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A study on Production Behaviour of Bongaigaon Refinery of Assam

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Abstract- Petroleum industry has important role in the process of industrialisation of Assam. There are four oil refineries in the state-Digboi Refinery, Guwahati Refinery, Bongaigaon Refinery and Numaligarh Refinery Limited. Bongaigaon Refinery, the third refinery in Assam was set up as public sector limited company in January 1972 and was commissioned in 1974 with headquarter at Dhaligaon in the old Bongaigaon district of Assam. The objective of the study is to analyse the production behaviour of Bongaigaon refinery using two production functions- Cobb-Douglas (C-D) production function and Constant Elasticity of Substitution (CES) production function.

Index Terms: Production Behaviour, Production Functions, Petroleum Industry, Assam.

I. Introduction

Assam has a unique historical distinction with regard to the process of industrial development like some other states of the country like Maharastra and West Bengal. In fact, the base for industrial development of the State was started with the establishment of tea plantation and oil industry in the upper Assam area as were the cases of Maharastra and West Bengal in regard to cotton textile and jute textile industries respectively. Although the rate of process of industrial development in Assam is slow compared to many emerging States like Gujarat, Haryana, etc. in spite of that the petroleum industry has made significant contribution to the process of industrial development in the State.

The petroleum crude oil in the country was first discovered in 1866 in and around Digboi and Naharkatia in upper Assam and consequent upon it, a refinery was established in Digboi under Assam Oil Company in 1901, a then British Company responsible for exploration and production of petroleum product in Assam.

The percentage contribution of Petroleum Industry towards Gross State Domestic Product ranges between 8 to 10 percent. (Report, Indian Bureau of Mines, Nagpur, 2005). Petroleum Sector in Assam provides direct and indirect employment to about 10,000 people. It may be noted that the direct employment of Bongaigaon Refinery was 1723 in 2005-06.

But indirect employment generation in the State as well as in the rest of the country in several times more than the direct employment due to linkage effects. Moreover, backward and forward linkages of the petroleum refining sector as a whole on the aggregate economy of Assam is quite significant. (Govt of Assam, Report, 1990).

At present, there are four Refineries in the State – Digboi Refinery, Guwahati Refinery, Bongaigaon Refinery and Numaligarh Refinery.

The first commercial activity of the Digboi refinery started with the despatch of the first batch of Kerosene to the market in January 1902. Digboi Refinery was entirely rebuilt in 1923. Simultaneously, the oil field production and refinery capacity increased. Ultimately Digboi emerged into a cost efficient commercially viable unit.

Establishment of another new refinery became necessary after discovery of new crude oil fields in the District of Sibsagar in upper Assam. The second refinery was commissioned at Noonmati area of Guwahati in 1961 and managed by Indian Oil Corporation (IOC) with the refining capacity of 1 MMTPA (million metric tonnes per annum).

Bongaigaon Refinery, the third refinery in Assam was set up as Public Sector Limited Company in January 1972 and was commissioned in 1974 with headquarter at Dhaligaon in the old Bongaigaon District of Assam, with the refining capacity of 2.35 MMTPA.

Again the Government of India set up the 4th Refinery in Assam at Numaligarh under Golaghat district of Assam. This new company, Numaligarh Refinery Limited (NRL) was set up in 1993 with the refining capacity of 3 MMTPA.

The factor which tempted to choose Bongaigaon refinery among the refineries of Assam for our study is that it is one of the high profit making refinery.

In 2005-06, profits before tax and profits after tax of Bongaigaon Refinery are Rs. 267.27 crores and Rs. 174.26 crores respectively.

The refinery consists of Crude Distillation Unit (CDU), Kerosene Treating Unit (KTU), Delayed Coker Unit (DCU) and Coke Calcination Unit (CCU).

II. OBJECTIVE

The object of the study is to analyse the production behaviour of Bongaigaon Refinery in terms of productivity, rate of return, economic efficiency etc. using two standard production functions like Cobb – Douglas (C-D) production function and Constant Elasticity of Substitution (CES) production function.

III. HYPOTHESIS

The hypothesis of the study is that the refinery is running under increasing returns to scale with high economic efficiency.

