Productivity of BOC Bangladesh Limited through Econometric Model

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Abstract

The main purpose of this study is to measure the productivity of BOC Bangladesh Limited. In this regard income statement information during 1991 to 2006 has been analyzed. The growth rates of the elements of income and expenditure have also been calculated. The Cobb-Douglas production function and a general productivity analysis have been introduced in this study. The growth rates of the elements of income and expenses are indicating excellent increasing trends during the study period. From the productivity analysis, it has been found that though the average productivity of BOC Bangladesh Limited is favorable during the period, but it is not highly satisfactory, due to increasing trends of expenditures. The Cobb-Douglas production function of our analysis indicates that the dependent variable like total income of BOC Bangladesh Limited during the study period has significant and positive relationship with the explanatory variables.

Introduction

BOC Bangladesh Limited is an important Company in Bangladesh. The Company's principal activity is to manufacture and supply industrial and medical gases, welding equipment and products, certain medical products, anesthesia & ancillary equipment & consumables etc. for the development of Bangladesh. The company continued to be the principal supplier in the country of industrial & medical products.

BOC Bangladesh Limited is both an old and a relatively new company. Old because it has been present in what are now Bangladesh, in one form or the other, since the days of British India. New, because it was registered under it's own identity only in 1973. The company began, after the independence of Bangladesh. BOC Bangladesh Limited stated out as Bangladesh Oxygen Plants and 3 Dissolved Acetylene plants, one of each in Dhaka, Chittagong and Khulna. In addition, it had an operating contract to run the Oxygen plants of Chittagong, Chittagong Steel Mills (CSM), which is still there today. For the manufacture of welding electrodes the company had only one very small extruder. From inception, the Company has remained the sole supplier of Medical Oxygen in the Country. In the mid 70's Nitrous Oxide plant still the only one in Bangladesh, was imported and installed in Dhaka to provide the nation with this vital anaesthetic gas. Later in the decade a Carbon Dioxide plant was bought and installed in Dhaka and this was

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the first in the country to produce dry ice. In the early 80's the first liquid gas plant was imported from New Zealand and again installed in Dhaka.

Bangladesh Oxygen Limited changed its name to BOC Bangladesh Limited in March 1995 in line with a world-wide program of the BOC Group. In March 1998 a second line of production was added to the integrated Electrode Factory at Rupganj, doubling capacity. Same year, a new site with a 20 TPD liquid plant was acquired in Shitalpur, Chittagong. The BOC Group, of which BOC Bangladesh Limited is a member, has its headquarters at Windlesham in the UK. It employs over 40,000 people and contributes to the economies of nearly 60 countries world-wide, with a turnover in excess of US$ 6 billion.

Objective and Methodology of the Study

The main purpose of the study is to measure the growth rates of elements of total income and expenditure and find out the productivity of the BOC Bangladesh Limited during 1991 to 2006. In this regard, information from Income Statements of BOC Bangladesh Limited, of the concerned years has been analyzed. To find out the growth rates of the elements of income and expenditure, the figures of the year 1994 have been taken as base. In case of calculation of the productivity, Cobb-Douglas production function has been used.
Accordingly, an increase in productivity is characterised by a shift of the production function (steepening slope) and a consequent change to the output/input relation. The formula of total productivity is normally written as follows:

- *Total productivity = Output quantity / Input quantity*

According to this formula, changes in input and output have to be measured inclusive of both quantitative and qualitative changes. In practice, quantitative and qualitative changes take place when relative quantities and relative prices of different input and output factors alter. In order to accentuate qualitative changes in output and input, the formula of total productivity shall be written as follows:

- *Total productivity = Output quality and quantity / Input quality and quantity*

Concept Used in the Study
Cobb-Douglas Production Function
The Cobb-Douglas production function for our purpose has been written in its stochastic form as follows:

$$Y = \beta_1 X_{2i}^{\beta 2} X_{3i}^{\beta 3} X_{4i}^{\beta 4} X_{5i}^{\beta 5} e^{Ui} \quad \text{----------(1)}$$

Where,

Y = Yearly Income of GB
X_2 = Yearly Interest Expenses of GB
X_3 = Yearly Salary & Allowance of BSB
X_4 = Yearly Depreciation of GB
X_5 = Yearly Other Expenses of GB

