Allocative and Technical Efficiency of Cricket Bats Manufacturing Industry in Kashmir Valley

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Abstract

The cricket bats manufacturing industry in South Kashmir is a prominent industrial activity with a reputation to supply quality products to the entire country. This paper is an attempt to evaluate the performance of this industry using the concepts of allocative and technical efficiency. The data required for the analysis was collected from 40 unitholders during a field survey in 2016. The technical efficiency was measured by employing the stochastic Cobb-Douglas frontier production function using the software STATA version 13. The results indicate the existence of idle capacity (technical inefficiency) to the extent of 25 percent. On the other hand, it was also observed that the sampled unitholders either overutilized or underutilized the inputs resulting in their allocative inefficiency as well. The education level and the family size were found to influence the efficiency positively.

Keywords: Allocative Efficiency, Technical Efficiency, Cricket Bats, Manufacturing Industry, Kashmir Valley

Introduction

A great deal of literature demonstrates the necessity of upgrading technology for improvements in the growth and productivity of any economic enterprise. However, there is an alternative viewpoint suggesting that if decision-making units are not fully efficient in utilizing the existing technology such a move may lead to a waste of resources. On account of this reasoning, a similar but costless gain is achievable if the firm managers could actually learn to make efficient use of current technology. The efficiency measurement involves two broad concepts, that is, technical efficiency and allocative efficiency. The product of these two efficiencies is referred to as economic efficiency. This paper is an attempt to measure input-specific allocative efficiency and firm-specific technical efficiency of a leading industry associated with the manufacturing of cricket bats in the South Kashmir district of Anantnag.

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This paper is organized into four sections. The first section serves as the background of the problem. The second section on data and methodology explains the nature of the data used along with the model specification. Analysis and interpretation of the results have been done in the third section, followed by the conclusions in the last section.

Background of the Sports Goods Industry

Against the backdrop of the COVID-19 disease, the importance of sport in mitigating the impact of the pandemic on health and well-being is receiving considerable attention globally. Pursuant to the General Assembly Resolution 73/74, the UN SG Report on "Sport: a global accelerator of peace and sustainable development for all" examines and emphasises the ways and means of building global resilience to counter future shocks through investment in sport and sport-related policies. Realizing its significance, the Ministry of Youth Affairs and Sports, Government of India have given a renewed impetus to this activity by launching a national flagship programme "Khelo India" aimed at mainstreaming sports as a tool for national, economic, and community development.

According to India Exim Bank (2021:1-3) the global sports goods industry is expected to be valued at US$600 billion by 2023. The global exports of sports goods stood at US$ 53.3 billion in 2019, with the largest contribution of 42.2 percent coming from China, followed by a share of about 8.6 percent by the USA, 4.2 percent by Germany. While the industry in India exports nearly 60 percent of its total output, the value of exports is low, and the sector accounted for only 0.09 percent of India's merchandise exports during 2019-20. The value of exports is also low when compared to the global market size. India was the 24th largest exporter of sports goods in the world in 2019, accounting for 0.56 percent of the global exports of sports goods during the year. Being the third largest producer in Asia after China and Japan, India currently manufactures more than 300 types of sports goods with the bulk of production coming from the dominant clusters of Jalandhar and Meerut.

The Valley of Kashmir is very famous for manufacturing cricket bats made from locally available willow logs. According to India Exim Bank (2021: 6) "Currently, there are no registered GIs in the sports goods industry, in spite of some products being unique to the country. Kashmir willow bat is one such product, which holds significance as it is made from some of the best quality wood in the world". According to a rough estimate, there are more than 400 CBM units providing employment to about 8000 people in Kashmir.

However, in Kashmir Valley, the only sports goods industry related to the manufacturing of cricket bats has remained confined to certain pockets of South Kashmir, especially on both sides of the National Highway in Bijbehara tehsil of district Anantnag. Although, this activity has also begun to spread in the adjoining district of Pulwama.[3] Moreover, Sethar Sangam in Anantnag has been notified as an industrial cluster for cricket bat manufacturing by the Government of Jammu and Kashmir. In this direction Common Facility Centre, Sethar was established at an estimated cost of Rs 4.61 crore with plant and machinery installed by Process cum Product Development Centre (PPDC)[4] Meerut incurring an expenditure of Rs 2.46 crore. The objective of this CFC is to facilitate the seasoning of willow clefts and provide all facilities to the cricket bat unitholders under one roof. This will enable the unit holders to use modern techniques in the production of world-class cricket bats.

