An Assessment of Total Factor Productivity (TFP) of SME Business in Bangladesh using DEA based Malmquist Productivity Index (MPI)

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ABSTRACT

For sustainable growth, SMEs play a dynamic role through creation of employment, increase of aggregate production, maximization of economic resources in the economy. Considering SMEs impact on diversified area of economy, the subject matter of SMEs productivity draw intense attention for intense research over last decade. In Bangladesh, as developing country, SMEs contribution becoming significant for employment generation, reduce income inequalities and lead to export through maximization of production. The objective of this study to assess SMEs performance for the period from 2005 to 2014. Study measures productivity using Malmquist Productivity Index (MPI) having one outputs and three inputs. We run regression analysis to identify residual by comparing expected output and an actual output having available inputs. Study result revealed that productivity index (MALM = 1) remains constant, but it is found that technical efficiency enhancement from 2010 to 2014, however overall efficiency declined by 2.6% as well. The residual analysis revealed no significant deviation between expecting output and actual output by using available inputs. This research outcome will give a glimpse about overall SME performance, which will induce researchers to go further in-depth analysis for bringing more insight for SME development.

Keywords: Malmquist index, Total factor Productivity, Data evolvement analysis, Residual analysis

JEL classifications: D24, L93

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INTRODUCTION

In the Mid 1960, SME emerge as alternatives of existing three economic situations. First, limited employment prospects in a large enterprise. Second, inequitable distribution of economic growth. Third, growing poverty level due to larger scale production having less productivity *(Ekpenyong, 1992).*

SMEs contribution towards economic growth is unquestionable because it plays a focal role in the socio-economic development. Nowadays, SMEs reache a unique spot in the economy from side to side employment generation, mobilization of economic resources, socio-economic stability and the possibility of production potentials. In developing countries, SME sector gets significant attention from policy makers, academicians and international agencies due to consider as an engine of sustainable economic growth. SMEs performance is critical towards economy for ensuring equitable development of the country. SMEs are very attractive for the study because they "live fast and fast disappear *(Reaz & Kanti, 2013)*." The role of SMEs in providing productive employment and earnings gained in importance among scholars and politicians, precisely because SMEs are an effective way of socio-economic development.

Over decade researchers conduct several studies focusing on performance evaluation, assessment of problem and prospects, financial problem of SMEs and significant one is to assess efficiency level of Small business. Some of the empirical research findings are stated below so as to identify research gap for further study on Small Business. Researchers are keen to evaluate the performance of SMEs over the period, *Alauddin (2015) & (Qamruzzaman, 2015)* concluded from their study that in the economic development, SME contribute significantly and also play role for employment generation, which act as remedies for poverty alleviation and women empowerment in the economy.

The productivity of SMEs are limiting of having an inadequate capital in the economy. SMEs, however, are contributing substantially for economic development but the process is blocked by limited source of financing in the economy. Scarcity of capital funding to SMEs limiting the potential capacity *(Chowdhury, Islam, & Alam, 2013).* In another study, *Temtime and Pansiri (2004)* pointed that longrun forecasting, manageringal apptidute and contineours government supporst are the critical facrtor for success of SME.

Emptical study shows that no of researchers focused on asseing efficiency level of SMEs for getting better insigh about SMEs performance over the decade. A study conducted by *Azrum and Haq (2016)* using Data envelopment Analysis (DEZ) of assessing level of efficienty. Study revealed that only few enterprises are performing efficiently in Turkey. Another study conducted by *Danijela Marjanovic (2014)* by applying DEA method and the study revealed that significant no of studied companies do not operating efficiently, which indicates do not use their optimal inputs and there is scope to progress their efficacy using the reference measure of efficient enterprises. Similar type conclusion drawn by *Purwanto (2014)* about Salatigan SMEs. He disclosed that only 2 out of 75 SMEs found performing efficiently in both CRS and VRS assumption and few SMEs were efficient either assumptions but only 23 SMEs performing inefficiently. According to *Aikaeli, Wellington, and Jehovaness (2014)* SME in Monrovia is performing inefficiently on the basis of Stochastic Frontier Analysis (SFA). *Heilbrunn, Rozenes, and Vitner (2011)* use DEA of identifying the success of SMEs in Israel, they pointed that success of SMEs immensely depend on concentreted markeing.