From the equation (1), it is clear that the relationship specified between the dependent and independent variables is nonlinear. However, through the log-transformation of the model, we can linearize it as follows:

$$\text{In } Y_1 = \text{In } \beta_1 + \text{In } \beta_2 X_{2i} + \text{In } \beta_3 X_{3i} + \text{In } \beta_4 X_{4i} + \text{In } \beta_5 X_{5i} + U_i$$
$$= \beta_0 + \text{In } \beta_2 X_{2i} + \text{In } \beta_3 X_{3i} + \text{In } \beta_4 X_{4i} + \text{In } \beta_5 X_{5i} + U_i \quad \text{---------- (2)}$$

In equation (2), In $\beta_1 = \beta_0$, and the model is linear now in parameters, and thus standard OLS is applicable. However, note that the model is nonlinear in variables Y and X, but linear in the logs of these variables. In short, equation (2) is a log-log or log-linear model. The attractive feature of such log-log models is that the slope (partial) coefficients measure the elasticity of Y with respect to X. That is, the partial slope coefficient measure the percentage change in Y for given percentage change in X. the second special feature of log-log models is elasticity coefficient between Y and X, β remains constant throughout.

The sum ($\beta_1 + \beta_2 + \beta_3 + \beta_4$) gives information about the returns to scale, that is, the response of output to a proportionate change in the inputs. If this sum is 1, then there are constant returns to scale, that is, doubling the inputs will double the output, tripling the inputs will triple the output, and so on. If the sum is less than 1, there are decreasing returns to scale – doubling the inputs will be less than double the output. Finally, if the sum is greater than 1, there are increasing returns to scale – doubling the inputs will be more than double the output (Gujarati 1998).

Productivity

Productivity is a measure of output from a production process, per unit of input. For example, labor productivity is typically measured as a ratio of output per labor-hour, an input. Productivity may be conceived of as a metric of the technical or engineering efficiency of production. As such, the emphasis is on quantitative metrics of input, and sometimes output. Productivity is distinct from metrics of allocative efficiency, which take into account both the monetary value (price) of what is produced and the cost of inputs used, and also distinct from metrics of profitability, which address the difference between the revenues obtained from output and the expense associated with consumption of inputs. It is the rate of the incremental income and incremental expenditure that measure the productivity of a bank. Bank's productivity is defined as percentage change in its earnings in relation to percentage change in its costs. To put it differently, the output responsiveness as measured by proportionate change in income in relation to proportionate change in expenditure, measures the productivity of a company.

Symbolically;

$$P = \{(\Delta I / I) / (\Delta E / E\}$$

Where, P = Productivity or output responsiveness to change in inputs

Δ = Delta (Change)

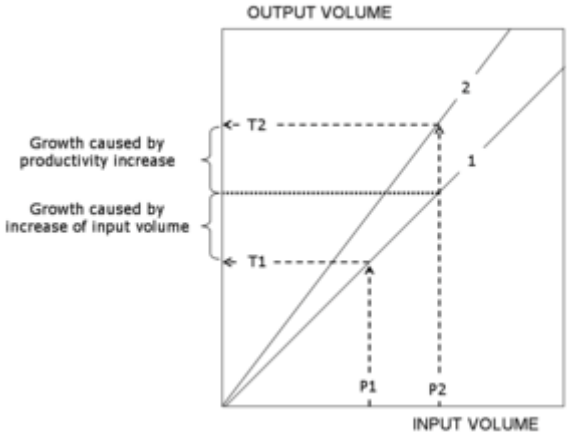
I = Total Income

E = Total Expenditure

In absence of specific indicators of output and input of a bank, the above measurement of productivity is widely used. Productivity of a bank is inversely related to cost responsiveness, i.e. higher cost responsiveness leads to lower productivity and vice-versa. The productivity (P) is greater than (1) one, is a sign of good health of the banks and vice-versa (Rahman 2002).

Economic growth and productivity: Why use Productivity

Production is a process of combining various material inputs and immaterial inputs (plans, know-how) in order to make something for consumption (the output). The methods of combining the inputs of production in the process of making output are called technology. Technology can be depicted mathematically by the production function which describes the relation between input and output. The production function can be used as a measure of relative performance when comparing technologies.



