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Factors Affecting Efficiency of Public Education Expenditure, Evidence from Ethiopian Public Universities

Mekonnen Mengistie, Ph.D.
Assistant Professor, Head Department of Public Financial Management and Accounting
Ethiopian Civil Service University (ECSU)

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ABSTRACT: This study evaluated how effectively selected Ethiopian public universities use their education budget. The research used a quantitative, explanatory approach with secondary data from the Ministry of Science and Higher Education, the Ministry of Finance, and the universities themselves. The entire population of public universities under MoSHE was the target. The study used Data Envelopment Analysis (DEA) to examine the efficiency of education spending. Data was analyzed using both static and dynamic panel data models. The researchers also used random effect panel data models to pinpoint specific factors that influence efficiency. The findings revealed that most of the universities in the study are relatively efficient when compared to their peers. The study identified university size and instructor workload as key factors affecting this efficiency. The researchers recommend that university administrators learn from their more efficient peers regarding resource management. They also advise the management to proactively manage the factors identified as affecting efficiency.

KEYWORDS: Efficiency, data envelopment analysis.

1. INTRODUCTION

Higher education is vital for a country's economic development by providing the skills and knowledge needed for innovation. Ethiopia's higher education system has grown remarkably since its beginning in 1943, expanding from just two universities in 1998 to 45 today. The government sees education as a crucial tool for reducing poverty and promoting economic growth.

Despite this expansion, Ethiopia's productivity significantly lags behind other developing nations and global averages. A 2022 report found that recent productivity gains are due to increased capital investment rather than improvements in Total Factor Productivity (TFP), which represents efficiency and innovation. According to the ILO, Ethiopia's labor productivity in 2020 was only 40% of the average for Sub-Saharan Africa. This is a major concern for policymakers, as productivity is a key driver of sustainable economic growth. The country's Growth and Transformation Plan II (GTP II) has made improving productivity a key policy goal, acknowledging that growth comes from better labor quality, capital intensity, and TFP growth. The resource-based theory critically initiates improvements in organizational resources. The theory views intellectual capital, physical capital, and financial capital as strategic resources, and their underutilization or ineffective use can affect an organization's efficiency (Venugopal et al., 2018). Therefore, higher education institutions with greater intellectual resources tend to be more efficient than those with fewer intellectual resources. This theory was used to assess the effect of various university programs, the student-to-instructor ratio, and the size of universities on the efficiency level of selected public universities.

According to the resource-based theory by Barnett (2001) and Grant (1991), an institution's resources are the source of its competitive advantage. Additionally, this theory considers intellectual capital as a core resource, and its underutilization or ineffective use leads to institutional inefficiency. From this theory, it can be inferred that universities with better intellectual capital have the opportunity to be more efficient than universities with limited intellectual capital. In line with this theory, the professional mix, proxied by the ratio of instructors with master's degrees and above relative to the total number of instructors in each university, is considered an HEI-specific factor that positively impacts the efficiency of public universities.

A theory that defines efficiency and its measurement is the X-efficiency theory. It is developed by (Button, 1994). It assumes that low productivity can occur because of the focus of the work of top managers; this is a kind of agency problem. As per the concept advocated by Leibenstein (1996) on size and productivity, to a certain point smaller working units are more productive than larger size institutions. This is usually the smaller firm size is everybody should contribute to an output and the chance to avoid a free rider. The result shows that units that are generally supervised are more efficient than those that are closely supervised. In this research, university size is considered as one factor that affects the efficiency level of universities. As per this theory, to a certain size, smaller units are more productive than larger ones and this study measured to what size extent Ethiopian public universities are efficient. In addition to X-efficiency theory, the canon of economy noted that a state needs to be economical in spending money. It should not spend more than the number of items of expenditure required to achieve the desired result. When resources are not wasted and used appropriately, social benefit can be maximized (Shirras, 1925). The second objective of this dissertation is to evaluate the

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efficiency of public universities; this theory noted that institutions need to be economical in spending money and should not use more resources than needed to produce output. In addition; this study used DEA to identify which university uses more input to generate the same output as compared to other universities based on X-efficiency theory notions.

The influential theory that defines efficiency in terms of an economic context is the Pareto optimality theory. Vilfredo Pareto, a nineteenth-century Italian economist and sociologist, introduced the concept of Pareto optimal. It is generally explained as a condition of resource allocation in which an alternative feasible resource allocation that can improve one party's condition without making at least one party worse off does not exist (Foss, 2012). If there is still a way to improve the allocation so that one party can be made better off without deteriorating the condition of the other party, then this current state of allocation is considered Pareto-inefficient. Pareto efficiency thus evaluates resources based on their comparative values against other possible allocations. This research studied the efficiency of public universities according to the Pareto efficiency concept, meaning that a university is labeled as efficient when there is no other university that can produce more output within a given input or the same output with less input. Data Envelopment Analysis (DEA) is employed to evaluate the technical efficiency of selected universities. In technical efficiency analysis, a decision-making unit is Pareto efficient when it scores one and Pareto-inefficient if it scores less than one.