Allocative and Technical Efficiency

In order to evaluate the performance of the cricket bats manufacturing (CBM) units, efficiency measurement concepts of allocative and technical efficiency have been employed in this study. Allocative efficiency (also known as price efficiency) is defined as the ability of a decision-making unit (DMU) to use the inputs in optimal proportion, given their prices, to minimize the cost of production or to maximize profits. This condition could be achieved by a firm depending upon its ability to equate extra revenue, also known as value marginal product (VMP), obtained from employing an additional unit of input with its price or marginal factor cost, under the conditions of perfect competition in both the product and factor markets. This principle is referred to as the neoclassical marginal rule of profit maximization. Thus, according to Lau and Yotopoulos (1971:95), “A firm is price-efficient if it maximizes profits, i.e., it equates the value of the marginal product of each variable input to its price”.

Technical efficiency, on the other hand, is a concept related to the ability of a DMU to produce the maximum (potential or frontier) level of output using the minimum possible level of inputs – an output-oriented measure. Technical efficiency also can be defined as the ability of a DMU to produce the same level of output keeping the input level same – an input-oriented measure. Conversely, technical inefficiency can be defined as a failure of a DMU to produce

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[3] There are 7 villages – Bijbehara, Charsoo, Hallamullaha, Sangam, Pujteng, Mirzapor, and Sethar – in South Kashmir where cricket bats are manufactured.

[4] Amongst the major sports goods clusters, only Meerut has a CFC called the Process cum Product Development Centre (PPDC) - an autonomous organization under the Ministry of Micro Small and Medium Enterprises, consisting of a tool room, state-of-the-art testing center, and a training section. It is engaged in quality up-gradation, technical assistance, R&D promotion, and providing training to the MSMEs in the region, especially those in the sports goods sector. (India Exim Bank, 2021:81).

the maximum possible output with the given inputs and technology (Bravo – Ureta & Pinheiro, 1993).

Significance of the Study

One of the grave problems associated with the Indian economy is that its structural transformation has not been in accordance with the standard structural path. Despite various policies and incentives provided over the period of time by the respective governments, the manufacturing sector has failed to make a significant contribution to the national economy. As the economy has grown, the manufacturing sector has peaked at a very low level – a phenomenon known as "pre-mature de-industrialization". Consequently, the resources have shifted over to the tertiary sector at an earlier stage resulting in its domination at an earlier stage (Economic Survey, 2014-15). The Jammu and Kashmir economy is no exception to this and has fallen trap to the same phenomenon.

Table 1 reveals the picture. It can be observed that while the primary sector of the economy has hardly undergone a change from 2011 -12 to 2020-21, the relative importance of the secondary sector has declined from more than 27 percent to about 25 percent during the same period of time. This decline in the secondary sector has mainly been due to the continuously squeezing share of the manufacturing sub-sector of the secondary sector from a high of 10.67 percent to just 7.4 percent during this decade. On the other hand, the tertiary sector has remained the recipient of all the resource inflows emanating from the secondary sector.

Since the structural change in our economy has occurred in violation of the standard norms of the structural change theory and not in accordance with the experiences of the developed or matured economies of the world, it becomes the task of utmost importance to

Table 1: Contribution of the Major Sectors to the Jammu & Kashmir Economy

Sector	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	UT of Jammu Kashmir	
									2019-20	2020-21
A. Primary	18.63	20.65	20.17	16.68	20.72	21.03	20.16	18.22	18.09	18.58
B. Secondary	27.64	27.47	27.54	25.40	27.15	27.88	28.20	27.86	27.17	25.29
of which Manufacturing	10.67	9.66	9.42	10.08	9.93	9.66	9.58	9.31	8.90	7.39
C. Tertiary	54.44	55.26	56.61	58.54	56.90	57.32	58.02	60.02	61.19	62.63

Source: Digest of Statistics, Directorate of Economics and Statistics, Government of J&K, 2020-21.

explore the possibilities of developing manufacturing sector in line with the resource endowments of our local economy. In this scenario, the cricket bats industry has a very vast potential to become one of the leading activities of our manufacturing sub-sector. A sustainable expansion of this industry is possible given the fact that Kashmir Valley enjoys a monopoly in the supply of willow logs, a dominant component that goes into its manufacture.