Components of economic growth (Saari 2006)

The production function is a simple description of the mechanism of economic growth. Economic growth is defined as any production increase of a business or nation (whatever you are measuring). It is usually expressed as an annual growth percentage depicting growth of the company output (per entity) or the national product (per nation). Real economic growth (as opposed to inflation) consists of two components. These components are an increase in production input and an increase in productivity.

The figure illustrates an economic growth process (exaggerated for clarity). The Value T2 (value at time 2) represents the growth in output from Value T1 (value at time 1). Each time of

measurement has its own graph of the production function for that time (the straight lines). The output measured at time 2 is greater than the output measured at time one for both of the components of growth: an increase of inputs and an increase of productivity. The portion of growth caused by the increase in inputs is shown on line 1 and does not change the relation between inputs and outputs. The portion of growth caused by an increase in productivity is shown on line 2 with a steeper slope. So increased productivity represents greater output per unit of input.

Table-1: Net Sales, Cost of Goods Sold, Admn. & Gen. Expenses and Other Income of BOC Bangladesh Limited

(Tk. In Lakh)

Financial Year	Net Sales	Growth Rates	Cost of Goods Sold	Growth Rates	Admn. & Gen. Expenses	Growth Rates	Other Income	Growth Rates
1991	4775.00	-	3470.00	-	586.00	-	120.00	-
1992	4613.00	-3.39	3004.00	-13.43	690.00	17.75	139.00	15.83
1993	4738.00	2.71	3011.00	0.23	744.00	7.83	259.00	86.33
1994	5298.00	11.82	3359.00	11.56	872.00	17.20	330.00	27.41
1995	6045.00	14.10	3839.00	14.29	1002.00	14.91	133.00	-59.70
1996	6807.00	12.61	4411.00	14.90	1482.00	47.90	32.00	-75.94
1997	7546.00	10.86	4901.00	11.11	1719.00	15.99	43.00	34.38
1998	8429.00	11.70	5257.00	7.26	2096.00	21.93	418.00	872.09
1999	10219.00	21.24	6426.00	22.24	1882.00	-10.21	23.00	-94.50
2000	10467.00	2.43	6012.00	-6.44	2036.00	8.18	31.00	34.78
2001	11718.00	11.95	6758.00	12.41	2319.00	13.90	-30.00	-196.77
2002	12878.00	9.90	7530.00	11.42	2471.00	6.55	31.00	-203.33
2003	12894.00	0.12	7659.00	1.71	2681.00	8.50	149.00	380.65
2004	12241.00	-5.06	7495.00	-2.14	2707.00	0.97	62.00	-58.39
2005	15534.30	26.90	10264.20	36.95	2954.86	9.16	25.25	-59.27
2006	23589.55	51.85	15581.98	51.81	4755.45	60.94	156.01	517.86
Avg.	9861.99	11.98	6186.14	11.59	1937.33	16.10	120.08	81.43
SD	5035.49	14.02	3243.13	16.43	1085.10	17.56	123.47	291.58
CV	51.06	117.04	52.43	141.71	56.01	109.05	102.82	358.08

Source: Annual Reports of BOC, 1991-2006.

Table-1 shows the Net Sales, Cost of Goods Sold, Admn. & Gen. Expenses and Other Income of BOC Bangladesh Limited. It is found that the average Net Sales, Cost of Goods Sold, Admn. & Gen. Expenses and Other Income of the company were Tk.9861.99 lakh, Tk.6186.14 lakh, Tk.1937.33 lakh and Tk.120.08 lakh respectively, and the average growth rates of Net Sales, Cost of Goods Sold, Admn. & Gen. Expenses and Other Income were 11.98 percent, 11.59 percent, 16.10 percent and 81.43 percent respectively. So, it is revealed that the growth of BOC Bangladesh limited during the study period is satisfactory.