2. FACTORS WHICH AFFECT EFFICIENCY

The main goals of measuring efficiency in the public sector are to pinpoint technical inefficiencies, which involves finding better ways to convert resources into results, and to address inefficiencies in the mix of production factors. To handle the complexities of higher education data, researchers can separate postgraduate students by degree type (e.g., Master's or Ph.D.) or use a dummy variable if that data isn't available. Subject differences can be handled by broadly categorizing postgraduates or by using subject-specific dummies. In this study, efficiency and total factor productivity are measured using clear indicators based on an input-output relationship, where these indicators should also be self-explanatory and cover multiple years to show long-term trends. The two main competing methods for estimating efficiency are parametric Stochastic Frontier Analysis (SFA), which assumes a functional relationship between inputs and outputs, and non-parametric Data Envelopment Analysis (DEA), which creates a piecewise function from observed data without making such an assumption. By grouping these indicators, researchers can better understand cause-and-effect relationships within the education system, providing a valuable management tool for policymakers and a transparent overview for the public.

High-quality higher education is crucial for modern economies, as it develops the advanced skills and human capital necessary for innovation and economic growth. The OECD has studied how higher education drives productivity, noting that countries with a higher percentage of doctorate holders tend to have greater research and development intensity. One popular method for evaluating efficiency in educational institutions is Data Envelopment Analysis (DEA), a technique used by researchers to assess how a set of decision-making units (DMUs) converts multiple inputs into multiple outputs. DEA has been applied in numerous studies globally, with over 30,000 cited articles on the subject, and has been used by various research groups to analyze the productivity of higher education. A key indicator of efficiency in this field is the teacher-student ratio, which is considered a critical factor for both educational quality and cost-effectiveness. The student-instructor ratio is often used in studies to evaluate the efficiency of public universities, as highlighted by a study on government education expenditure in Indonesia (Achmad, Djoko & Lilik, 2017).

The provided text identifies several independent variables that affect expenditure efficiency in universities. These include the university's size (measured by admission capacity), the number of academic programs it offers, the composition of its academic staff by rank, and the student-to-instructor ratio.

Due to their conceptual simplicity and intuitive association with the higher education process, graduation rates are a popular way to measure instructional output and trends. They are a valuable metric for university administrators and funders to gauge whether their "final product" is being produced at the expected rate and on schedule. Graduation rates have parallels in other industries, such as the speed of cars coming off an assembly line or the rate at which bank loans are repaid.

A study by Moreno (2017) examined how various factors influence public expenditure efficiency in developed countries using a Data Envelopment Analysis (DEA) model. The research found a clear relationship between government expenditure efficiency and the state of a country's development.

A study by Barra and Zotti (2016) used Data Envelopment Analysis (DEA) and the Malmquist index to measure the teaching and research efficiency of departments at the University of Salerno from 2005 to 2009. They found that the social science and technology departments were more efficient in research quality, while the humanities and social science departments excelled in teaching. Similarly, Nazarko and Šaparauskas (2014) applied DEA to evaluate the efficiency of 19 Polish universities of technology. Their model used inputs like government subsidies and the number of academic staff, and outputs such as weighted student numbers, international student percentages, and faculty research achievements to conduct a comparative analysis.

In a study by Erkoç (2016), the efficiency of Turkish public universities was measured using a non-parametric method called Data Envelopment Analysis (DEA). The research, which covered the period from 2005 to 2010, calculated the technical and cost efficiencies of these institutions. The model used a specific mix of inputs and outputs to determine these efficiencies. The outputs were defined as the number of full-time undergraduate and postgraduate students, the number of indexed publications per academic staff member, and the total amount of research grants received. The inputs included the total number of academic staff, as well as several expenditure types: labor expenditures (salaries), capital expenditures, goods and services expenditures for daily operations, and total expenditures.

The Growth and Transformation Plan (GTP) was a five-year national development plan in Ethiopia, running from 2010/11 to 2014/15. Its purpose was to help the country achieve the Millennium Development Goals (MDGs) and its long-term vision for development. The plan was built on previous successful pro-poor and pro-growth policies implemented since 1994.

A key objective of the GTP was to expand and improve the quality of education services and meet the MDGs in the social sector. This goal was a major strategic pillar for ensuring rapid, broad, and equitable economic growth.

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In a study by Ghebru and Holden (2014) on Ethiopia's land certification program, researchers examined its impact on agricultural productivity in the Tigray region. They used a Data Envelopment Analysis (DEA)-based Malmquist productivity index to separate productivity changes into two components: technical efficiency gains and technological advancements. The study's key finding was that there was no significant evidence to suggest that productivity differences were due to technical inefficiency. Instead, the low efficiency of farms in each group indicated that the land certification program needed to be supported by complementary measures, such as an improved financial framework, to achieve its promised benefits.

A two-stage study by Selim and Bursalıoğlu (2015) examined the efficiency of 51 Turkish public universities from 2006 to 2010. The first stage used Data Envelopment Analysis (DEA) to measure efficiency, followed by a random-effects Tobit model in the second stage to identify influencing factors. The study found that university efficiency varied, ranging from a high of 47% in 2008 to a low of 35% in 2009. The number of female students was found to have a significant positive effect on a university's relative efficiency.

