International Journal of Research in Social Sciences
Vol. 8 Issue 3, March 2018,
ISSN: 2249-2496 Impact Factor: 7.081
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

CAPACITY UTILIZATION, PRODUCTIVITY AND PRODUCTION FUNCTION: RESULTS ON PUBLIC SECTOR UNIT (BVFCL, NAMRUP)

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Keywords:
Capacity Utilization;
Productivity;
Causality;
Production Function.

Abstract

This paper analyses the relation between capacity utilization and productivity of BVFCL, Namrup for the period 2003- 2013. The results point out that both in short run and long run the factors are related to each other. However, it is capacity utilization that granger cause productivity. Specification and estimation of CD (Cobb- Douglas), CES (Constant Elasticity of Substitution) and VES (Variable Elasticity of Substitution) production function indicates that BVFCL follows CD production function..

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1. Introduction

An economy is composed of three main activities, namely- production, consumption and distribution and the most important inputs of production are labour, capital and land. Out of the three inputs capital is scarce factor in most of the developing countries which leads to unemployment or underemployment of related production factors, mainly labour, thus leading to a lower growth rate. The presence of disequilibrium in the economy due to underutilization of inputs capacity is reffered to as output gap, which is the discrepancy between the actual output and the potential output. Capacity underutilization is an important issue for industries as it discourages technological progress which shrinks growth and leads to an inefficient industrial structure. A common thread running through various measures undertaken in the industrial sector has been to improve the productivity and efficiency of the industries. This presents us with a paradox: if capital is scarce in developing countries, why is it underutilized?

The three sectors, viz. primary, secondary and tertiary sector are inter-related, due to which the benefits and improvements in any one sector is diffused throughout all the three sectors of the economy. It is therefore very pertinent to improve all the three sectors, for improving the status of the economy. The effective utilization of capacity ensures balance in growth and reflects quality management, appropriate administrative decision of government in licensing of new investment. Proper utilization of capacity reflects the influence of government decision making, the degree of monopolization within an industry, markets supply and demand conditions and the attitude of the managers of the firms in utilization of capacity in under developed countries.Capacity utilization should be effectively done as most of the public sectors are highly capital intensive but their built in capacity is hugely underutilized, therefore continued, regular and intensive monitoring of all major public sector enterprises is essential . A measure of Capacity Utilization (CU) is necessary to know the levels of the utilization of existing production capacity in the production process. Measuring the rate of capacity utilization requires identifying the capacity output Y* and then, the capacity utilization rate is defined as the ratio of the actual output Y_o to capacity output Y* (Kirkley et al., 2002) i.e.,

$$CU = Y_o/Y^*$$

The economic concept of productive capacity is usually defined as the output which can be produced at minimum average total cost, given the existing plant and organization of production and factor prices. Engineering capacity refers to the maximum potential output per unit of time that a plant can produce under given conditions when there are no constraints on the flow of variable inputs and no cost boundaries. The two concepts differ as certain volume of production with the existing capacity may be technically feasible but not economically possible. Whereas, the operating concept of capacity depends on various factors, such as number of shifts in work, quality of managerial staff, availability of repair and replacement parts. Decision of capital expansion or multi-shift operation will be undertaken depending, on the alternative costs and gains both in short –run and long- run. For developing countries purchase of new equipment is costly and not easily available, thus, the use of multi-shift operation is more favourable in developing countries like India. Multi-shift operation would save additional capital outlay and at the same time generates employment opportunities without involving additional capital expenditure. The engineering measure of capacity is a physical measure, its estimation doesn't require information regarding input prices. Alternatively, economic measure requires the information regarding the prices of factor inputs to estimate a cost-function. Engineering definition of capacity is most preffered and incidentally the same definition is the basis of the capacity definition of central statistical organization(CSO), Ministry of Statistics and Program Implementation, India (Paul, 1974).

