

Total Productivity Growth in the Private Universities in Republic of Yemen Using Malmquist Productivity Index

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Abstract:- This paper aims to evaluate the total productivity growth of (18) Private Universities in Republic of Yemen. The performance of the Private Universities is specified on the Total Factor Productivity Change (TFPCh) and Technical Efficiency Change (EffCh). Output orientated DEA-Malmquist index was used to assess the productivity growth of (18) Private Universities in two academic years (2012/2013) and (2013/2014) and was used two input variables (number of enrolled students in Bachelor and number of Teaching Staff) and one output variable (number of graduated of students). The results showed that (10) private universities achieved remarkable positively growth in Malmquist Index for Total Factor Productivity and (12) Private Universities or (66.67%) attained positively growth in Technical Efficiency Change (EffCh). The Technological Change Index showed that (4) Private Universities only showed a technological progress.

Keywords:- Total Productivity Growth, DEA, Malmquist Productivity Index.

I. INTRODUCTION

Education represents the gate that the society goes ahead towards improving and developing the manner of his life. Higher education (HE) grew quickly from an elite to a mass system. Higher education (HE) plays an essential role in an economy, by promoting economic growth, increasing productivity and contributing to social cohesion (Kosor, Maja Mehaljevic & et al, 2019: 396).

Higher Education Institutions (HEI) must draw from leading operational and administrative practices to better leverage institutional capabilities, streamline processes, and reorganize to satisfy demands for new modes of delivering education and services.

Private Higher Education (PHE) comes in Republic of Yemen a result increasing demanding of higher education (HE), accedes the needs of community and demands of the labor market. There are (38) Private Universities and Higher Institutions in Republic of Yemen in 2013/2014. (Supreme Council Educational Planning, 2015: 49).

Productivity management in (HEIs) is the effectiveness using for all resources (inputs) to achieve limited objectives and optimum productivity (outputs) in limited time.

Therefore, there is always controversy about measurement of productivity in Higher Education Institutions (HEIs).

Productivity growth in Higher Education Institutions (HEIs) is the only way to achieve an average of a positive economic developing on the long-term and it is a critical source for improving internal process of education levels and productivity efficiency.

This paper aims to measure total productivity growth of (18) private universities in Republic of Yemen by using the output orientated DEA-Malmquist index in estimating the productivity growth from data of (18) private universities in two periods of time 2012/2013 and 2013/2014 academic years.

II. METHOD

➤ Data Envelopment Analysis (DEA):

Data envelopment analysis (DEA) is a non-parametric modern Quantitative Methods approach for evaluating and measuring the productivity of a group of related entities in order to make the best decision (Budair, 2021a:249).

DEA is a mathematical linear programming approach based on the technical efficiency concept (TE), it can be used to measure and analyze TF of deferent entities: productive and non productive, public and private, profit and nonprofit seeking firms. DEA is non parametric approach that calculate efficiency level by doing linear program for each unit in the sample (Al- Delaimi & al-Ani ,2006).

The DEA models used for efficiency calculation may have constant returns to scale (CRS) or variable returns to scale (VRS), with the goal of minimizing inputs or maximizing outputs. The most basic forms of DEA are CCR (Charnes, Cooper and Rhodes) and BCC (Banker, Charnes and Cooper (Budair, 2021a:250).

DEA measures the efficiency of the decision making units (DMUs) by the comparison with best producer in the sample to drive compared efficiency. DEA submits subjective measure of operational efficiency to the number of homogenous entities compared with each other, through a number of samples unit which form together a performance frontier curve envelopes all observations. So, this approach called Data Envelopment Analysis (Battal, Ahmed H. & et al, 2013:41).

➤ *DEA-Malmquist Productive Index:*

Malmquist productivity index is a useful technical tool to measure total productivity of (HEIs), and this technique allows partition the productivity growth components to its resources and the possibility of using multi inputs and outputs at the same time for those educational institutions (EIs).

Malmquist productivity index is a non-parametric approach to analyze the change in Total Factor Productivity (TFP) between two time periods or two educational institutions or more, and this approach depends on calculating the distance ratio between the periods of the structure and compare them on the distance function.

$$M_0(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \times \left[\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D_0^t(x^t, y^t)}{D_0^{t+1}(x^t, y^t)} \right]$$

- M_0 = Malmquist productivity Index,
- D_0 = Distance function,
- (x^{t+1}, y^{t+1}) = represents the production point of the productivity,
- (x^t, y^t) = relative production point of the productivity,
- t = period of benchmark technology,
- $t+1$ = the next period of technology,
- function $\frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^t, y^t)}$ represents the Technical Efficiency
- $D_0^t(x^t, y^t)$
- Change Index (TEC),
- And function $\frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})} \times \frac{D_0^t(x^t, y^t)}{D_0^{t+1}(x^t, y^t)}$ represents

Technology Efficiency Change Index (TECH), which the Total Factor Productivity Change (Malmquist Index for productivity) consists of from the following rule:

➤ *Total Factor Productivity Change (TFPCh) = Technological Change (TEChCh) X Technaical Efficiency Change (EffCh).*

And the Technical Efficiency Change (EffCh) Index consists of two essential elements: Pure efficiency Change (PECh) and Scale Efficiency Change (SECh).