A separate dissertation by Dong (2010) analyzed the cost efficiency of the Chinese banking sector between 1994 and 2007, using both parametric Stochastic Frontier Analysis (SFA) and non-parametric DEA methods. The average cost efficiency was found to be approximately 91% using the SFA model, while the DEA and a "New DEA" model yielded average efficiencies of about 89% and 87%, respectively.

Selim and Bursalıoğlu (2015) conducted a two-stage study on the efficiency of 51 public universities in Turkey between 2006 and 2010. The first stage used Data Envelopment Analysis (DEA) to measure the universities' bootstrapped efficiency. DEA is a method commonly used to evaluate the performance of various organizations, including hospitals, banks, and schools, by comparing the ratio of their weighted outputs to their weighted inputs. The study found that the efficiency of Turkish public universities fluctuated during the period, ranging from a high of 47% in 2008 to a low of 35% in 2009, with average efficiencies of 37% in 2006 and 2010, and 39% in 2007.

A study by Anyanwu and Erhijakpor (2007) analyzed panel data from several African countries between 1990 and 2002 to determine the relationship between government education expenditure and school enrollment rates. The research found that increased government spending on education had a positive and significant direct effect on primary and secondary school enrollment. However, the study also concluded that spending alone is not enough to achieve high-quality human capital.

3. CONCEPTUAL FRAMEWORK

In the process to construct the conceptual framework, various theories and empirical studies have been used. The major sources for this conceptual framework are presented as follows.

Research by Wolszczak-Derlacz (2011) on Efficiency of European public higher education institutions a two-stage multicounty approach was made to scrutinize efficiency and its factors in higher education institutions using a two-stage data envelopment analysis. Economies of scale, number and composition of faculties, sources of funding, and gender staff composition were among the main determinants of higher education efficiency identified. Yun (nd) discussed the assistance of education expenditure towards the growth of labor productivity under the Ordinary Least Square (OLS) estimation. The empirical result suggested that the relationship between productivity and government spending on education is positive and statistically significant. Thorbecke (2003) indicated that the increase in public education expenditure can contribute to economic growth and poverty alleviation. Chen (2009) examined the effects of public education expenditures on economic growth. The authors investigated the relationship depends on the government spending level, tax structure, and parameters of production technologies. As per Cummins & Santomero (1999) and Cummins, Weiss & Zi (1999), there are many reasons for technical inefficiency. If a company is operating at an inappropriate size (either too small or too large) it is termed as scale inefficient. While a company using its inputs and outputs in wrong proportions is termed as mix inefficient.

Mainly the conceptual framework is taken from Daghbashyan (2011) and Coelli (1996). To analyze the effect of factors on universities' education expenditure efficiency; a variable used by Daghbashyan, was adopted. According to Daghbashyan the exogenous variables affecting the activity of HEI are categorized into HEI-specific factors and staff-specific factors. The study investigates the efficiency of Sweden higher educational institutions to analyze the factors that affect the efficiency of universities. Higher educational institution's specific factors such as the size of universities, instructor’s load, instructors and student characteristics as well as government allocations are suggested to be the potential determinants of universities' efficiency.

In studying, factors that affect university education expenditure productivity; Coelli (1996) was used. As per Coelli, total factor productivity change is decomposed into efficiency change, technical efficiency change, scale efficiency change, and pure efficiency changes. All these variables have been used to see the effect on total factor productivity change.

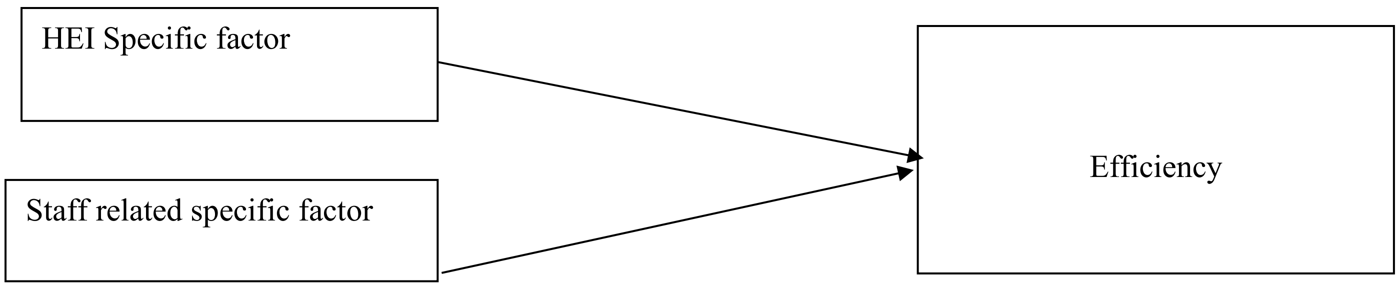

Figure 1 Conceptual framework
Source: Adapted from (Daghbashyan, 2011)

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The above conceptual framework firstly identifies the variables that affect government expenditure efficiency. The efficiency, the dependent variable which shows the optimal relationship between inputs and outputs was measured using DEA. The major inputs used to measure efficiency were labor, intermediaries, and capital expenditures, and also several graduates in undergraduate programs and the number of graduates in postgraduate programs were considered as output. Some of the exogenous factors are Higher education-specific factors and staff-specific factors. Higher education-specific factors and staff specific factor are the independent variables which were used in this research to test their effect on Ethiopian universities expenditure efficiency.