Agriculture being the prime occupation of the state, income generation and economic development of the region is integrated with agricultural production. The productivity of the agricultural sector is dependent on the use of fertilizer beside resources like cultivable land, irrigation facility and high yielding seeds. Modernization of agriculture sector is essential to ensure the food security to its rapidly growing population. Thus, it is expected that the demand for fertilizer will increase in the future and to meet the increasing demand of fertilizer ,the full capacity utilization of existing capital by fertilizer industry plays a significant role. Capacity utilization measures the proportion of available productive capacity of an economic unit that is currently utilized. One of the critical determinants of productivity is the rate at which installed capacity has been utilized. An increase in the utilization of existing capacity increases the output without any need to undertake additional investment in capital stock. Capacity utilization is one of the major indicators of the efficiency of the industrialization process as it influences the cost of production, profitability and the generation of internal resources.

Total factor productivity (TFP) shows the relationship between a composite input and the output of production process. Economic growth can be obtained either by increasing inputs or by improving factor productivity. Productivity growth occurs when a higher output can be attained with a given amount of input, or a certain level of output can be attained with smaller amounts of factor input, i.e. improve efficiency. Productivity is not everything, but in the long run it is almost everything (Krugman, 1990). Thus, in the course of time the only sustained manner to increase per capita gross domestic production (GDP) is possible through increasing the amount of output produced by a given quantity of inputs that is raising total factor productivity (TFP).

Public Sector enterprises have been functioning in almost all the key areas of industrial activity. For growth of the national economy it is necessary that public sector enterprises should be productive. The measurement of productivity is pre-eminently a quantitative and technical problem. The concept of factor productivity gives the contribution which one or all used factors make to production. This concept is reflected in a ratio between product (output) and the factor or factors used (input). BVFCL is the only urea producing company in the entire Assam, other North-Eastern States, West Bengal and Bihar where still a supply shortfall to the extent of 26 Lakh MT exists. The unit being close to the source of Feed/ Fuel Natural Gas lowers basic cost of Natural Gas and hence lowers absolute cost of production in the units. Lower transportation cost of the natural gas because Namrup plants are located near the gas generation points, offsets high cost of transportation related to supply of urea to companies situated in other distant North-Eastern states of India.It becomes crucial to study the pattern and level of growth of productivity and efficiency of the only fertilizer unit of NER. Changes in productivity become all the more significant for the developing countries where the resources are limited in supply and have a very high social opportunity cost. Productivity, capacity utilization and efficiency are all interelated.
In economic analysis the concept of production function is integral and literature defines it as the functional relationship between outputs and inputs of an economic process. The study of production function provides a link between input market and commodity market as it helps to make investment decisions on choice of production technology which influences investment

pattern and helps in income distribution because one can work back to the distribution of the proceeds of production from the production function itself. The study of production function often assumes a specific numerical value for elasticity of substitution which is an important parameter of econometric studies. The use of the popular Cobb-Douglas (CD) function implies that elasticity of substitution, denoted by σ, equals unity, while the use of the less popular fixed coefficient model and straight-line isoquant (the linear) production function implies that σ equals zero and infinity respectively. This parameter, however, can assume any value between zero and infinity. Famous constant elasticity of substitution (CES) production function (Arrow, Chenery, Minhas, and Solow, Brown and de Cani) allows the value of the parameter σ to be constant. However, the elasticity of substitution parameter σ can be a variable depending upon output and/or factor combinations (Hicks, Allen), so that the assumption of a constant σ may lead to specification bias. The most widely used production function, in recent times, has been the constant elasticity of substitution (CES) production function (Arrow et al, 1961) which includes Cobb-Douglas as well as Leontief formulations as special cases (Kazi. 1980). But it has the restrictive assumption; the elasticity of substitution parameter in this production function is not variable along an isoquant, though it can take different values for different industries. The variable elasticity of substitution production function (VES) or homothetic production function' over- comes this defect of the CES, as it explicitly permits the capital-labour ratio to be an explanatory variable of productivity which does not enter into the theoretical and empirical specification of the CES production function.