Aslo found that researcher shown interest of assessing technical efficiency level of SMEs. A study conducted by *Alias Radam (2008)* using stochastic frontier model, study revealed that insignificnat (3.06%) no of SMEs are peroformiing with efficiency. While *Workineh (2016)* pointed from his study that SME in Tanzania shows signifincantly associatoin with technical efficiency level over the period. While, *Rahmah Ismail (2014)* discoverd through his study that technical efficiency of Malaysian SMEs at moderate level. Whereas, *Prusa (2009)* analyzes the efficiency of Czech SMEs and concluded that the signifincant no of firms operate below full efficiency; with only a few companies (industries) belonging to top performers as per DEA outcome.

Form empirical study,It is apparently manifest that insignificant only few research are conducting over the year base on theoretical aspects not considering any advanced econometric models. Such insufficient analysis induces us to go for this study. The aims of the study to assess productivity of SMEs at aggregated level using DEA Based Malmquist Productivity Index (MPI). Remaining sections are as follows: Section II SME in Bangladesh, Section III presents in details the methodology used total factor productivity analysis, Section IV discusses the results, obtained by using DEA approaches. Section V. concluding and policy recommendations.

SME IN BANGLADESH

The worth of SMEs toward sustainable growth is well identified and recognized, especially for developing countries. SME represents as real lever for development for emerging economy *(Konrad, Adenauer, & Stiftung, 2015)* like Bangladesh. With current trend of Bangladesh, SME is renowned as vehicles of economic progress by employment generation, poverty alleviation, enhancing the standard life in the economy, leading economy towards achieving vision 2021 of sustainable development *(Rashid, 2012).*

SMEs contribution towards, in recent period, economic growth is well noticed by government and policymakers. According to Bangladesh Economic Review -2015, the contribution of SME to GDP is increased by 21% from the year 2014-2015, apart from that SME also consider 80% of industrial employment and 90% of industrial output and 25% of overall employment in the economy.

The road to SME development face no of obstacles including access to finance, absence of skilled manpower, infrastructural limitation and support service from other related institutions *(Hoque, Sultana, & Thalil, 2016).* Getting credit by SME from financial institution is a great difficulty*(Uddin, 2014)*, since financial institutions assume higher risk involvement *(Islam, Yousuf, & Rahman, 2014); (Rahmatullah, Mukul, & Islam, 2014).* In regards to financing constraint of SME, Bangladesh government introduce special financing scheme "SME loan under refinancing" to promote SMEs contribution in the economy. Apart from government initiative, financial institutions, especially private banks offer no of financial support to SMEs. Still getting all those credit facilities from financial institutions SMEs face one prime obstacle as collateral requirement *(Chowdhury et al., 2013), (Bosri, 2016).*

Along with financial institutions, various specialized institutions also offering credit facilities to SME. In this process, specialized bank BASIC, in 1988, was established with an objective to facilitate financing opportunities for small and cottage industries. In recent period, both bank and non-bank financial institutions (NBFIs) extend their effort for allowing credit to SME with various financial products. As of 31st March 2017, financial institution, especially private commercial banks disburse 32,519 core as credit among 146419 SMEs, which is 26% of target loan disbursement to SME sectors. While, NBFIs disburse about 1,322 core among 7690 SEMs, which is about 27.56% of total target disbursement *(Bangladesh Bank, 2017).*

Employment creation by absorbing large manpower is one the key input of SME in economy *(Ayyagari, Beck, & Demirgüç-KunT, 2011)*; *(Kok et al., 2011).* Country like Bangladesh, SME can be uses as key for everlasting problem of unemployment in the economy. By the character of absorbing larger scale of manpower, SMEs emerge as driver of grating employment in developing counties. SMEs the dominated business sector with the contribution about 95% of industrial output.