In this study efficiency is the relation between input and output. The selected inputs to assess efficiency are types of university expenditures; such as personnel expenditure (labor), goods and service expenditure (intermediaries), and fixed asset expenditure (capital). The outputs are the number of graduates in undergraduate programs and the number of graduates in postgraduate regular programs of public universities. The framework presented institution aspects and staff factors that affect the productivity of universities.

4. METHODS

The research used a mixed-methods approach, combining qualitative interviews to address the first research question on university performance with quantitative data to measure efficiency and productivity for the remaining five questions. The study's design was both descriptive, used to analyze policy documents and practices at MoSHE and the universities, and explanatory, with a concurrent triangulation design applied to provide a detailed analysis of factors affecting education expenditure efficiency. The target population included all 45 public universities under MoSHE, with data collected from the entire population for secondary analysis and from key officials at MoSHE and the Ministry of Finance for qualitative interviews. Ultimately, the study relied on both primary and secondary data from four sources: the universities themselves, MoSHE, the Ministry of Finance, and the Ethiopian Plan and Development Commission.

In addition to the main input-output variables used for efficiency analysis, other exogenous variables that affect universities' expenditure efficiency and productivity have been studied in this research. The following variables which affect higher education efficiency have been adapted from Daghbashyan (2011). Accordingly, the exogenous variables affecting the activity of Higher education institutes (HEI) are categorized into higher education-specific factors and staff-specific factors. The study investigates the efficiency of Sweden higher educational institutions to analyze the factors that affect the efficiency of universities. Stochastic frontier analysis was applied. Higher educational institutions' specific factors such as the size of universities, instructor's load, instructors and student characteristics as well as government allocations are suggested to be the potential determinants of university efficiency.

Ho1: the size of public universities does not affect the expenditure efficiency

Ha1: Public Universities Size affects the level of efficiency of public universities

According to Shakeout theory, smaller institutions are unable to collect sufficient capital compared to larger ones because they lack management ability which implies a positive relationship between size and performance. The other theory, divisibility theory contradicts in a way that there is no relationship or there is a negative relationship between size and efficiency because if the technology is divisible, the larger the institution will have no operational advantage when compared with the small ones as they will be able to provide service at cost per unit output.

This hypothesis was formulated to test which of the above theories are valid in the Ethiopian public university's context.

Ho2: Share of academic rank in university teachers do not affect the efficiency of university expenditure

H_a2: Share of academic rank in university teachers affects the efficiency of university expenditure

Ho3: Low student to instructor ratio has no relationship with the expenditure efficiency of a public university

Ha3. Low student to instructor ratio has a positive relationship with the expenditure efficiency of a public university

The student-instructor ratio is also considered as one staff-specific factor which can affect the efficiency levels of a public university.

Ho4: Numbers of programs in the university has no relation with the efficiency of university expenditure

Ha4. The numbers of programs in the university have a strong relationship with the efficiency of university expenditure

Academic program expansions in universities aim to fulfill the various needs of the economy with the required fields/ programs that demanded economic development. In addition, the increase in the number of programs in a university leads to an increase in the total number of universities and this may also lead to high administration expenditure. The higher the administration expenditure may also cause the lower in the efficiency negatively.

The above hypothesis was formulated to test whether the expansion in academic programs affects efficiency adversely or positively.

Even though there are many indicators of productivity, the number of graduates is one important output that all academic institutions produce. Graduation rate represents one broad measure to represents one key accountability indicator (Leveille, 2006); (Titus, Vamosiu, & McClure, 2017). Two-stage DEA analyses firstly measure the efficiency level of universities using input and output and then it analyzes the sources of inefficiency in the second stage. For this research question; the efficiency result (dependent variable) is taken from the above efficiency study result generated from the DEA model.

The sources of inefficiencies' (independent variables) may be environmental or institutional. The environmental variables that are used to study this research question were classified as higher education-specific factors and staff-specific factors. Higher education-specific factors are university size (proxied by the number of full-year equivalent students), Number of academic programs which can be measured by several departments or programs offered by universities. The teacher with Student ratio is used to measure the degree of human resource input in terms of teachers with the size of the student population. Similarly, staff specific factors are instructor level of education measured by the number of full-time professors, associate professors, assistant professors, and lecturers relative to total instructors in each university and instructors' level of education which is measured by the percentage of full-time staff or ratio of full-time academic staff to all academic staff, percentage of professors among academic staff (it is the ratio of professors to all academic staff).