1.Review of Literature:

Banerjee (1971) attempted to relate the resource use pattern in the industrial sector with productivity by analyzing productivity trends in Indian manufacturing industries for the period 1946-58 and 1959-64. During both the period under consideration the growth of labour productivity was relatively more than growth of capital productivity. The increase in labour productivity was achieved mostly as the industry was becoming capital deepening and fall in capital productivity was due to inefficient employment of capital. Total productivity was measured using Solow Index, Kendrick Index and finally CES production function. But the analysis justified the existence of C-D production function and also increasing returns to scale. Trends in productivity of Indian manufacturing industries were analysed by Goldar(1983) for the period 1951 -78. The estimates of C-D production function was found to be unsuitable, CES was used. Kendrick index, Solow index, and Translog index found labour productivity to be rising due to increase in capital intensity, whereas capital productivity was showing a declining trend. Under utilization of capacity was noticed due to shortage of fuel, power and improper infrastructure. This was affecting productivity negatively and less attention was paid to improve the efficiency of the manufacturing industries. Tisdell and Kibra (1989) studied 40 jute spinning mills using a quadratic function and evidence were found that actual utilized (operating) capacity increases first at a decreasing rate as a function of mill- age and after peaking declines asymptotically. The downward phase is due to machine breakage which is a serious problem because maintenance is poor especially in PSU and spare parts are not available or consist of poor quality substitutes or are available after considerable delays given that many of these have to be imported and foreign exchange is short in supply. Subhramanian (1992) analyzed the partial and total productivity of labour and capital, nature of returns to scale and estimated elasticity of substitution between capital and labour in cotton textile industry. Partial productivity of labour was found to increase due to capital intensity and that of capital has fallen due to decline in capacity utilization as a result of frequent power cuts. Both Kendrick and Solow estimates of TFPG indicated a decline due severe power cut, workers strike, and others. In the study it was found that as both Kendrick and Solow assumed linear homogeneous production function and Hicks neutral technical progress which was not suitable for Indian industry, So, Subhramanian opted to estimate production function and observed that Indian industry had CES production function which assumed decreasing returns to scale. The average TFPG rate at the aggregate level was -8.6% in the pre-reform period, but was -5.2% in the post-reform period. Kumari (1993) analyzed productivity in 11 groups of manufacturing industries in India's public sector, viz steel, minerals and metals, coal , chemicals, power, petroleum, heavy engineering goods, medium and light engineering goods, transportation equipment, consumer goods and textile industry, using Kendrick index, Solow index and Divisia index.And application of Cobb-Douglas production function estimation reveal constant returns to scale for public sector groups like minerals and metals, coal, power, petroleum, chemicals, heavy engineering, medium and light engineering and textiles, and for rest it was not constant. Similarly CES production function estimation shows that return to scale is constant for groups like coal, power, chemicals, heavy engineering and textiles and for the remaining it is not constant.

Ahmad (1973) stated that knowledge about capacity utilization is required to know the maximum output that can be produced using existing capacity and required expansion of capacity for targeted output. Employment is directly and per unit capital service cost is inversely related to rate of capacity utilization. There can be no economic justification for expansion of capacity until existing capacity is satisfactorily utilized, increased working hours and efficiency would raise production further. Afroz and Roy (1976) in their study for the period 1972-73 found significant under utilization of capacity in manufacturing industries of Bangladesh. The reasons for underutilization of capacity cited were: paucity of foreign exchange to buy raw materials, market demand for the product is low, imbalance in machinery, failure of power supply, welfare implications and managerial difficulties. Sastry (1980) in his paper discussed different measures of capacity utilization viz., Wharton Index of Capacity utilization, The RBI Index of Potential Utilization, Maximum Output per Spindle/Looms, Measure based on two shifts, Minimum Capital- Output Ratio Measure and NPC Measure based on Machine Hours. Sastry finally used Wharton index of capacity utilization, Minimum capital output ratio measure and Maximum output per spindle found decline in capacity utilization during the period. The rate of capacity utilization was around 70% and the important factor determining capacity utilization is availability of raw material in cotton industry of India. Ray and Pal (2008) attempted to estimate the rate of capacity utilization in Indian Chemical Industry at aggregate level and analyzed its trend for a period of 25 years. A declining trend of capacity utilization was noticed after mid 90's due to slow increase in actual output resulting from stagnated demand and rapid expansion of capacity output as a result of abolition of licensing rule consequent to economic reform. Economic measure of capacity utilization is always higher than engineering measure.

2. Objectives:

1. To analyze the relationship between factor productivity and capacity utilization of BVFCL fertilizer unit, Namrup.

2. To assess the production behavior of BVCL fertilizer unit, Namrup.

3. Data: The main source of data, used for the study is secondary data drawn from the annual reports of the selected unit from 2003-2013.