Table-2: EBIT, Interest Expenses, Tax and Net Income of BOC Bangladesh Limited

(Tk. In Lakh)

Financial Year	EBIT	Growth Rates	Interest Expenses	Growth Rates	Tax	Growth Rates	Net Income	Growth Rates
1991	839.00	-	1.00	-	380.00	-	458.00	-
1992	1058.00	26.10	0.00	-100.00	294.00	-22.63	764.00	66.81
1993	1242.00	17.39	0.00	N.A	456.00	55.10	786.00	2.88
1994	1397.00	12.48	0.00	N.A	480.00	5.26	917.00	16.67
1995	1337.00	-4.29	2.00	N.A	523.00	8.96	812.00	-11.45
1996	946.00	-29.24	111.00	5450.00	241.00	-53.92	594.00	-26.85
1997	969.00	2.43	176.00	58.56	56.00	-76.76	737.00	24.07
1998	1494.00	54.18	223.00	26.70	85.00	51.79	1186.00	60.92
1999	1934.00	29.45	304.00	36.32	170.00	100.00	1460.00	23.10
2000	2450.00	26.68	257.00	-15.46	160.00	-5.88	2033.00	39.25
2001	2611.00	6.57	401.00	56.03	190.00	18.75	2020.00	-0.64
2002	2908.00	11.37	221.00	-44.89	597.00	214.21	2090.00	3.47
2003	2703.00	-7.05	111.00	-49.77	525.00	-12.06	2067.00	-1.10
2004	2101.00	-22.27	150.00	35.14	520.00	-0.95	1431.00	-30.77
2005	2316.87	10.27	132.66	-11.56	647.98	24.61	1559.85	9.00
2006	3252.12	40.37	43.88	-66.92	901.73	39.16	2462.52	57.87
Avg.	1847.37	11.63	133.35	447.85	389.17	23.04	1336.09	15.55
SD	785.17	22.29	124.09	1576.10	232.94	68.52	642.01	30.16
CV	42.50	191.70	93.06	351.93	59.86	297.37	48.05	193.94

Source: Annual Reports of BOC, 1991-2006

Table-1 shows the EBIT, Interest Expenses, Tax and Net Income of BOC Bangladesh Limited. It is fount that the average EBIT, Interest Expenses, Tax and Net Income of the company were Tk.1847.37 lakh, Tk.133.35 lakh, Tk.389.17 lakh and Tk.1336.09 lakh respectively, and the average growth rates of EBIT, Interest Expenses, Tax and Net Income were 11.63 percent, 447.85 percent, 23.04 percent and 15.55 percent respectively. Though the growth rates of interest expenses and tax fluctuated over the period, but it is revealed that the growth of BOC Bangladesh limited during the study period is satisfactory.

Table-3: Total Income, Total Expenses and Productivity of BOC Bangladesh Limited

(Tk. In Lakh)

Financial Year	Total Income	Income Change	Total Expenses	Expenses Change	Productivity	Remarks
1991	4895.00	-	4437.00	-	-	-
1992	4752.00	-0.03	3988.00	-0.11	0.27	Favorable
1993	4997.00	0.05	4211.00	0.05	0.93	Favorable
1994	5628.00	0.11	4711.00	0.11	1.06	Favorable
1995	6178.00	0.09	5366.00	0.12	0.73	Favorable
1996	6839.00	0.10	6245.00	0.14	0.69	Favorable
1997	7589.00	0.10	6852.00	0.09	1.12	Favorable
1998	8847.00	0.14	7661.00	0.11	1.35	Favorable
1999	10242.00	0.14	8782.00	0.13	1.07	Favorable
2000	10498.00	0.02	8465.00	-0.04	-0.65	Unfavorable
2001	11688.00	0.10	9668.00	0.12	0.82	Favorable
2002	12909.00	0.09	10819.00	0.11	0.89	Favorable
2003	13043.00	0.01	10976.00	0.01	0.72	Favorable
2004	12303.00	-0.06	10872.00	-0.01	6.29	Favorable
2005	15559.55	0.21	13999.70	0.22	0.94	Favorable
2006	23745.56	0.34	21283.04	0.34	1.01	Favorable
Avg.	9982.07	0.09	8645.98	0.09	1.15	Favorable

Source: Annual Reports of BOC, 1991-2006

Table – 3 shows the productivity of the BOC Bangladesh Limited. During the study period the average total income, total expenditure and productivity were Tk. 23745.56 million, Tk. 21283.04 million and 1.15 respectively. The average productivity of BOC Bangladesh Limited was positive during the period. Productivity was unfavorable in the years 2000. Though the average productivity of BOC Bangladesh Limited is favorable during the period, but it is not highly satisfactory. It has been found that the changes of expenditures are nearly or equal to changes of its income during the period, as a result the productivity did not increase significantly. A company can be divided into sub-processes in different ways; yet, the following five are identified as main processes, each with a logic, objectives, theory and key figures of its own. It is important to examine each of them individually, yet, as a part of the whole, in order to be able to measure and understand them. The main processes of a company are as follows