Research Methodology

The Study Area and Sampling Procedure

The cricket bats manufacturing activity in Kashmir valley is mostly concentrated in the twin districts of Anantnag and Pulwama. At the time of the field survey, according to the unpublished official data of the District Industries Centre (DIC) Anantnag, the total number of registered CBM units in these districts was 273. Out of this, some 200 CBM units were alone found in district Anantnag. Accordingly, district Anantnag was chosen for field investigation. A random sample of 20 percent was taken from the population comprising 40 CBM units. Primary data were collected from unit holders using a survey method involving a structured questionnaire. The socio-economic data collected included the sex of respondents, age, marital status and formal education levels. Production information collected included output, type of labour used in production, varieties of inputs used, and plant and machinery. Data about constraints faced by unit holders and suggestions to increase their outputs were also collected.

Estimation of Technical Efficiency

Estimation of technical efficiency involves employing a stochastic frontier production function that can either be derived from Cobb-Douglas or the translog production function. Following Aigner, Lovell, & Schmidt (1977) and Meeusen & Broeck (1977) who estimated the technical efficiency using a stochastic production frontier with a composite error term specified as:

$$Y = f(X_i; \beta) + v - u \qquad (1)$$

Where, Y, and X_i are vectors of output and input levels respectively and β represent a vector of unknown parameters to be estimated, $f(X_i; \beta)$ is a stochastic production function. The term v -u is a composite error term. Where v is a two-sided $(-\infty < v < \infty)$ normally distributed random error $[v \approx N(0, \sigma^2_v)]$ that captures the stochastic effects outside the control of a decision-making unit (e.g., weather, natural disasters, and luck), measurement errors, and other statistical noise. The term u is a one-sided $(u \geq 0)$ non-negative efficiency component that captures the technical inefficiency of the firm. It measures the shortfall in output Y from its maximum value, given by the stochastic frontier $f(X_i; \beta_i) + v$. This shortfall in output is associated with firm-specific attributes under decision-making units' control. We assume *u is* independently and identically distributed $[u \approx N(0,\sigma^2_u)]$ and follows a half-normal distribution. The two components *v* and *u* are also assumed to be independent of each other. The parameters are estimated by the maximum likelihood method. Thus, following Battese and Coelli (1995) technical efficiency of the i-th firm is derived as:

$$TE_i = \exp(-u_i) \quad (2)$$

whereas u_i can be expressed as:

$$u_i = Z_i\delta + W_i \quad (3)$$

where Z_i is a vector of firm-specific variables associated with technical inefficiency and δ is a vector of unknown parameters to be estimated, and W_i are random variables defined by the truncation of the normal distribution with zero mean and variance σ^2_u. Stata -13 was used to provide the maximum likelihood estimates (MLE) of the first and second variance parameters, expressed as:

$$\sigma^2 = (\sigma^2_u + \sigma^2_v) \quad (4)$$

and,

$$\gamma = (\sigma^2_u / \sigma^2_u + \sigma^2_v) = (\sigma^2_u / \sigma^2). \quad (5)$$

Following Ojo (2003), this study specified the stochastic frontier production function using the log-linear Cobb- Douglas production function that in its estimation form is presented below:

$$LnY = \beta_0 + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \beta_4 LnX_4 + v - u \quad (6)$$

Y = Output, X_1 = Capital, X_2 = Industrial inputs, X_3 = Non-industrial inputs, X_4 = Human labour, β_0 = intercept, $\beta_1, \ldots\ldots\beta_4$ = parameters to be estimated.