3.1. Measurement of Output:

The variable output (V) has been defined as gross value added. The value of output has been deflated by the commodity price index (wholesale price index or WPI), compiled from different volumes of the 'Index Numbers of Wholesale Prices in India'. The index numbers for the years 2005-2013 were given at the base 2004-05, whereas for the rest of the period (2003-2004) the base year is 1995-96. The price index corresponding to the years 2003-2004 have, therefore, been converted into the 2004-05 base before deflating the output series.

3.2 Measurement of Capital

The perpetual inventory method, which is based on the relationship between the capital stock at a point of time and investments up to that point, has been used for this purpose. Let Ko denote the base year capital stock, $\mathbf{I_t}$ the gross investment (at base year prices) in fixed assets in year t, then fixed capital stock in year T denoted by K_T is given by:

$K_t = Ko + \sum_{t=0}^{T} It$

The gross investment I_t is given by:

$I_t = [B_t - B_{t-1} + D_t]/P_t$

Where B_t is the book of fixed assets at the end of year t, D_t is the amount of depreciation allowances made during year t and P_t is the capital goods price deflator.

The capital goods price deflator is a weighted average of price indices of value of investment on completion of construction and installation works and on purchases of equipments and instruments, the weights being relative magnitudes (50%) of these two categories of assets in the base year. For construction, the implicit price deflator is computed as the ratio of the index of gross domestic capital formation at current and constant (2004-2005) prices obtained from the RBI, Statistical Handbook of Indian Economics is used. The official Wholesale Price Index Number of Machinery and Transport Equipment of 1993-94 from the RBI is used. It is then converted 2004-05 base.

3.3 Measurement of Labour:

In case of labour, the stock available to the industry is the number of persons employed by it during a year. Total employees are used as a measure of labour, as it includes both workers as well as persons other than workers.

4.<u>Relation between TFP (Translog) and CU:</u>

TFP needs to be adjusted for pro-cyclical movements, downturn periods in demand are characterized by excess capacity whereas during upturn periods production capacities are fully utilised. Hence, TFP estimates could be biased if capacity utilisation is overlooked in productivity analysis. For analysis the relation between productivity and capacity utilization; the Translog Productivity Index and Taylor mehod of capacity utilization is being used.

4.1 Stationarity: The stationarity properties of the time series variables have been checked by using Augmented Dickey-Fuller (ADF) unit root test as proposed by Dickey and Fuller (1981). The ADF unit root test requires the estimation of the following regression.

$$X_t = \alpha + \beta t + \rho X_{t-1} + \varepsilon_t$$

Where, α is the intercept, β is the co-efficient of lagged term, ρ is the number of lagged term chosen to ensure that ε is white noise. The optimal lag length is chosen by using the Akaike Information Criteria (AIC). Based upon this estimate the hypotheses of the test are:

H_0: ρ= 1, i.e., there is a unit root – the time series is non-stationary.

H_1: ρ< 1, i.e., there is no unit root – the time series is stationary.

Table 1:ADF Test Result (2003-2013) (No Intercept, No Trend)

Variables	**ADF test Statistic**	**Critical values**	**Decision**
TFP TRANSLOG	-1.936 [3]	-1.950	Unit root or non-stationary at level
CU	0.924 [2]	-1.950	Unit root or non-stationary at level
DTFP	-3.167 [3]*	-1.950	I(1) i.e. stationary at first difference
DCU	-1.818 [2]**	-1.600	I(1) i.e. stationary at first difference

The critical values are those of Davidson and MacKinnon (1993)

**Indicates 5% significance level and ** indicates significance at 10 %. It represents rejection of null hypothesis of unit root at 5% and 10% of the critical values. The figure in the parenthesis indicates lag order. The lag selections are in compliance with the Akaike Information criteria.*

The results of ADF unit root test shows that the null hypothesis of the presence of a unit root is rejected for both the variables of the study when they are transformed into their first differences. That is, both the series are stationary on first differencing. Therefore CU and TFP are integrated of order one i.e. I (1). After confirming stationarity of the two series, the study proceeds to conduct co-integration test to ascertain that the variables are co- integrated.

4.2 Co integration: The Johansen Co integration test can be rightly applied as the unit root test determined that all the series are integrated of the same order I (1). The test is carried out by using two statistics, the Trace Statistic (λ_{trace}) and Max-Eigen Value Statistic (λ_{max}).