IV. METHODOLOGY

The production behaviour of Bongaigaon refinery is investigated with the help of production function. In this study production functions, namely, Cobb-Douglas (C-D) production function and Constant Elasticity of Substitution (CES) production function are applied in our empirical investigation.

The usual Cobb-Douglas production function in the form

$$Q = AK^{\alpha}L^{\beta}e^{u}$$

Where Q, K and L denote output, capital and labour and A, α and β are the parameters and u is random variable, is used in the estimation of the production behaviour of Bongaigaon refinery. Parameters are estimated using the Least Square Method after logarithmic transformation of the variables. (Cobb C.W. & Douglas P.H., 1928)

The generalized form of Constant Elasticity of Substitution production function developed by Arrow, Chenery, Minhas and Solow,

$$Q = A[\square K^{\square}+(1-\square)L^{-\square}]^{-\square\square\square\square}e^{u}$$

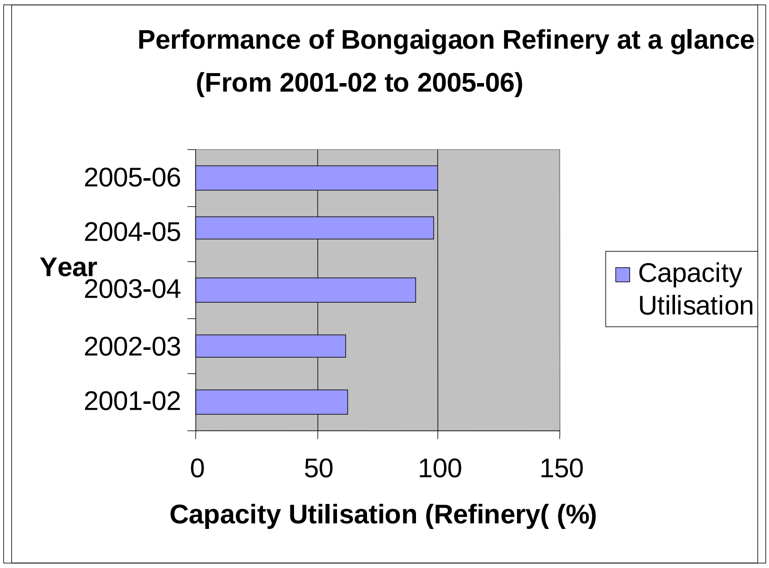
Where Q, K and L have the same meaning as in the case of C-D production function, has been used in our empirical investigation. The CES production function has been estimated adopting Kmenta's method. (Kmenta, 1986)

The status of production of Bongaigaon refinery in recent years has been furnished in the Table (1)

Table 1. Performance of BRPL at a glance (From 2001-02 to 2005-06)

Year ended 31 March	2001-02 Rs. Lakh	2002-03 Rs. Lakh	2003-04 Rs. Lakh	2004-05 Rs. Lakh	2005-06 Rs. Lakh
Crude throughput (Refinery) (MMT)	1.475	1.463	2.127	2.311	2.356
Capacity Utilisation (Refinery) (%)	63	62	91	98	100
Distillate yields (Refinery) (%)	81.2	82.8	85.8	84.1	89.5
Fuel Loss (Refinery) (%)	6.5	6.5	5.6	5.5	5.4

Source : 32nd Annual Report 2005-06, BRPL



Highlights of Physical Performance:

- The percentage of capacity utilization in BRPL is satisfactory in recent years. In 2005-06, 100% capacity utilization creates a record in the history of BRPL.
- The refinery processed 2.35million tonnes of crude oil in 2005-06 which is also remarkable.
- In 2005-06, there is lowest fuel & loss of 5.4% on crude throughput. Previous year fuel & loss was 5.5%.

In 2001-02 distillate yields of the refinery was 81.2%, which again shows satisfactory yield i.e. 89.5% in 2005-06.

From above analysis it is found that the physical performance of refinery is most satisfactory in the year 2005-06.

Review of Literature on Empirical Production Function:

A good deal of analytical literature exists at broad levels like comprehensive analysis of various industries. But few empirical studies have been carried out relating to the production behaviour of specific industries.