- real process
- income distribution process
- production process
- monetary process
- market value process

Productivity is created in the real process, productivity gains are distributed in the income distribution process and these two processes constitute the production process. The production process and its sub-processes, the real process and income distribution process occur simultaneously, and only the production process is identifiable and measurable by the traditional accounting practices. The real process and income distribution process can be identified and

measured by extra calculation, and this is why they need to be analysed separately in order to understand the logic of production performance. BOC Bangladesh Limited should concentrate on its expenditures to increase its productivity.

Table – 4: Estimation of the Cobb-Douglas Production Function

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	
	B	**Std. Error**	**Beta**			R = 0.999 R Square = 0.997 Adj. R Square = 0.996 Stander Error = 314.406 DW = 1.906 F = 946.945
(Constant)	-54.358	244.764		-.222	.828	
Cost of Goods Sold	.946	.135	.613	7.023	.000	
Admn. Expenses	1.365	.385	.296	3.549	.005	
Interest Expenses	4.219	1.140	.105	3.702	.003	
Tax	2.504	.720	.117	3.478	.005	
Dependent Variable: Total Income						

Table-3 shows the estimation of the Cobb-Douglas production function. In this function the dependent variable is the Log –form of total income of BOC Bangladesh Limited during the study period and the independent variables are the Log-form of Cost of Goods Sold, Admn. Expenses, Interest Expenses and Tax Expenses. From estimation of the equation it has been found that the explanatory variables have significant positive correlation with the dependent variable like total income. The R – square value is 0.997, which indicates that the explanatory variables have 99 percent effect on the dependent variable. The F-value 946.945 shows that the whole regression equation is highly significant.

According to the rule of returns to scale of the Cobb-Douglas production function, if the sum of the slope coefficients is greater than 1, there are increasing returns to scale, doubling the inputs will more than double the output. Here we found that the sum of $(\beta_1 + \beta_2 + \beta_3 + \beta_4) = 9.034$, which indicates the increasing returns to scale.

Conclusion

In this we tried to measure the productivity of BOC Bangladesh Limited. From the above analyses it has been found that the growth rates of the elements of total income and total expenditure indicates the excellent increasing trends during the study period. Though the average productivity of BOC Bangladesh Limited is favorable during the period, but it is not highly satisfactory. It has been found that the changes of expenditure of BOC Bangladesh Limited are nearly or equal to changes of its income during the period, as a result the productivity did not increase significantly. The Cobb-Douglas production function shows a significant relationship among the dependent variable like total income and the elements of expenditure such as Cost of Goods Sold, Admn. Expenses, Interest expenses and Tax expenses. This production function indicates an increasing return to scale, which reveals that if the elements of cost increase the income of BOC Bangladesh Limited will be increased more than double.

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Appendix

Income Statement of BOC Bangladesh Limited

(Tk. In Lakh)

Particulars	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Net Sales	4775	4613	4738	5298	6045	6807	7546	8429	10219	10467	11718	12878	12894	12241	15534.3	23589.55
Cost of Goods Sold	3470	3004	3011	3359	3839	4411	4901	5257	6426	6012	6758	7530	7659	7495	10264.2	15581.98
Admn. expenses	586	690	744	872	1002	1482	1719	2096	1882	2036	2319	2471	2681	2707	2954.86	4755.45
Other Income	120	139	259	330	133	32	43	418	23	31	-30	31	149	62	25.25	156.01
EBIT	839	1058	1242	1397	1337	946	969	1494	1934	2450	2611	2908	2703	2101	2316.87	3252.12
Interest expenses	1	0	0	0	2	111	176	223	304	257	401	221	111	150	132.66	43.88
Tax	380	294	456	480	523	241	56	85	170	160	190	597	525	520	647.98	901.73
Net Income	458	764	786	917	812	594	737	1186	1460	2033	2020	2090	2067	1431	1559.85	2462.52

Source: Annual Reports of BOC, 1991-2006