miranda, M. A. T., & Gutiérrez, J. O. F. (2021). Technical Efficiency of Public Universities in Peru. *Industrial Data*, *24*(1), 1.

Mishra, P., Pandey, C. M., Singh, U., Gupta, A., Sahu, C., & Keshri, A. (2019). Descriptive statistics and normality tests for statistical data. *Annals of cardiac anaesthesia*, *22*(1), 67.

Myeki, L. W., & Temoso, O. (2019). Efficiency assessment of public universities in South Africa, 2009-2013: Panel data evidence. *South African Journal of Higher Education*, *33*(5), 264-280.

Nafukho, F. M., Wekullo, C. S., & Muyia, M. H. (2019). Examining research productivity of faculty in selected leading public universities in Kenya. International Journal of Educational Development, 66, 44-51.

Ngobi, K. R., Yawe, B. L. and Dbumba-Ssentamu, J. (2019a). Technical Efficiency of African Public Universities: A Data Envelopment Analysis. European Journal of Business and Management, 11(3), 173-188.

Ngobi, K. R., Yawe, B. L. and Dbumba-Ssentamu, J. (2019b). Total Factor Productivity Growth of African Public Universities: *Journal of Economics and Sustainable Development*. https://doi.org/10.7176/jesd/10-2-16

Odhiambo, G. (2018, December). The role of Kenyan universities in national development. In *FIRE: Forum for International Research in Education* (Vol. 4, No. 3).

Oringo, J. O., & Muia, A. M. (2016). Constraints on research productivity in Kenyan universities: case study of University of Nairobi, Kenya. *International Journal of Recent Advances in Multidisciplinary Research*, *3*(8), 1785-1794.

Osumba, P. O., & Sang, P. K. (2021). Management Science Tools and Operational Efficiency of Public Universities in Kenya. *African Journal of Emerging Issues*, *3*(1), 25-42.

Otiende, W., Omolo, J. W., Thuo, J. K., & Wagude, J. (2024). Influence of Organizational Resources on the Performance of Public Universities in Kenya. African Journal of Empirical Research, 5(1), 311-318.

Sulo, T., Kendagor, R., Kosgei, D., Tuitoek, D., & Chelangat, S. (2012). Factors affecting research productivity in public universities of Kenya: The case of Moi University, Eldoret. *Journal of Emerging Trends in Economics and Management Sciences*, *3*(5), 475-484.

Teichler, U. (2007). *Higher education systems: Conceptual frameworks, comparative perspectives, empirical findings*. Brill.

Temoso, O., & Myeki, L. W. (2023). Estimating South African higher education productivity and its determinants using Färe-Primont index: Are historically disadvantaged universities catching up?. *Research in Higher Education*, *64*(2), 206-227.

Universities Funding Board (UFB) (2023a). Public Universities in Kenya. Retrieved from https://www.universitiesfund.go.ke/public-universities-2/

Universities Funding Board (UFB) (2023b). Funding Framework. Retrieved from https://www.universitiesfund.go.ke/parameters-used-in-the-funding-model/

Universities Funding Board (UFB) (2024). Universities Annual Allocations. Retrieved from https://www.universitiesfund.go.ke/universities-data/

Viverita, V., & Wibowo, S. S. (2007). Efficiency, technological progress and productivity changes in Indonesian State Universities, 2001-2005. In Indonesia Council Open Conference.

Wachira, C. W. (2018). *Effect of Government funding on operational efficiency of public universities in Kenya* (Doctoral dissertation, University of Nairobi).

Worthington, A., & Lee, B. (2008). Efficiency, technology and productivity change in Australian universities, 1998–2003.