Some studies relating to the production behaviour of industries are :-

Recently a number of authors like Buck and Atkins (1976), Dixon and Thirlwall (1975), Tooze (1976) have fitted Constant Elasticity of Substitution (CES) production function to regionally differentiated census of production data for U.K. manufacturing industries. The estimated values of parameters of these production functions especially the value of the elasticity of substitution have been used both in the analysis of regional problems and as a basis for regional policy recommendations. Pokorney (1993) used Cobb-Douglas (C-D) production function for the estimation of behaviour of U.K. coal- mining industry. He used a time series data over the period 1964 to 1980.

There have been many applications of C-D production function to individual industries. An interesting contribution based almost completely upon engineering data in the metal machine industry is a study by Kurz (1963).

A study on cross-section production functions and the elasticity of substitution in American manufacturing industry was done by C.E. Ferguson (1963). The author used international data from 19 countries and 24 industries to fit this regression. The author used Arrow, Chenery, Minhas, Solow (ACMS) model. He found that the elasticity of substitution between capital and labour in manufacturing industry was less than unity.

A study on production functions for Australian manufacturing industries was done by W.T. Burley (1973). This paper takes as its point departure the Arrow, Chenery, Minhas, Solow (ACMS) (1958) time series estimation of the side relationship of the CES production function and proposes an energy measures of capital namely, horsepower.

Another well known cross section study is by Hilderbrand and liu (1965). Though they took a C-D production function but allowed an important modification. The parameters α and β are taken to vary over the cross section and depends on the quality of capital and labour. Their model is –

$$Q = AK^{\alpha\ (InRi)}\ L^{\beta(InSi)}\ €i$$

Where Ri and Si are the measures of quality of capital and labour respectively.

Nerlove (1963) also used cross section data to study the behaviour of US electric supply industry. He studied the returns to scale of the industry.

Dhrymes (1965) did some extensions and facts for the CES class of production functions.

An alternative estimates of the elasticity of substitution – an inter-metropolitan CES production function analysis of U.S. manufacturing industries, 1958-1972 was prepared by Christos C. Paraskevopoulos (1979).

Clague (1967) did an international comparison of industrial efficiency between Peru and U.S. by fitting CES production function. The study is important in the sense that the careful studies on inter-country differences in productivity are few in number. The study measured the efficiency parameters of eleven manufacturing industries in Peru and the U.S.

Another related work on the efficiency of cotton textile industry in various countries was carried out by the Economic Commission for Latin America (1950). Similarly, attempt was made by Health (1957) to measure the efficiency of a group of industries taken together in Canada and Britain, by fitting C.D. production function.

Ashraf (1986) in one of his studies fitted CD production function for different Indian industries. The importance of the study is that the selections of variables were done on the ground that the model should not emphasize only on the demand side or supply side factors, e.g. in one of the models, output is taken to depend not only on industrial power but also on the per-capita income.

Mohanty (1986) exploited C-D type production function to see the behaviour of the small scale industries of Orissa. Mohanty took time series data for five years only from 1976-77 to 1980-81 to estimate the C-D production function, but the study has a limitation of very smaller degrees of freedom.

Edward J. Mitchell (1968) presented a production model with two labour inputs explaining the international pattern of labour productivity and wages.

Thus, keeping in view different production functions used to study the production behaviour of industries, we have adopted the appropriate production functions to suit our data for empirical study of Bongaigaon refinery.

Regression Analysis:

The Cobb- Douglas production function of the following form has been estimated

$$Q = AK^{\alpha} L^{\beta} e^{u}$$

Q = Output produced by the industry, K = Capital, L = Labour,

α, β and A are parameters and u is disturbance term.

Data of 0utput., Labour and Capital have been collected for 16 years. i.e. from 1990-91 to 2005-06.

Table. 2

Estimated Results of Cobb-Douglas (C-D) Production Function of Bongaigaon Refinery

Regressor	Co-efficient	t- ratio

Constant	93.901	-
Capital	1.009	2.806*
Labour	2.384	3.042*

$R^2 = .71$ Degrees of freedom = 13

* significant at 5% level

F = 15.535, significant at 5% level

The estimated results for Bongaigaon refinery shown in the table 2. Elasticity of output with respect to capital (α) and elasticity of output with respect to labour (β) are 1.009 and 2.384 respectively. Since α +β>1, the industry is operating under increasing returns to scale. It implies that proportionate rise in output is larger than proportionate rise in capital and labour inputs. The hypothesis of increasing returns to scale is accepted.