Estimation of Factors Affecting Technical Efficiency (T.E)

For analysing the influence of the firm-level characteristics on technical inefficiency, the linear model is estimated as shown below:

$$u_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 \quad (7)$$

Where u_i is as defined before. Z_1 = Age of unit holder, Z_2 = Household size, Z_3 = Experience in years, Z_4 = Education. δ's, are coefficients of unknown parameters to be estimated along with the variance parameters σ^2 and γ $(0 < \gamma < 1)$

Estimation of Allocative Efficiency (A.E)

Estimating input-specific allocative efficiency has been done using a Cobb-Douglas production function. This study assumes that output (cricket bats) is dependent on capital, human labour, industrial inputs and non-industrial inputs. Therefore, allocative efficiency is estimated following physical production relationships derived from the Cobb – Douglas production function. Thus, the specific model estimated is given by:

$$Q = AX_1^{\alpha_1} X_2^{\alpha_2} X_3^{\alpha_3} X_4^{\alpha_4} X_5^{\alpha_5} \varepsilon \qquad (9)$$

From (3) the linear production function in its estimation form can be re-written as:

$$LnQ_i = LnA + \sum \alpha_i LnX_i + \varepsilon \qquad (8)$$

$$LnQ = \alpha_0 + \alpha_1 Ln X_1 + \alpha_2 Ln X_2 + \alpha_3 Ln X_3 + \alpha_4 Ln X_4 + \alpha_5 Ln X_5 + \varepsilon \qquad (9)$$

Where Q = Output, X_1 = Capital, X_2 = Industrial input, X_3 = Non-industrial input, X_4= Family labour, X_5 = Hired labour and α_0 is the intercept term. $\alpha_1, \alpha_2, \alpha_3, \alpha_4,$ and α_5 are parameters to be estimated, and ε is a residual term.

The measure of allocative efficiency is defined as a ratio of the value marginal product (VMP) to the marginal input cost (MIC). Following Chukwuji (2006), allocative efficiency analysis is determined by estimating a Cobb-Douglas production function using OLS. It is followed by computing the value of the marginal product (VMP_i) for each factor of production, which then is compared with the marginal input cost (MIC_i), which under perfect competition conditions equals input price (Px_i)

$$MP_{xi} = \partial Q/ \partial X_i = \partial (AX_1^{\alpha 1} X_2^{\alpha 2} X_3^{\alpha 3} X_4^{\alpha 4} X_5^{\alpha 5} \varepsilon) / \partial X_i \qquad (10)$$

$$= \alpha_i AX_1^{\alpha 1} X_2^{\alpha 2} X_3^{\alpha 3} X_4^{\alpha 4} X_5^{\alpha 5} \varepsilon) / X_i = \alpha_i Q/X_i = \alpha_i {*} AP \qquad (11)$$

$$AP = Q/X_i = AX_1^{\alpha_1} X_2^{\alpha_2} X_3^{\alpha_3} X_4^{\alpha_4} X_5^{\alpha_5} / X_i \qquad (12)$$

$$AE = MP_{xi} {*} P_q / MIC_{xi} \qquad (13)$$

Where Q = geometrical mean of output; X_i = geometrical mean of input i ; α_i = OLS estimated coefficient of input i. The value of the marginal product of input i (VMP_i) can be obtained by multiplying the marginal physical product (MP_i) by the price of output (P_q). Thus, allocative efficiency is determined by comparing the value of the marginal product of input i (VMP_i) with the marginal input/factor cost (MIC_i). Hence, if $VMP_i > Px_i$, the input is underused and the firm's profit can be raised by increasing the use of this input. Conversely, if $VMP_i < Px_i$, the input is overused and to raise the firm's profit, its use should be reduced. The optimum point of allocative efficiency (maximum profit) is reached when $VMP_i = Px_i$.

Results And Discussion

Descriptive statistics

The descriptive statistics related to the variables used for analysis is depicted in table -2. The mean output in Anantnag is 13122 bats, average capital expenditure is Rs 387367.7, industrial input expenditure is 2726753, and non-industrial input expenditure is Rs.1078538. The table also shows that, on average, Anantnag bat manufacturing enterprises are employing 7 persons, with a minimum of 4 persons and a maximum of 13 persons. The table also shows that the mean education of manufacturing unit holders is higher secondary level.