(a) The trace test (**λ_{trace}**) is represented as follows:

$Trace = -T\sum_{r+1}^{n}(\log\lambda_i)$ ---------- (1)

In equation (1) the trace test evaluates the null hypothesis that there is r or less cointegrating vectors against the alternative hypothesis that there are more than *r*.

(b) The maximum Eigen value test (**λ_{max}**) is represented as follows:

λ_{max} $= -T\ log(1-\lambda_i)$ (2) ----------(2)

In equation (2) the null hypothesis is that there are exactly r cointegrating vectors as opposed to the alternative hypothesis that the cointegration vectors = r+1.

According to this procedure based on 'Maximum Likelihood method' and 'Eigen value statistics', co-integration is said to exist if the values of computed statistics are significantly different from zero. If the variables are found to be co-integrated, it implies the existence of a linear, stable and long-run relationship among variables. This means that the variables tend to move together to its steady state path in the long run.

Table 2: Results of the Johansen's Test of Cointegration- Results for CU and TFP

Null Hypothesis(λ_{trace} test)	Trace Statistic	5% Critical value
r=0	31.12*	15.41
r ≤0	3.85	3.76
Null Hypothesis(λ_{max} test)	Max Statistic	5% Critical value

r=0	27.27 *	14.07
r ≤0	3.85	3.76

** Implies rejection of the null hypothesis of no cointegration at 5% critical level.*

***r** refers to the number of cointegrating equation*

From Table 4, it is observed that Trace statistics and Maximum –Eigen statistic for null hypothesis for no cointegration relations is rejected at 5 per cent levels. In the line of both Maximum –Eigen statistic and Trace statistics, there is a cointegrating relationship among the variables. It is confirmed that there is more than 1 cointegrating relation among the variables. The results of the unrestricted cointegration rank test confirmed that there is a long run significant relationship among TFP and CU. In line with theory, these tests demonstrate that in the long run, TFP of BVFCL is related to its CU. This test accepts the hypothesis that there exist a long run relation between CU and TFP. As the variables are co integrated we run VECM,to check their short run relationship.

4.3 Vector Error Correction Modelling (VECM): Vector Error Correction Modelling (VECM) is a special case of the VAR model that provides important information on the short run relationship between any two cointegrated variables. The VEC specification restricts the long run behaviour of the endogenous variable to converge to their cointegrating relationships while allowing for a wide range of short run dynamics. The cointegration term is known as the error correction term (speed of adjustment) since the deviation from long run equilibrium is corrected gradually through a series of partial short run adjustments. Therefore, VEC specification provides evidence on the short run causality among variables concerned for models that are not stationary in their levels but are in their differences (i.e., I(1)). The following model specifies vector error correction estimates in the present study, involving two variables, $X_t$and Y_t which are cointegrated:

$$\Delta X_t = a_1 + b_1 ect_{1t-1} + \sum_{i=1}^{m} c_1 \,\Delta X_{t-i} + \sum_{i=1}^{n} d_1 \,\Delta Y_{t-i} + e_{1t}$$

$$\Delta Y_t = a_2 + b_2 ect_{2t-1} + \sum_{i=1}^{m} c_2 \,\Delta Y_{t-i} + \sum_{i=1}^{n} d_2 \,\Delta X_{t-i} + e_{2t}$$

. Where, $\Delta X_t =$ first difference of TFP

ΔY_t = first diffence of CU

e_{1t} and e_{2t} are white-noise residuals

ect_{1t-1}, ect_{2t-1} are error correction terms

The VECM specification illustrates that if the coefficient of the error correction terms are statistically significant, then the system is in a state of short run disequilibrium and the value coefficient represents the proportion of disequilibrium that is corrected in the next period. On the other hand, if the coefficient of error correction terms were found to be statistically insignificant it would imply that the system under investigation is in the short run equilibrium

Table 3:Results of VECM Test

Variables	DTFP	DCU
ECT	-.71**(.073)	.018(.04)
DTFPG(-1)	-.48 **(.09)	-.026 (.052)
DCU(-1)	-7.42** (1.06)	-.386 (.606)
CONST	.106 (17.84)	.084 (10.15)
R-sq	0.95	0.40
Chi2	95.62**	3.42
Log likelihood= -74.86 AIC= 18.63 SBIC= 18.83		

*Standard errors are given in parenthesis. ** Significant at 5 %,*

The VECM test results are provided in Table 3, the error correction term (ECT, which shows the speed of adjustment in the system) is significant and has correct sign. The value of ECT implies that 71(approx) % of the disequilibrium in the system gets corrected in one quarter, when TFP is the dependent variable. The coefficients of lagged variables are significant implying that short run causality relationship exists among the study variables.