METHODOLOGY OF THE STUDY

The methodology of the study

Assessment of Productivity requires substantial amount of consideration while selecting methodology, based on multifactor analysis. Among various methodology for measuring productivity, Malmquist Productivity index (MPI) is widely used described by *Coelli, Rao, and Battese (1998)*.This method was introduced by *(Malmquist, 1953)* as a quantity index for analyzing consumption of inputs and *Fare, Grosskopf, Norris., and Zhang (1994)*constructed an MPI directly from input and output data using DEA by combining their ideas with the measurement of efficiency from *Farrell (1957)* and the measurement of productivity from Caves, Christensen, and Diewert (1982). As *Chen (2003)* puts it, the DEA-based MPI has widely accepted for measuring productivity change in various industries.

Data Envlopment based Productivity Index

DEA is a powerful service management and benchmarking tool which is introduced by *Banker, Charnes, Cooper, and Schinnar (1984)*. DEA is a non-parametric analysis used in operational research and economic to estimate the productive efficiency of different decision-making units (DMUs), where, multivariable are used, having interrelation among them.

DEA can be applied in two aspects either focusing input orientation or output orientation. Input orientation DEA focused on to making inefficient DMUs to efficient ones through reduction of proportionate input having the output remain constant. While DMUs becoming efficient with proportional increase of output from current production level with given level of inputs.

In DEA,

X_{ij} represents inputs,

Yi_j represents outputs and

DMU_j as Decision Making Units,

Where, i = 1, 2, 3, 4……..n

So, maximum Productivity of DMU_j can be express as,

$$\text{Max, } \frac{\text{Total amout of output by DMUs}}{\text{Total available input used in the process}}$$

$$Max\ \frac{\sum_{l=1}^{r}(\beta_l y_{ij})}{\sum_{m=1}^{w}\sigma_m x_{ij}} = \Phi \qquad (1)$$

$$\text{Subject to; } \frac{\sum_{l=1}^{r}(\beta_l y_{ij})}{\sum_{m=1}^{w}\sigma_m x_{ij}} \leq 1$$

$\beta_l\ and\ \sigma_m \geq 0$, l = 1, 2, 3…….r; m = 1, 2, 3…….w; j = 1, 2, 3……n;

In the equation (1), the value of $\beta_l\ and\ \sigma_m$ is nonnegative variable weight for optimal output in the give level of input and DMUs to be consider as efficient units only if the value of $\Phi = 1$. *Fare et al. (1994)* assume a constant returns to scale (CRS) in their analysis.

The required LPs are:

$$[D_o^m\ (Y_m Q_m\ )]^{-1} = max_{\partial,\lambda}\ \partial,$$

$$s.t \qquad -\partial Q_{im} + Y_m \emptyset \geq 0,$$

$x_{im} - X_m\emptyset \geq 0,$

$\emptyset \geq 0$ (2)

$[D_o^v (Y_v q_v)]^{-1} = max_{\partial,\emptyset}\ \partial,$

$s.t \quad -\partial Q_{iv} + Y_v\emptyset \geq 0,$

$x_{iv} - X_v\emptyset \geq 0,$

$\emptyset \geq 0$ (3)

Assessment of Productivity of any production process works as a driver for increasing level of efficiency. Data envelopment base MPI measures changes in productivity at time t+1, and t with multivariable inputs and outputs. Productivity can be measured either input oriented or output orientation. In this study, we focused on output oriented Productivity analysis because we are using economic aggregated data rather firm-specific data. Output oriented MPI can be symbolized as follows;

$$MI = \frac{\Delta_0^t(\gamma_0^{t+1}, q_0^{t+1})}{\Delta_0^t(\gamma_0^t, p_0^{t+1})} \frac{\Delta_0^{t+1}(\gamma_0^{t+1}, q_0^{t+1})}{\Delta_0^{t+1}(\gamma_0^t, q_0^t)}^{1/2} \quad (4)$$

In this model, comprise of $\gamma_0^{t+1}, q_0^{t+1}$ to the frontier at time *t*. similar, we can produce the mixed period measures $\Delta_0^{t+1}(\gamma_0^t, q_0^t)$ for the time period *t+1.* Productivity of DMUs is measured on the basis of following guidelines;

$\boldsymbol{M_t^i}$< 1Indicates a decline in productivity.