Table 2: Descriptive Statistics of variables

Variables	Unit	Mean	Minimum	Maximum	St. Deviation
Output	Nos	13122	7000	20500	3361.980
Capital	Rupees	387369.7	207000	660400	122724.5
Industrial inputs	Rupees	2726753	1582000	4100000	612690.5
Non-industrial inputs	Rupees	1078535	686000	1537000	193496.2
Family labour	Numbers	393.7	250	500	125.1
Hired labour	Numbers	1543.75	750	2750	542.6
Education	years	12	5	17	3.00

Source: Field Survey 2016.

Allocative Efficiency

The results reported in table 3 show that estimated coefficients are positive and significant for all parameters. According to these results, the estimated elasticity of output with respect to capital, industrial inputs, and non-industrial inputs are 0.10, 0.45, and 0.30 indicating that a 10 percent increase in each of these inputs is expected to increase the output by 1 percent, 4.5 percent, and 3 percent respectively.

Table 3: Estimation of Input Elasticities – OLS Model

Variables	**Coefficients**	**Std. Error**	**t stat**
Intercept	-4.233***	0.741	-5.712
Capital	0.103**	0.035	2.928
Industrial inputs	0.448***	0.100	4.473
Non -industrial inputs	0.301**	0.103	2.922
Family labour	0.021	0.016	1.315
Hired labour	0.198***	0.037	5.298

Source: Field Survey 2016. ***, *** significant at 5% and 1% levels respectively.*

Table 4: Allocative Efficiency Estimates

Variables	**Coefficients (β_i)**	**APP**	**MPP**	**VMP**	**Factor price (Px_i)**	**AE (VMP/ Px_i)**	**Resource Use**
Capital	0.10	0.73	0.07	51.60	1	51.60	Under-utilized
Industrial input	0.45	0.63	0.28	196.67	1	196.67	Under-utilized
Non-Industrial input	0.30	0.68	0.20	143.38	1	143.38	Under-utilized
Family labour	0.02	1.59	0.03	22	280	0.07	Over-utilized
Hired labour	0.19	1.30	0.24	168	280	0.60	Over-utilized

Source: Field Survey, 2016.

These results are consistent with the findings of other researchers like Muslesh, Ghani and Mahmood (2007). It indicates that industrial inputs like willow, grips, threads and stickers are relatively output elastic, hence suggesting that their greater use is still beneficial. The coefficient of family human labour is 0.02. This means that a 10 percent increase in human labour would result in a 0.2 percent increase. The coefficient of hired human labour is 0.19, which implies that a 10 percent increase in hired human labour would result in an almost 2 percent increase in output. Results in table 4 indicate that CBM enterprises of Anantnag scored allocative efficiency scores of 51.60, 196.67, and 143.38 for capital, industrial inputs, and non-industrial inputs respectively, indicating underutilization of these inputs. On the other hand, family labour and hired labour with allocative efficiency scores of 0.07 and 0.60 are overutilized.

Technical Efficiency

Referring to table 5, all estimated coefficients of CBM units are statistically significant at 1 percent, 5 percent and 10 percent levels. The estimated maximum likelihood coefficients of capital, industrial input cost, non-industrial input cost and human labour show positive values. All the variables have positive coefficients indicating that an increase in these variables would result in an increase in output. Furthermore, the coefficients of all the inputs in the OLS model (table 3), showing the average performance, are by and large, similar to the coefficients of the frontier model (table 5), showing the best performance, except that value of the intercept has improved from -4.23 in the OLS model to -2.94 in the frontier model indicating that the technical progress is Hicks' neutral.

Table 5: Maximum Likelihood Estimates of Stochastic Frontier Production Function

Variables	Coefficients	Std. Err.	Z	P>IZI
Capital	0.170***	0.029	5.87	0.000
Industrial inputs	0.398***	0.106	6.79	0.001
Non-Industrial inputs	0.141*	0.107	2.01	0.080
Human labour	0.312*	0.028	1.35	0.106
Cons	-2.945***	0.563	-11.44	0.000
Sigma _v	0.065	0.028		
Sigma _u	0.100	0.023		
sigma2	0.013	0.000		
Gama (γ)	0.735	0.024		
Log likelihood=100.5				