4.4 Granger Causality tests:

This study uses Granger Causality Test suggested by C. W. J. Granger (1969) for testing the causality between TFP and CU, in the VAR framework. A time series, X, is said to Granger-cause another time series, Y, if using past values of X improves the prediction of current values of Y. This can be tested by running a regression of Y on past values of Y and X.

The null and alternative hypotheses of the test are:

H0: No causal relation between Total factor productivity (TFP) and Capacity Utilisation (CU)

H1: Causality between TFP and CU.

The above hypothesis are tested in the context of the VAR of the following form of bivariate linear auto-regressive model of variables x_t (TFP) and y_t(CU).

$$y_t = \sum_{i=1}^{n} \propto_i \ x_{t-j} + \sum_{j=1}^{n} \beta_j \ y_{t-j} + u_{1t}$$

$$x_t = \sum_{i=1}^{n} \alpha_i \ y_{t-j} + \sum_{i-1}^{n} \delta_j \ x_{t-j} + u_{2t}$$

Table 4: Results of GRANGER CAUSALITY TEST

Lag	Null hypo	F- Statistics	p-value
2,2	TFP does not cause CU	**.49593**	**0.6421**
2,2	CU does not cause TFP	**20.232**	**0.0081****

*** significant at 5%*

The test result suggests lag order of 2 as optimal lag based on Akaike information criterion. The null hypothesis ‘TFP does not granger-cause CU’ is accepted. But the null hypothesis ‘CU does not granger-cause TFP’ is rejected at 5% level of significance. Thus, the results suggest uni-directional causal linkage between TFP and CU in case of BVFCL, i.e improvement in CU improves productivity.

5. Specification and Estimation of Production Function:

The production function captures the relation between output and input, algebraically it can be represented as:

$Q = f(K, L)$

Where, $K(\geq 0)$ and $L (\geq 0)$ represents the amount of capital , labour and (Q) value added. In particular, CD production functions can be specified as follows:

$Q = A K^{\alpha} L^{\beta}$

The specification of C D production can be arrived as:

$\text{Log } Q = a_0 + a_1 \text{ Log } K + a_2 \text{ Log } L$

Table: 5 Estimation of CD production function without Technical Progress

Variables/ Parameters	Estimated Coefficient	p- value
Constant (a_0)	226.48	0.49
Log K (a_1)	-18.11	0.55
Log L (a_2)	-2.95	0.006
RTS (a_1+a_2)	-21.06	-
Adj R-squared	0.55	-
F statistics	7.05	0.01

Note : RTS represents returns to scale Source: Author's Calculation

Table 4 result shows that only the co -efficient of labour is significant but with an inverse relation with output. The Adj R^2 value is 0.55, which indicates that 55% variation in output is explained by the regressors.

Table: 6 Parameters of CD production function without Technical Progress

Variables/ Parameters	Estimated Coefficient
Distribution	0.86
RTS	-21.06

Note : RTS represents returns to scale

Source: Author's Calculation

The return to scale for CD production function indicates decreasing returns to scale. The distribution parameter represents the share of the capital in BVFCL is 86 percent. Thus, the remaining 14 percent share is attributed by labour. As share of capital is so huge, improvement in technology becomes highly essential. The elasticity of substitution equals to unity which implies that the factor shares will remain constant for any capital-labor ratio because any changes in factor proportions will be exactly offset by changes in the marginal productivities of the factor inputs. Thus, the observed income shares will be constant through time.

The validity of the Cobb-Douglas function has been questioned as empirically the value of the elasticity of substitution is not necessarily restricted to unity and much evidence has shown that the capital and labor can be substituted for each other in varying degrees. It is unlikely that the substitutability is uniform in different sectors and in different industries.