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The dependent variable is the efficiency of public universities measured in the Malmquist productivity index model used in research question number two.

$$\max\theta = \beta o + \beta 1UNSZ + \beta 2NPU + \beta 3ILE + \beta 4INSL$$

$\max\theta$ - Efficiency of public universities as measured by the DEA model in research question number one
β_o- constant variable to be determined from the regression results of variables that will be used in this specific equation
$\beta 1$ and $\beta 4$ are coefficients in respective variables defined hereunder
UNSZ- Stands for the size of universities measured by the ratio of the number of regular students of a university to the total number of regular university students
NPU - Number of academic programs in a university
ILE – instructor level of education measured by the number of full-time professors, associate professors, assistant professors, and lecturers and relative to total instructors in each university
INSL – instructor load measured by the ratio of students with instructors
To analyze the effect of factors that affect education expenditure efficiency; panel data random effect model and Stata 16 software were used.
Computer software like DEAP 2.1 is used for data computation and analysis purposes. In this study DEA model is used to analyze the efficiency of 22 universities in ten years. To analyze the total factor productivity change, the Malmquist productivity index was applied.
Efficiency of public universities expenditure was analyzed using Data Envelopment analysis by BCC models with a variable return to scale assumption. The DEAP 2.1 application software was used to compute various efficiencies. Regarding the question related to the performance measurement practice of the ministry of higher education and universities selected for this study, descriptive data analysis techniques were applied.
The other research questions like the exogenous factors which affect efficiency, factors that affect total factor productivity change, and determining the contribution of program expenditures on the efficiency, were regressed by multiple regressions model.
Stata 16 has been used to regress data for analysis and to examine the existence of predicted relationships among the independent variables and dependent variables.
In this research; output-oriented variable return to scale Malmquist DEA analysis was used. Output-oriented means maximization of output with a given input. The output-oriented assumption is selected because public universities are given limited resources and are expected to increase output in a given input. The variable return to scale model will be used with the understanding that in public universities, there is no constant return to scale, which means the increase in input may not increase output proportionally. Malmquist productivity index is an extension model of data envelopment analysis (DEA), which is used to measure efficiency analysis (ten years) panel data.
The study used panel data for the study period from 2015 to 2023 about the defined input and output variables from selected public universities and one-year cross-sectional primary data was gathered through interviews.

5. RESULTS AND DISCUSSIONS

In this section, the factors which affect the expenditure efficiency of public universities are analyzed. Panel data regression analysis was used to study the effect of the variables on the expenditure efficiency of public universities resulted from the data envelopment analysis model.
In analyzing determinants of efficiency; a Zara D. (Daghbashyan), a conceptual framework was used in this study. According to Zara D. (Daghbashyan), the exogenous variables affecting the activity of HEI are categorized into HEI-specific factors and staff-specific factors. Higher educational institutions specific factors such as the size of universities, instructor's load, instructors and student characteristics as well as government allocations. In addition, HEI specific factors, such as higher education size (proxied by the number of full-year equivalent students), load per teacher, defined as the ratio of full-time student equivalent to the number of teaching and research personnel and staff specific factors such as the share of professors in teaching research personnel.
The following random effect panel regression model regressed the relationship and the effect of exogenous variables on the efficiency of public universities.

6. PANEL DATA REGRESSION MODEL

To run the panel data regression a strongly balanced (no missed data) 10 year and 22 universities data were analyzed using Stata 16.
In panel data model analysis, there are static and dynamic models. There are three types of static models in longitudinal/panel data regression analysis. These are pooled regression models; which pooled all observation (number of universities) together and run the regression by neglecting cross-section and time-series nature of data. This model does not consider the heterogeneity that may exist among universities. It believes that there are no unique characteristics across sections (universities) and also it assumes no universal effect across time.
The fixed effects model accounts for the unique, unobserved characteristics of each entity (like a university in this case). It does this by giving each entity its own unique intercept value in the model. The key assumption is that these unique features do not change over time and are not correlated with the dependent variable. In essence, it captures what makes each university different from the others, assuming those differences are constant throughout the study period.
The random effects model assumes that all universities share a common average intercept value. It treats the individual differences between universities as random deviations from this common mean. The core assumption here is that these unique, time-constant features of each university are not correlated with the independent variables in the model.
The second category of a panel data model is the dynamic panel data model. It takes into consideration both unobserved time-specific effects as well as unobserved grouped effects. This model is usually considered appropriate when there is a relationship between the prior period results with the current period.
In this research first, the static panel data model was applied, and to get a comparative result dynamic panel data model was also used.

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7. THE BREUSCH-PAGAN LAGRANGE MULTIPLIER (LM) TEST

The Breusch-Pagan LM test is used to decide between a random effects model and a simple pooled OLS (Ordinary Least Squares) regression.

- Null Hypothesis (H0): The variance across different entities (in this case, universities) is zero. This implies there is no significant difference between the universities and no panel effect.
- Alternative Hypothesis (H1): The error variances are a multiplicative function of one or more variables.

If you reject the null hypothesis, it means there is a significant random effect, and the random effects model is a better fit than the pooled OLS. If you do not reject the null hypothesis, pooled OLS is the preferred model. The LM test helps determine if a panel data model is necessary at all, specifically contrasting the random effects model with the pooled OLS.

F-Test for Fixed Effects

The F-test for fixed effects is used to compare a fixed effects model with a pooled OLS regression. This test determines whether the fixed effects model significantly improves the model's goodness-of-fit.

- Null Hypothesis (H0): All of the individual-specific intercepts (ui) are equal to zero. This would mean there are no unique, time-invariant differences between the entities.
- Alternative Hypothesis (H1): At least one of the individual-specific intercepts (ui) is not zero.