Source: Field Survey, 2016. **, *** significant at 10%, and 1% levels respectively.*

The maximum likelihood estimates provide estimates of the variance parameters sigma squared (σ^2) and gamma (γ). The first variance parameter sigma square (σ^2) determines whether there is technical inefficiency or not. The value of sigma square (σ^2) is 0.01 indicating that all the firms in the sample are not fully efficient. The second variance parameter gamma (γ) determines whether all the deviations from the frontier are due to random error or technical inefficiency. If γ is equal to zero, then all the deviations from the frontier are caused by random error. Higher values of gamma (γ) imply that much of the variation in the composite error term is due to inefficiency. The result shows that gamma (γ) is estimated to be 0.73 indicating that over 73 percent of the total variation from the frontier is due to technical inefficiency. The study also shows that 27 percent of variations from the frontier are due to random error. Thus, the analysis shows that there is a presence of inefficiency.

Distribution of Technical Efficiency

Technical efficiency computed for each manufacturing unit is shown in Table 6. The mean technical efficiency of manufacturing enterprises is estimated to be 75 percent which indicates that manufacturing enterprises in Anantnag can increase the current level of output by 25 percent with the same level of inputs. This result is consistent with the findings of other researchers like Nikaido Yuko (2004). The study also reveals that more than half of manufacturing enterprises in Anantnag were operating below 80 percent of the optimum level of production.

Table 6: Range of Technical Efficiency

TE level %	No. of firms	Percentage (%)
< 20	0	0
20-39	0	0
40-59	3	7.5
60-79	23	57.5
80-99	14	35.0
Total	40	
Mean TE (%)	0.75	
Minimum TE (%)	0.54	
Maximum TE (%)	0.95	

Source: Field Survey, 2016

Factors Affecting Technical Efficiency

Table 7 shows the linear regression results of T.E scores against explanatory variables. Results indicate that household size, experience and education significantly affected the level of technical efficiency among the sampled decision-making units.

Table 7: Determinants of Technical Efficiency

Variables	Coefficients	Std. Err.	t-ratio
Age	0.007	0.19	0.03
Household size	0.089*	0.05	1.70
Experience	0.062*	0.04	1.46
Education	0.361***	0.07	4.53
Intercept	-1.56	0.70	-2.21

*Source: Field Survey, 2016. *,*** denote significance at 10%, and 1% respectively.*

Household size, experience and education are found to positively and significantly affect the technical efficiency of manufacturing enterprises at 10 percent, 10 percent and 1 percent significance levels respectively. These results are in line with the findings of Amos (2007) where family size and education were also found to have a positive and significant effect on technical efficiency among cocoa-producing households in Nigeria. Hyuha et al., (2006) also report a positive and significant impact of experience and education levels on efficiency.

Conclusions

To sum up, given the existing technology embodied in the machinery and equipment of a particular vintage used for the production process, the output is expected to increase significantly because of the presence of a lot of idle capacity in this industry as evidenced by allocative and technical efficiency analysis. The technical efficiency analysis gives the indication that even without changing the current input mix, there is the possibility to expand the mean level of output by about 25 percent, if factors affecting productivity like education, and training are given due emphasis. Furthermore, for profit maximization, it is advisable for the CBM units to make use of more inputs like capital, industrial and non-industrial inputs, while, at the same time, the excessive use of labour needs to be reduced. Particularly, it appears advisable for manufacturing enterprises to make increasing use of industrial inputs, a dominant component of which is willow logs/clefts, for optimum allocation of resources leading to maximization of profits. However, the supply of willow logs seems to be a major constraint facing this industry, due to which this industry is operating at suboptimal capacity utilization. The state government needs to initiate urgent and serious efforts to overcome the various problems encountered by the business community. The education level of unit holders is found to be positively affecting technical efficiency. Therefore, to encourage large-scale production by involving more educated youth towards this sector, the government needs to develop an appropriate investment climate by providing incentives and a market-friendly environment so that this industry becomes a major attraction for educated youth. However, the government must also take necessary steps to maintain the ecological balance by developing an appropriate linkage between the conservation and utilization of willow plantations. Education is believed to have a positive relationship with the adoption of new technologies and advisory services resulting in improved efficiency.

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