The CES production function is intrinsically non-linear, which indicates that there is no direct way to estimate the parameters by OLS. However, Kmenta (1967) suggested that OLS technique could be used, by showing that, the CES could be approximated by the following equation:

$Q= A[\ \delta K^{-\rho} + (1-\delta)L^{-\delta}]^{\nu/\rho}$

$\text{Log } Q = \text{Log } A + \nu\delta \text{ Log } K + \nu(1- \delta)\text{Log } L - (1/2)\nu\delta\rho(1- \delta)\ (\text{Log } K - \text{Log } L)^2 + u_i$

This form is similar to the CD specification except for the addition of the squared term. Cobb-Douglas production function hypothesis can be tested by examining the coefficient attached to $(\text{Log } K - \text{Log } L)^2$. The above form can be written as:

$\text{Log } Q = a_0 + a_1 \text{ Log } K + a_2 \text{ Log } L + a_3 (\text{Log } K - \text{Log } L)^2 + u_i$

Table: 7 Estimation of CES production function without Technical Progress

Variables/ Parameters	Estimated Coefficient	p- value
Constant (a_0)	468.9	0.18
Log K (a_1)	-86.98	0.12
Log L (a_2)	52.87	0.15
(Logk-log L)^2 (a_3)	7.69	0.13
RTS (a_1+a_2)	-34.11	-
Adj R-squared	0.46	-
F statistics	6.74	0.01

Note : RTS represents returns to scale

Source: Author's Calculation

This function is linear and homogeneous, i.e., there are constant returns to scale. The efficiency parameter y changes output for given quantities of inputs; the distribution parameter δ ($0 \leq \delta \leq l$) determines the division of factor income. Table 6 provides the estimates of the coefficients of the model. The estimated coefficient of a_3 is statistically insignificant reflecting CD production function is applicable for BVFCL. Only 46 percent of variation in output is explained by the regresor.

Table:8 Parameters of CES production function without Technical Progress

Variables/ Parameters	Estimated Coefficient
Distribution	2.54
RTS	-34.11
Substitution	-0.29
Elasticity of Substitution	0.77

Note : RTS represents returns to scale

Source: Author's Calculation

The return to scale reflects decreasing returns to scale. The substitution parameter presents the elasticity of substitution is 0.77, which is not significantly different from 1. Such a unitary less elastic coefficient represents that proportionate change in capital labor ratio is less than the proportionate change in their respective prices, i.e it is relatively inelastic.

The CES function is also subject to the restriction or limitation that the value of the elasticity of substitution is constant, although not necessarily unity. When $\sigma > 1$,an increasing share of national income goes to capital as the capital-labor ratio increases. If $\sigma < 1$, then capital's share declines as this ratio increases. When $\sigma = 1$, income shares are unaffected by changes in the capital-labor ratio.

However, when the capital/labor ratio varies due to changes in the factor price ratio, it is possible that the elasticity of substitution does not remain constant. Thus, production function with the property such that the elasticity of substitution could vary as the capital/labor ratio varied, is more desirable.

Revankar proposed a variable elasticity of substitution production function, where the elasticity of substitution could vary as the capital/labor ratio varies. He started with the hypothesis that the elasticity of substitution is a linear function of capital and labor; thus

$\sigma= \sigma(K,L)$

$= 1+ (\rho-1 / 1-\delta\rho)K/L$

Based on this hypothesis, he proposed a production function of the form

$V = \gamma K^{\alpha(1- \delta\rho)} [L +(\rho - 1)K]^{\alpha\delta\rho}$

Where α,δ,ρ, and γ are parameters.

$\gamma > 0$, $\alpha > 0$, $0 < \delta < 1$, $0 \leq \delta\rho \leq 1$, $L/K > (1-\rho)/1 - \delta\rho$

Taking log on both sides, the equation transforms into,

Log V = log γ + α log K +$\alpha\delta\rho$ log L+ $\alpha\delta\rho^2$ log K (considering log $\gamma = A_0$, α=1 constant returns to scal**e)**

Table: 9 Estimation of VES production function

Variables/ Parameters	Estimated Coefficient	p- value
log γ	226.48	0.48
A	-0.45	0.53
P	6.48	0.52
Adj R-squared	0.54	-

Source: Calculated by the author

The elasticity of substitution varies linearly with capital-labour ratio. As ρ increases from zero to $1/\delta(> 1)$, the elasticity of substitution increases steadily from 0 to infinity. In VES model, if the elasticity of substitution is less than 1, which indicates that elasticity of substitution increases as the industry gets more labour intensive and vice versa. But in the present analysis the condition, $L/K > (1-\rho)/1 - \delta\rho$, associated with the VES model forwarded by Ravenkar is not satisfied. Thus, CD production function is most suited for BVFCL; i.e it has unitary elasticity of substitution.