$\boldsymbol{M_t^i}$=1 implies no change in productivity from time *t* to *t+1*.

$\boldsymbol{M_t^i}$> 1Indicates an increase or improvement in productivity.

MPI consists of two components, one component explains the charges of efficiency level of DMUs and second component explain changes of Technical efficiency over the period. By decomposition of equation (2), the equation can reproduce in the following ways;

$$MI = \frac{\Delta_0^t(\gamma_0^{t+1}, q_0^{t+1})}{\Delta_0^t(\gamma_0^t, p_0^t)} \left[\frac{\Delta_0^t(\gamma_0^{t+1}, q_0^{t+1})}{\Delta_0^t(\gamma_0^{t+1}, p_0^{t+1})} \frac{\Delta_0^{t+1}(\gamma_0^t, q_0^t)}{\Delta_0^{t+1}(\gamma_0^t, q_0^t)}\right]^{1/2} \quad (5)$$

Where, $\frac{\Delta_0^t(\gamma_0^{t+1}, q_0^{t+1})}{\Delta_0^t(\gamma_0^t, p_0^t)}$, measures of efficiency level, and $\left[\frac{\Delta_0^t(\gamma_0^{t+1}, q_0^{t+1})}{\Delta_0^t(\gamma_0^{t+1}, p_0^{t+1})} \frac{\Delta_0^{t+1}(\gamma_0^t, q_0^t)}{\Delta_0^{t+1}(\gamma_0^t, q_0^t)}\right]$, measures technical efficiency of DMUs.

Considering output oriented method, performance to be assessed on the basis of revenue generation with a given inputs. Efficiency improvement can be said if it is observed revenue increases with the given inputs over the period. By the adoption of the new production process, the level of efficiency can be changed. Therefore, two components in Productivity index, the level of efficiency and technical efficiency value should be >1. If efficiency score goes less than <1, which indicated that productivity level is decreasing from *t* to *t+1*. The following section, we applied DEA base MPI to measure SMEs productivity of Bangladesh from **2005 to 2016.**

EMPIRICAL IMPLEMENTATION

Data source

Study use time series aggregated data, which is collected from various sources such as, Bangladesh Bank annual reports, SME foundation annual reports, Export promotion Bureau, Bangladesh Bureau of statistics, Ministry of finance annual reports. One measure

of output, sales revenue which proxies the physical performance. Number of SMEs, Number of workers and capital flow from financial institutions which are taken as a proxy for the three inputs. The present paper is based on results for the period 2005 to 2014 of data aggregation regarding SMEs.

Table 1: Basic Descriptive Statistics 2005-2016

	Revenue	*Capital*	*No of SME*	*Employment*
Mean	68463.65	2213638	48151.57	453970.3
Standard Error	5227.604	354649.6	2359.236	57550.93
Median	65526.25	1961536	47648.62	412600
Standard Deviation	16531.14	1121501	7460.558	181992
Sample Variance	2.73E+08	1.26E+12	55659923	3.31E+10
Kurtosis	-1.06459	-1.61585	-1.14631	3.946338
Skewness	0.40498	0.348175	0.202847	1.290322
Range	49063.8	2939468	22185.04	721108
Minimum	46819.7	896632.8	37814.96	162997
Maximum	95883.5	3836101	60000	884105
Sum	684636.5	22136383	481515.7	4539703

Table 1 exhibits some descriptive statistics of research variables. Mathematically speaking, the indicators are;