The provided example shows an F-test result of $F(21, 152) = 2.66$ with a p-value ($Prob > F$) of 0.0003. Since this p-value is less than the typical significance level of 0.05, the null hypothesis is rejected. This indicates that the fixed effects model provides a significant improvement over the pooled OLS model, so the fixed effects model is the preferred choice. The F-test helps decide whether the fixed effects model is a better fit than a simple pooled OLS regression.

In summary, the LM test helps decide between a random effects model and a pooled OLS, while the F-test compares a fixed effects model to a pooled OLS.

Breusch and Pagan Lagrange multiplier test for random effects

Estimated results	Variance	Standard deviation
Efficiency	.0353595	.1880412
E	.0272352	.165031
U	.0028569	.0534497
Test: Var(u) = 0 chibar2(01) = 4.34 Prob > chibar2 = 0.0186		

When we observe above Breusch and Pagan Lagrange multiplier test for random effects; the probability values are less than 5%. This indicates that we should reject the null hypothesis in favor of the random effect model ($p < .0186$).

8. HAUSMAN 1978 TEST

To check which model is suitable for this study (fixed or random effect model); the Hausman test was applied.

To run the Hausman test, a hypothesis needs to be developed first:

Ho: random effect model is appropriate

Ha: fixed effect model is appropriate

Hausman fixed effect:

Hausman (1978) specification test

	Coef.
Chi-square test value	3.102
P-value	.541

If the p-value is statistically significant; a fixed effect model will be used, otherwise a random effect model is suitable for the study. In the Hausman 1978 test result on the above table; the p-value is 0.541. This is above .05 p-value. According to this result, the null hypothesis was not rejected, meaning that the random effect model is appropriate for making determinants of efficiency analysis. Accordingly; the random effect model is applied in this research.

9. POST ESTIMATION RESULTS OF RANDOM EFFECT MODEL

Serial Correlation Test

Serial correlation tests are typically used for macro panels with long time series (over 20-30 years) and are generally not a concern in micro panels, which have very few years of data. When present, serial correlation can lead to smaller standard errors and a higher R-squared value than is accurate. A constructed hypothesis to test serial correlation

H0: there is no serial correlation

Ha: there is a serial correlation

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Pesaran CD Test Result

Pesaran's test of cross-sectional independence = 0.597, Pr = 0.5503

The average absolute value of the off-diagonal elements = 0.285

According to the above Pesaran CD test result, the p-value is greater than 0.05 (Pr = 0.5503). This implies that we fail to reject the null hypothesis. Meaning that there is no serial correlation, which is desirable in a good model.

According to (Baltagi, 2005) in a small panel data; heteroscedasticity and autocorrelations are not usually a problem. To correct the effect of heteroscedasticity and autocorrelation problems; panel data robust random effect was applied and it assumed that the problems are solved.

Table 1 Panel Data Robust Random Effect Model Regression results

Efficiency	Coef.	Robust St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
UNSZ	1.791	.802	2.23	.026	.219	3.364	**
INSL	.011	.004	2.53	.012	.002	.019	**
NPU	.00041	0	1.76	.078	0	.001	*
ILE	-.029	.012	-2.36	.018	-.053	-.005	**
Constant	.592	.073	8.08	.000	.449	.736	***
Mean dependent var	0.837		SD dependent var		0.188		
Overall r-squared	0.172		Number of obs		220.000		
Chi-square	44.999		Prob > chi2		0.000		
R-squared within	0.051		R-squared between		0.500		

**** p<.01, ** p<.05, * p<.1*

Source: Stata 16 result, 2020

UNSZ – stands for university size

INSL stands for instructor load

NPU- stands for a number of programs in a university

ILE- stand for instructor level of education

R squared (R^2)- defines that to what level dependent variable is explained by the independent variables. The R^2 in this model indicates that the efficiency of public universities is explained by the size of the university, instructor load, and instructor level of education uniquely. In addition; the F statistics of p-value is 0.0000. According to the result, the model is fit. Since P-value is less than 0.05, which is considered as the model is fit and all the independent variables are jointly defined.

There are two types of factors that influence the activity of Higher Education Institutions (HEIs): HEI-specific factors and staff-specific factors. The former includes the size of the institution, which can be measured by the number of full-year equivalent students, and the load per teacher, which is the ratio of full-time student equivalents to teaching and research staff. The latter category, staff-specific factors, relates to the composition of the academic workforce, such as the proportion of professors within the teaching and research personnel. To remove the heteroscedasticity effect on the model, panel data regression robust was used.

HEI-specific factors, such as higher education size and load per teacher are presented in the above model. As per the above regression result; the p-value of the size of universities (UNSZ) is .0258, which is less than 0.05. This indicates that the size of universities affects the efficiency of universities. This implies that a unit increase size of public universities increases the efficiency of a public university by 1.791. In the same table, the coefficient of the size of universities (UNSZ) is 1.791, meaning that the efficiency and size of the university have a positive relationship. Organizations are not able to mobilize resources easily like of big companies since they lack management ability. Due to this, the size of an institution has a positive impact on efficiency of an institution.