6. Measures of Returns to Scale:

The term returns to scale refers to the changes in output produced when all the factors of production are changed by the same proportion. The returns can be constant, increasing or decreasing over the entire range of production. In the Cobb-Douglas production function the sum of the parameters α and β shows returns to scale. This study attempts to see the nature of returns to scale for BVFCL by checking the hypothesis that the industry is running at constant returns to scale. For this purpose the study makes use of restricted and unrestricted least squares (RLS & URLS) techniques as outlined below (Gujarati 2007).

The general form of Cobb-Douglas production function in log linear form is

Log Q = Log A + α Log K + β Log L + u -------------------(i)

Where Q is output, L is labour, K is capital and U is the usual disturbance term and assumed to be white noise. A, α, β are the positive parameters. We want to test whether $\alpha + \beta = 1$ or not for

BVFCL. Both URLS and RLS techniques have been applied in the Cobb- Douglas production function to see whether the industries are running under constant returns to scale or not assuming the null hypothesis that the industry concerned operates under constant returns to scale.

For URLS, first we are to estimate α and β using OLS from (i). And for RLS, the model (i) converts into

$$\text{Log}(Q/L) = \log A + \beta \log (K/L) + u$$

Where Q/L is the output labour ratio and K/L is the capital labour ratio. Now the null hypothesis can be tested using the F – test statistic,

$$F = \frac{(RSS_R - RSS_{UR})/m}{RSS_{UR}/(n-k)}$$

From the Cobb-Douglas production function estimated with the help of ULS technique we got $\alpha + \beta = -21.06$ which appears to depict decreasing return to scale ($\alpha + \beta < 1$). However, it is imperative to examine the hypothesis of constant returns to scale against the hypothesis of decreasing returns to scale.

The F value calculated on the basis of RLS and ULS , is F= 10.09 which is significant at 1% level. Hence the hypothesis constant returns to scale is rejected at 1% level and it can be concluded that the industry is operating under decreasing returns to scale.

7. Conclusion:

The study is based for the time period of 2003 to 2013 makes an attempt to analyse the relation between CU and TFP of BVFCL. The analysis was carried out using econometric and time series tools. The recent Johansen's Test of Co integration, VECM and Granger Causality technique was adopted to find out the short run and long run behavior of the linkages between CU and TFP. The results yielded by these techniques confirm to the actual scenario in the BVFCL, i.e in both long run and short run CU and TFP are related and it's CU which influences TFP and not other way round.

The fertilizer sector serves as an essential infrastructure for the agricultural sectors by providing them the necessary support. In Assam for example, which is primarily agrarian, the expansion and development of the agricultural sector is largely driven by the availability of fertilizer. In the absence of proper fertilizer, agricultural activities would be carried out in primitive ways and there would be no capacity for transformation and modernisation of this sector. Similarly, in the absence of much large scale industries in the state, small scale industries and cottage industries can be developed. Likewise expansion of trade and commerce depends on industrial and agricultural sector improvement. Thus development and expansion of various sectors of the economy depends on industrial health. With development and improvement in fertilizer unit they can expand and enrich their productivity. The increased productivity will help to augment the total output and income of the state. But at the same time it is to be accepted that there is still much more scope for them to build up in this state and thereby channelize the industrial sector. They should strengthen their linkages with the various sectors of the economy to yield high growth rates over time. The production function analysis reveals that CD production is proper for BVFCL and hence the elasticity of substitution is unity. Labour has negative relation with output and capital is insignificant which hints towards the fact that due to insignificant impact of capital the contribution of labour is negative. BVFCL must concentrate on improving productivity by ensuring full utilization of capacity.

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