The efficiency parameter A is equal to 93.901 implying high economic efficiency of the industry. One of the hypotheses is of our study is that the industry is operating under high level of economic efficiency. Hence, the hypothesis is accepted. From the statistical point of view the estimated regression line fit the data well because R^2 is .71. That is 71% variation of output is explained by the regressors.

It is found that Variance of Inflation Factor (VIF) is 2. Since VIF is less than 10, there is no severe multicollinearity problem.

The Durbin – watson d statistic is found to be 1.78 implying no autocorrelation.

Estimated Constant Elasticity of Substitution (CES) Production Function

The CES production function of the following form has been estimated for the Bongaigaon refinery –

$$Q = A[\square K^{\square}+(1-\square)L^{-\square}]^{-\square\square\square\square} e^{u}$$

Where Q is the output produced by the industry, K is capital, L is total labour employed, δ, □, □ and A are parameters and u is the disturbance term. To estimate the above regression equation for Bongaigaon refinery time-series data (period) has been taken into consideration.

The estimated CES production function for Bongaigaon refinery is –

$$\text{In } Q = (11.711) \text{ In } K + 8.085 \text{ In } L + 2.027 (\text{In } K – \text{In } L)^2$$

$R^2 = .84$

F = 21.688, significant at 5% level

Table 3: Estimated Results of CES Production Function of Bongaigaon refinery

A	55.334
δ	3.23
□	.155
□	3.626

For Bongaigaon refinery, the distribution parameter δ is estimated 3.23 and substitution parameter □= .155. Hence substitution between capital and labour is

(1+ □) = .865, which is smaller than unity implying relatively inelastic. Again □□□□□□indicating returns to scale is estimated at 3.626 implies that the refinery is operating under increasing return to scale. The proportionate rise in output is larger than the proportionate rise in capital and labour inputs. Hence the hypothesis of increasing returns to scale is accepted. R^2 is .84. and .81 implying good fit. F statistic is also found to be significant. For Bongaigaon refinery, the efficiency parameter (55.33) is found to be very high implying high level of economic efficiency i.e. the industry is operating with good management and satisfactory technical efficiency. Thus the hypothesis of high economic efficiency is accepted.

The hypothesis of the study is tested by using two production functions i.e. Cobb-Douglas (C-D) production function and Constant Elasticity of Substitution (CES) production function. In the estimation of these two production functions, we get that the Industry is running under increasing returns to scale with high economic efficiency. The high economic efficiency is seen implying efficient management as well as high technical efficiency. That is, hypothesis is found to be true.

In view of the shortfall in crude oil production in the North East Region vis-à-vis the available refining capacity, the allocation of Ravva crude oil to Bongaigaon refinery is vital for the economic operations of the oil refineries in the North East. This is helping the north east refineries including Bongaigaon refinery to achieve better capacity utilization.

Implementation of improved quality specification Bharat Stage-II for HSD (High Speed Diesel) and MS (Motor Spirit) has commenced from 1st January 2005. Bharat Stage-III (Euro III equivalent) specifications for HSD and MS have come into force from April 2010.

Besides, Bongaigaon refinery has established a Diesel Hydro treatment facility to meet Euro – III/IV quality specification. Motor Spirit (MS) produced at the refinery conforms to Bharat Stage-II specifications. However for meeting BS-III specification of MS, which is effective from April, 2010 and to lower the production of demand limited Naptha, the refinery has initiated action to implement MS Maximisation & Quality Upgradation Project.

The company is engaging a consultant to study its petrochemicals business to determine the future course of action.

Conclusion : The Board of Directors of Bongaigaon refinery in their meeting held on 7th July, 2005 had approved in principle the merger of the company with holding company Indian Oil Corporation Limited. Further steps are being taken in this direction. It is expected that merger will lead to synergic benefits resulting in improvement in group's profitability.

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