This result is in line with a study by Evanoff and Israilevich (1991) and Casu and Girardone (2006). As per a study by Evanoff and Israilevich (1991), larger institutions may have more professional management teams which are more efficient in resource management, thereby resulting in a higher result. In addition; according to Casu and Girardone (2006) big organizations may have experienced economies of scale from expansion in size. But this result is in contrary to a study by Delis and Papanikolaou (2009). They concluded that larger institutions are more complex and therefore more difficult to manage. Hence, bureaucratic problems may exist in large institutions that may lead to less efficient operating outcomes. Analysis of the relationship between size and university efficiency provides useful information for regulators and allows university presidents and management at a different level to assess the optimal scale at which to conduct their major functions.

In the case of instructor load (proxied by the ratio of a number of students to instructors), the variable has a positive relationship by a coefficient of 0.011, and the p-value is 0.012, which is significant at a 5% level. This shows the instructor load and university expenditure efficiency have a positive relationship as the coefficient is positive (0.011). In addition; it can be inferred that instructor load has a significant effect on the efficiency of a university in the case of Ethiopian public universities selected for this study since the p-value is less than 0.05. Accordingly, it can be inferred that the increase in instructor load by one unit, increases the public universities' technical efficiency by 0.011. In the above model result; the two-tail p-value for instructor load is less than 0.05 and this shows the instructor load variable uniquely affects the dependent variable, technical efficiency of public universities. Even if instructor load has a positive effect on technical efficiencies of public universities, the coefficient is too small (0.011) and from this, it can be concluded that the instructor load affects the technical efficiency of universities weakly.

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To analyze the effect of a staff-related factor on efficiency, the education level of the instructor is included in the model. As per the regression result above, the p-value of instructor level of education (ILE) is 0.0180 and thus significant at 5 percent. The coefficient value of instructor level of education to university technical efficiency is negative (-0.029). which affects the efficiency of public universities?

It can be inferred that the increase in the level of university instructor's level of education leads to the decrease in the efficiency of universities. As per the table; one unit increase in instructors' level of education leads to a decrease by -0.029 in the public universities' technical efficiency. This may be due to the increase in the salary of instructors when their level of rank increase from one level to another. According to the higher educational institution salary scale, change in rank provides an increase in a salary of more than 15% change in average from rank to rank. As per the above result; it can be inferred that the increase in instructors' level of education is not substantiated in an increase in output in Ethiopian public universities. As per the other researcher's result, usually, the increase in the number of professor's shares is the decrease in inefficiency.

According to Ethiopian public universities from 2015 to 2023; large program expansion was observed to generate sufficient professionals in various disciplines. This dissertation analyzed the effect of this program expansion practice on the efficiency of public universities. To study the effect of program expansion on efficiency; a ten-year number of programs were collected from 22 universities.

As per the panel data regression result on the above table; the coefficient of the number of programs to technical efficiency is positive but too small (0.00041) moreover, the p-value is 0.078, which is above 0.05 level of significance, but significant at 0.10 level. It was assumed that the increase in the number of programs in a university, increases the cost of administration and it was expected to have high-cost inefficiency unless it is substantiated by a proportional increase in output from the programs. However, as per the F- statistics result in the above model, the p-value above .05 level of significance, this shows some program expansion in universities do not have a significant effect on the technical efficiency of universities.

10. DYNAMIC PANEL DATA MODEL RESULT

The dynamic panel data model offers some advantage in comparison to the static version (fixed effect and random effect). It addresses the heterogeneity of individuals and also several instrumental variables. According to Baltagi, short panels, which use a large number of individuals (22 universities in this case) and a short period (10 years) are advised to use a dynamic panel data model.

In addition to the previous static version of the panel data model, analysis is made based on a dynamic panel data model for comparing the results and investigating the difference. The result is presented in the following table.

In dynamic panel data; to test the effect of the previous year's efficiency over this year's efficiency; the lagged dependent variable (lag. Efficiency) is used as an additional independent variable.

Table 2. Dynamic Panel Data model Random Effect Model Regression Result

Efficiency	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
L.Efficiency	.205	.065	3.13	.002	.076	.333	***
UNSZ	1.879	.916	2.05	.04	.084	3.673	**
NPU	0	0	0.92	.356	0	.001	
INSL	.008	.004	2.15	.031	.001	.015	**
ILE	-.038	.015	-2.50	.012	-.067	-.008	**
Constant	.478	.074	6.45	0	.333	.623	***

Mean dependent var	0.837	SD dependent var	0.184
Overall r-squared	0.227	Number of obs	198.000
Chi-square	56.511	Prob > chi2	0.000
R-squared within	0.039	R-squared between	0.741

**** p<.01, ** p<.05, * p<.1*

Mainly it is believed that the one-period performance of an organization may have a positive or a negative effect on the current or future period performance. In a similar assumption; previous period efficiency results may affect the current efficiency performance of a university. To accommodate the previous year's effect of performance over this year's performance; in addition to the static panel model, a dynamic panel data model has been used.