➤ *Technical Efficiency Change (EffCh) = Pure efficiency Change (PECh) X Scale Efficiency Change (SECh).*

Equation above presents the components of the Malmquist index. The equation on the right represents the efficiency change (EC), which is the distance function from period t technology to period $t+1$ technology, using input and output quantities. The equation inside the bracket represents the technical change from period t to period $t+1$. The Malmquist index is composed of geometric means of two output-based Malmquist index from period t to period $t+1$. Geometric means are used because DEA does not account for measurement noise. In the Malmquist index, all values are ranged from 0 to 1.

DEA-Malmquist Index measures the changing of the *Total Factor Productivity* (TFP) between two time periods or two organization or more, this index depends on calculating the distance percentage between the basis period and comparing on the distance function, and shows those institutions are operating on the efficient frontier. A value greater than one (>1) using Malmquist Index indicates a positive improvement while a value lesser than one (<1) indicates a decline in an institution's performance over the period or denotes deterioration in performance. A constant (1) value means no improvement in performance or change in productivity of the private universities.

III. PRODUCTIVITY

➤ *Production:*

The production in the Higher Education represents that process in which accomplishes transforming the available resources (the inputs) in the universities (institutions) to qualified graduated students who have high scientific qualifications (the outputs).

➤ *Productivity:*

"Productivity" _in general_ means the optimum using and with high degree of the efficiency and effectiveness for those available and different production factors, like; working, capital, natural resources, and other inputs.

➤ *Total Productivity:*

The researcher showed "*Total Productivity*" is the finality eventuation for the output as all and incoming produce elements in formatting the product during limited time. (Budair, 2021c: 11).

Total Productivity for producing factors which measures the effectiveness' used resources_not only its quantity_ and measures total efficiency in any economy that using for workers, capital, and varied elements like; Technology. (Lazaer, 2018:11).

➤ *Productivity Efficiency:*

The ability of the institution for exploiting its available resources and possibilities during the inputs and outputs without overproducing or decreasing to produce the optimum performance (Budair, 2021b: 77).

IV. DATA AND RESULTS

The data which have been used in this paper have been taken from the Supreme Council for Education Planning in Ministerial Presidency for the two academic years 2012/2013 and 2013/2014. The Input variables are number of enrolled students and number of academic teaching staff. The Output variable is graduated students. DEAP software has been used for analyzing the data.

DEA-Malmquist (output-orientated) method is employed to decompose the total factor productivity change (TFPCh) into technological change (TECHCh) and technical efficiency (EFFCH). Technical efficiency is further

decomposed into scale efficiency (SECh) and pure efficiency change (PECh).

Table No. (1) shows the list of Private Universities in Republic of Yemen with five Malmquist indices. (See Below).

Table No. (1) shows that there is a Technical Efficiency Change (EffCh) in all private universities (Science & Technology, Yemenia, National, Saba, Al-Eyman, Shar'eia Sciences, Future, Modern Science, Azal for Science & Technology, Arabia for Science & Tech, Yemenia & Jordanian, and Al-Hekmah) and the percentage of the Technical Efficiency Change (EffCh) of those private universities came as the following: (21.6%, 20.8%, 9.2%, 16.4%, 28.2%, 33.9%, 41.9%, 34.4%, 9.2%, 88.8%, 35.9%, 66.6%) respectively. Where declined (Arwa Queen, Al_Ahqaf, Alandalos, International Lebanese, and Dar Al_Salam Science & Tech), and the regression percentage came (42.2%, 6.1%, 28.6%, 29.5%, 10.6%) respectively, where Al_Nasser university is the only university that got the value (1) so doesn't need improvement or decreasing. The geometric mean for the (EffCh) came (1.114).

Most of Private Universities scored regression in Technological Change (TECHCh) reached the percentage (0.05).