Y_1 = sales revenue in million

X_1 = Capital flow from financial institutions

X_2 = on of SMEs

X_3 = no of Employment

Table 2: Correlation Matrix

	Revenue	Capital	No of SMEs	Employment
Revenue	1			
Capital	.992**	1		
No of SMEs	.997**	.989**	1	
Employment	.082	.049	.116	1
**. significant at 0.01 level				

Table 2 exhibits internal directional relationship among research variables over the periods. It is clearly manifested that SMEs revenue generation is strongly correlated in a positive direction with Capital flow from financial institutions and No of SMEs and which is significant as well but the relationship between revenue generation and employment is not strongly related which indicates that employment in SMEs has a negligible impact on revenue generation in SME sector which is against the assumption as labour intensive.

Malmquist Productivity Index (MPI)

The Malmquist TFP index shows deviation of productivity in two periods, assuming common technological involvement. Changes of productivirty can be positive, which means improvement of production level from past or negative, which means decline of production. An MPI which is greater(less) than one reveals an efficiency increase (decrease) or technical progress (regress). MPI allows the researcher to differentiate firms from technical efficiency changes to effective efficiency changes by shifting production frontier. Table 3 shows the efficiency change, technical change, pure technical change, scale efficiency change and MPI of SME in Bangladesh over the period of 2005 to 2014.

Table 3: Malmquist Productivity Index

year	Malmquist index (MALM)	Technical efficiency Changes	Pure technical efficiency	Congestion efficiency	Scale efficiency
05-06	1.000	0.690	1.000	1.000	0.690
06-07	1.000	0.983	1.000	1.000	0.983
07-08	1.000	0.706	1.000	1.000	0.706
08-09	1.000	0.621	1.000	1.000	0.621
09-10	1.000	2.428*	1.000	1.000	2.428
10-11	1.000	0.887	1.000	1.000	0.887
11-12	1.000	1.160	1.000	1.000	1.160
12-13	1.000	1.048	1.000	1.000	1.048
13-14	1.000	1.032	1.000	1.000	1.032
mean	1.000	0.976	1.000	1.000	0.976

Above table 3 depicts overall productivity index of Small Business in Bangladesh from the year 2006 to 2015. According to Malmquist index (MALM) over the period, productivity remains unchanged as you seen (Table -3) that total factor index is 1.00 throughout the research period. it is apparent (see Table -3) that level of technical efficiency has decreased by 2.4% between 2005 to 2014 of Small Business, Highest technical efficiency changes happened in 2010 (2.428), Apart from that year 2012 to 2014 also show better technical efficiency level changes but the overall technical efficiency level changes is 97.6% which indicates small enterprise should go for development for economic contribution. It is also observed that from year'06 to year'09 having technical efficiency change is less than MALM index but from year'10 to onwards technical efficiency changes (TEC) shows greater improvement, while Productivity index shows constant returns to scale.

Regression analysis

We to go for regression analysis to evaluate the relationship between explanatory and exogenous variables in this research. Regression is to conduct to estimate future output variable changes due to changes of exogenous variables in future.

Table 4: Regression Analysis

Statistics				
Multiple R	0.991			
R^2	0.992			
Adjusted R^2	0.995			
Standard Error	1063.6123			
N	10			
ANOVA				
	df	*SS*	*MS*	*F*
Regression	3	2452718337	8.18E+08	722.7028 (0.00)
Residual	6	6787626.753	1131271	
Total	9	2459505964		

Table 4 exhibits regression model fit statistics. It is apparent from model fit statistics data which we use is perfectly fit regression model having model tested value R^2 is 0.99 which is more that standard score (>.70) apart from that the coefficient of F-statistics is significant P-value < 0.05. By the consideration of all model fit aspects, it is confirmed that data is best fitted to the regression model.