As per the above dynamic panel data model result presented above; r- square result is 0.22 which shows that an improvement from 0.17 to 0.22. F-statistics p-value of the model is 0.000, which is significant and this dynamic panel model also fits to interpret the result of the model. Like results obtained in the static panel model, the independent variables such as the firm size of university (UNSZ), instructors load (INSL) and instructors' level of education (ILE) all mentioned variables are found significant at 0.05 level of significance. In addition, similarly, with the static model result; the firm size of university (UNSZ) and instructors load (INSL) have a positive effect on the efficiency of public universities and instructor level of education has also observed a negative and significant effect on the efficiency of public universities; this is also similar result as compared to the static panel data model. in this dynamic panel data model, a slight difference noticed was the magnitude of coefficients value, which shows some variables like the firm size of a university and instructors' level of education shows an increase whereas others show decline as compared to the static panel data model.

In the above dynamic panel data model, the newly introduced lagged dependent variable which is lagged total factor productivity change shows a p-value less than 5%, which is significant at a 0.5 level of confidence. This indicates that the previous period efficiency result affects the current or the future period performance.

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Even though the p-value of lagged dependent variable is significant at 0.05 level and this also ensures the presence of an effect of the previous dependent variable over the current period, the overall result is found similar between the static and dynamic models. This shows that the model used to analyze is fit and the accuracy of variables is validated.

These research major findings are mainly consistent with the following research result like Longe (2003) who made a study on factors which affect; teacher/student ratio mentioned as a core indicator of efficiency. It was also noted in a study by Achmad, Djoko & Lilik (Kamaruddin et al.) on Efficiency and Effectiveness of Government Expenditure on Education at East Java, Indonesia, the ratio or the number of teachers per student was used to evaluate the efficiency level of universities. Similarly, as per Zara Daghbashyan (Daghbashyan); the exogenous variables affecting the activity of Higher education institute (HEI) such as the size of universities, instructor's load, instructors and student characteristics as well as government allocations were identified as positive determinants of universities efficiency.

As per the major finding on factors that affect efficiency; all variables considered as independent variables show consistency with the above-mentioned study result except instructors' level of education. It was assumed that the increase in the level of education in instructors has a positive contribution to inefficiency. In contrary to another study result, instructor's level of education has a negative significant effect on Ethiopian public universities efficiency performance. As per this researcher's understanding; the increase in professional-level increases to pay more benefit to instructors but it can be inferred that the salary increase was not supported by instructors' level of efficiency.

Summary of Hypothesis Testing on factors which affect education expenditure efficiency

As per the above regression result; the following hypothesis was tested:

Ho1: Public University's size does not affect the level of efficiency of public universities

Ha1: Public Universities Size affects the level of efficiency of public universities

According to the above robust panel regression model result, the coefficient of university size to the efficiency of universities is 2.611 at p-value 0.000. This shows that public universities' size affects the level of efficiency of public universities positively. The null hypothesis is rejected.

Ho2: Numbers of programs in the university has no relation with the efficiency of university expenditure

Ha2. Numbers of programs in the university has strong relation with efficiency of university expenditure

In the regression result; the coefficient of a number of programs, shows a positive .00041; which shows a slight positive effect on efficiency, but the p-value is above 0.05. This is insignificant at the 0.05 level. This regression model implies that no evidence shows the expansion of programs affects the efficiency of public universities.

The null hypothesis was not rejected, meaning university program expansion does not affect technical efficiency.

Ho3: instructors' level of education in a university affects the efficiency of university's expenditure negatively

H_a3: Instructor's level of education in a university affects the efficiency of university expenditure positively

In the random effect model regression result above, the coefficient of academic rank to the efficiency of public universities is -.0280. This indicates that the higher the instructor's level of education affects the efficiency of public universities adversely, even if the coefficient is weak. The null hypothesis was not rejected.

Ho4: high student to instructor ratio has a negative effect on the technical efficiency of a public university's

Ha4. High student to instructor ratio has a positive relationship with the expenditure efficiency of a public university

In the above panel data random effect model result, the coefficient of instructor load to efficiency is 0.010. This shows that the increase in student to instructor ratio increases the efficiency of public universities. The null hypothesis was rejected.

11. CONCLUSION

Larger public universities tend to be more efficient, while the number of academic programs offered has no significant impact on efficiency. The study found that university size has a significant positive effect, with a coefficient of 2.611 and a p-value of 0.000. This suggests that as universities grow, their efficiency improves. Conversely, the number of programs had a very small, statistically insignificant positive effect (coefficient of 0.00041), indicating that simply adding more programs doesn't make a university more efficient.

An instructor's level of education (academic rank) was found to have a statistically significant negative effect on efficiency, with a coefficient of -0.0280 (p-value of 0.0200). This suggests that a higher proportion of instructors with advanced degrees and ranks is linked to decreased efficiency. The study hypothesizes this is because the increased salary costs of a highly educated faculty are not being matched by a proportional increase in university output, leading to lower expenditure efficiency.

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26) *Note: The entries for Adema (2001), Daghbashyan (2011), Dong (2010), Foss (2012), Gul et al. (2014), Henderson (2003), Hibbert et al. (2013), and Trow (2007) were incomplete in the provided list. I have formatted them as well as possible based on the available information.*

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