In Malmquist Index for Total Factor Productivity (TFPCh) for the academic years (2012/2013) and (2013/2014) the results came that the private universities (Science & Technology, Yemenia, National, Saba, Future, Modern Science, Arabia for Science & Tech, Dar Al_Salam Science & Tech, and Al-Hekmah) achieved positively growth and the percentage averaged (16.6%, 1.1%, 18.9%, 2.9%, 23.1%, 275.2%, 179.6%, 80.7%, 43.5%) annually respectively. Total Factor Productivity Change (TFPCh) in these Private Universities refers to increase the growth in Technological Change (TECHCh). And scored the Private Universities (Arwa Queen, Al_Ahqaf, Shar'eia Sciences, Alandalos, International Lebanese, Azal for Science & Technology, Yemenia & Jordanian and Al_Nasser) remarkable decreasing in Total Factor Productivity Change (TFPCh), this decreasing refers to backward the growth in the Technological Change (TECHCh). Malmquist Index for productivity scored positively growth attained (5.8%) and this growth in Total Productivity Change interprets to Technical Efficiency Change (EffCh) essentially. The Technological Change Index showed that (4) Private Universities only showed a technological progress.

Figure No. (1) shows Total Factor Productivity Change of Private Universities in Republic of Yemen.

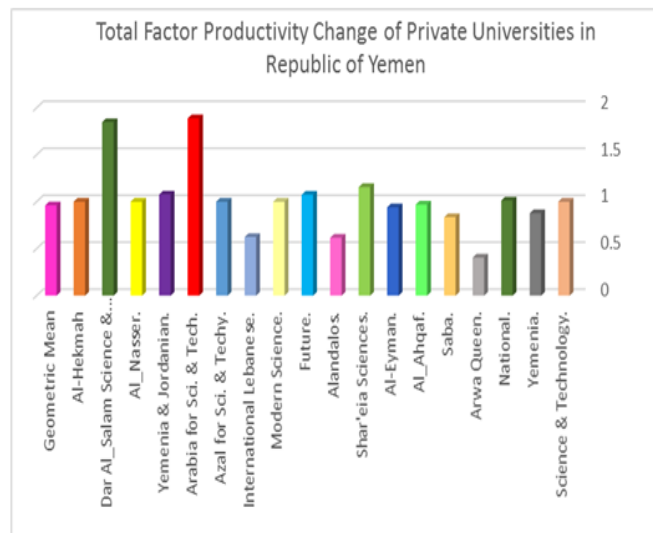


Fig 1 Total Factor Productivity Change of Private Universities in Republic of Yemen

V. CONCLUSIONS

This paper aims to estimate the productivity growth of (18) private universities in Republic of Yemen for two academic years (2012/2013) and (2013/2014) using Malmquist Index for Total Factor Productivity which consists of two essential elements: (1) Technological Change (TECHCh) and (2) Technical Efficiency Change (EffCh). There are two input variables (number of enrolled students in Bachelor and number of Teaching Staff) and one output variable (number of graduated of students). (12) out of (18) private universities achieved positively growth and attained (66.67%) in Technical Efficiency Change (EffCh) and (6) private universities got decreasing in the growth averaged (33.33%).

Malmquist Index for Total Factor Productivity achieved remarkable change scored (5.8%) in the period (2012/2013) and (2013/2014) academic years, there (10) private universities or (55.56%) are efficient and achieved remarkable growth. The Technological Change Index showed that (4) Private Universities only showed a technological progress.

Thus, the new findings in this paper may give impetus to Ministry of Higher Education and Scientific Research, Private Universities Administrators, and the decision makers to adopt measures that would be beneficial to the improvement Public and Private Universities in terms of inefficiency and unproductive growth.

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Table 1 Malmquist Productivity Index of Private Universities in Republic of Yemen

Universities	TFPCh	TECHCh	EFFCh	SECh	PECh
Science & Technology.	1.166	0.959	1.216	1.216	1.000
Yemenia.	1.011	0.837	1.208	1.377	0.877
National.	1.189	1.088	1.092	1.080	1.012
Arwa Queen.	0.398	0.689	0.578	1.429	0.405
Saba.	1.029	0.884	1.164	1.392	0.836
Al_Ahqaf.	0.578	0.616	0.939	0.968	0.970
Al-Eyman.	1.000	0.780	1.282	1.363	0.941
Shar'eia Sciences.	0.815	0.608	1.339	1.159	1.156
Alandalos.	0.618	0.866	0.714	1.159	0.616
Future.	1.231	0.868	1.419	1.321	1.074
Modern Science.	3.752	2.792	1.344	1.344	1.000
International Lebanese.	0.610	0.866	0.705	1.129	0.624
Azal for Science & Technology.	0.945	0.863	1.096	1.096	1.000
Arabia for Science & Tech.	2.796	1.481	1.888	1.000	1.888
Yemenia & Jordanian.	0.916	0.674	1.359	1.263	1.076
Al_Nasser.	0.931	0.931	1.000	1.000	1.000
Dar Al_Salam Science & Tech.	1.807	2.020	0.894	0.484	1.848
Al-Hekmah.	1.435	0.861	1.666	1.666	1.000
Geometric Mean	1.058	0.950	1.114	1.159	0.961

Source: The Researcher Depending on Outputs of DEA-Malmquist Program ver. 2.1