Table 5: Coefficient of Regression Model

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	-28158.08	12605.54	-2.233	0.061
Capital (β)	0.001	0.002	0.701	0.500
No of SMEs (π)	1.937	0.383	5.056	0.002**
Employment (α)	-0.001	0.001	-1.579	0.165

Table 5: exhibits variables coefficient with the corresponding P-value of the regression model. It obvious that among all variables, both capital (0.001) and No of SMEs (1.937) have positive contribution towards SME development in Bangladesh, while Employment in SMEs has a negative impact on overall SME development though the coefficient is insignificant (-0.001), which indicated that labor productivity is decreasing over the period in SMEs. Considering associated P-value of variables coefficient, it is proved that establishment of new SMEs can significantly affect development of SMEs over other variable contribution in the development process

So by the consideration of regression model output, the equation of SME development can be explained by exogenous variable changes in the following manner:

$$Y_{t=} \int Capital, No\ of\ SME\ \&\ Employment \quad (6)$$

$$Y_{t\,=} (\psi + \beta * capital + \pi * No\ of\ SME + \alpha * employment) \quad (7)$$

$$Y_{t\,=} (-28158.08 + .001 * capital + 1.937 * No\ of\ SME - 0.001 * employment) \quad (8)$$

Table 6: Residual output from Regression analysis

Year	*Predicted Y*	*Residuals*
2005	46565.18	254.52
2006	50434.70	937.50
2007	54742.35	334.85
2008	59079.53	(325.63)
2009	62394.92	175.78
2010	70074.94	(1593.14)
2011	75874.16	(977.16)
2012	82393.24	(500.74)
2013	88497.27	390.73
2014	94580.22	1303.28

Residual from regression output indicates the comparison between actual and expected to be the consideration of available inputs. It is apparent (see table – 6) that in the year of 2008, 2010, 2011 and 2012 having less productivity in comparison to predictive value on regression analysis. By using regression analysis you try to assess the comparative productive performance of SMEs in Bangladesh. Apparently, we are observing no significant difference between actual GDP contributions and expected GDP by using available resources by SME in Bangladesh. We only can experience an insignificant deviation from actual GDP which is indicated that decrease of technical efficiency of SME.

CONCLUSION AND POLICY RECOMMENDATION

This empirical study focused on to assess total factor productivity (TFC) by using Malmquist Productivity index using Data Envelopment Analysis (DEA). Study results revealed that over the period from 2005 to 2014 productivity index of SME in Bangladesh is remain constant (MLMI= 1) but we observed fluctuation in changes of technical efficiency level, maximum technical efficiency level attained by SME sector in the year of 2010 afterward showing negative changes in technical efficiency. Although, technical efficiency level is more than 1, having indicated that SME

producing more outputs using currently available inputs but from 2010 to 2014 it is decreasing in nature. We also used regression analysis to establish linear relations between the dependent variable and independent variables. Study revealed that among all three tested variables institutional development (No of SMEs) have significant impact on SME productivity and the remaining two has insignificant contribution to SME productivity improvement.

With the understating of all study results, it is recommended that this preliminary study is a signal to take necessary action by the employment of comprehensive research. Though over the year, on of research been conducted by researchers but no one goes for application of the econometric model to assess SME performance. Through this study, we tried to do some initial analysis to find a glimpse of SME in Bangladesh. Due to unavailability of pertinent data of SME of Bangladesh, we only use three variables but to get better insight researchers should incorporate more variables.

The limitation of using is DEA is unable to address any intervention by exodus variables widely known as white noise, having non-stochastics character, thereby may have over-estimated the magnitude of inefficiencies. The data utilized in the study are aggregated data and not firm level data. This is because firm level data is not easily accessible. The study also assumes that all SMES under evaluation is fairly homogenous, utilizing a similar set of inputs to produce identical outputs. This can only be achieved if we are evaluating a group of firms operating similar business activities such as banking or financial institutions, hospitals and others. The methodology can be revised, expanded and applied to other public and private organizations.

FURTHER RESEARCH DIRECTION

Considering the findings of the research, it creates a new pave of avenue to future research to the application of more advanced econometric models in analysis performance of SME in Bangladesh.

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