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Estimation of Economic Efficiency of Sugar Industry in Uttar Pradesh: A Frontier Production Function Approach

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Sugar industry of the state of Uttar Pradesh has a symbiotic relationship with the rural masses and serves as a nerve centre for the rural development. The state of Uttar Pradesh is one of the major sugar producing states in the country. The state registered 20.35 lakh ha area under sugarcane cultivation out of the total 44.03 lakh ha of area under sugarcane in the country in 2002-03 (CMIE, 2004). During the same period, the production of cane was 11.62 million tonnes accounting for 38.61 per cent of the total cane production of the country. The state recorded a growth of 2.84, 1.38 and 1.43 per cent annually in sugarcane production, productivity and acreage, respectively during 1961-2002. There is a network of 113 sugar factories in the state out of the total of 453 sugar factories in the country (Anonymous, 2003). In spite of the existing good forward and backward linkages in the state, there was a great deal of instability in sugar production compared with other industries as a result of interdependence and interrelationship between gur, khandsari and white sugar. Nearly 60 per cent of the cane produced in the state is sold to gur and khandsari production units. Cane growers take advantage of the present system of operation and depending upon the acreage of crop, and the price of gur relative to the sugar prices, they regulate supply of cane to the factories thereby posing a serious threat to the sugar industry affecting its performance adversely.

Although the state holds a leading position in production of sugar (28.6 per cent of total), its average recovery (9.05 per cent) is below the country's average recovery (9.75 per cent). In view of the slow growth and increasing instability in production, the sugar economy of the state could benefit a great deal from inefficiency studies. Moreover, the estimates on the extent and sources of inefficiencies could help to improve efficiency or to develop new technology to raise the sugar productivity in Uttar Pradesh. This necessitates an analysis of efficiency of the sugar factories across different regions of the state, which in turn, would help in formulating the policy measures to mitigate the various constraints in the Indian sugar industry, particularly in Uttar Pradesh.

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METHODOLOGY

Sampling Design

There were 113 sugar factories in the state as on March 2003 of which 45 were in the private sector, 37 in the public sector and 31 in the co-operative sector. During 2001-02, 47 sugar factories in eastern Uttar Pradesh, 41 in central Uttar Pradesh and 25 in western Uttar Pradesh were in operation in the state.

For the selection of sugar factories, all the sugar factories were grouped into three regions, viz., western, central and eastern region. This grouping was made in consonance with sugar zoning concept adopted by the Government of India and Indian Sugar Manufacturers Association (ISMA) and not according to the administrative zoning.[1] Further, 21 factories, seven each in private, public and co-operative sectors were selected from each region randomly. Thus, in all 63 factories were selected and manufacturing details and data on costing parameters was collected from the Indian Sugar Mills Association, New Delhi, Uttar Pradesh Cooperative Sugar Federation, Lucknow, Uttar Pradesh Sugar Corporation, Lucknow and CMIE prowess data base for the year 2001-02.

A cursory look at Table 1 indicates that, there were 67 sugar factories till the end of second five-year plan period out of which nearly half of the factories were in the eastern region. The private sector accounted for a maximum of 36 number of factories. The co-operative sector had only two factories, one each in the western and central region. A major thrust was given for setting up of co-operative factories after the fourth plan but the concentration was mainly in the central and the eastern region. The number of factories increased to 113 by the end of 2002 across the regions.

TABLE 1. SECTOR -WISE AND ZONE-WISE ESTABLISHMENT OF SUGAR FACTORIES IN UTTAR PRADESH

	Western			Central			Eastern		
Year	Private	Public	Cooperative	Private	Public	Cooperative	Private	Public	Cooperative
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Before 1960	9	7	1	10	5	1	17	17	Nil
1961-70	0	0	1	0	0	1	0	0	0
1971-80	1	0	3	1	3	7	0	3	3
1981-90	0	0	1	0	1	9	1	0	4
1991-2002	1	1	0	3	0	0	2	0	0
Total	11	8	6	14	9	18	20	20	7

Table 2 shows the crushing capacity and the crushing duration across various sectors and zones in the state. The private sector which accounted for only 41 sugar factories had a crushing capacity of 159400 tonnes crushing per day (TCD), commanding nearly 55 per cent of the share in the total cane crushed while the public and co-operative sectors had 20 and 25 per cent share respectively, which clearly

reflects the lower capacity size of plants in these two sectors. Most of the plants are having a size of 2500 TCD or even less in these sectors, which eventually affects the performance of the factories.

TABLE 2. NUMBER OF FACTORIES, CRUSHING CAPACITY AND CRUSHING DURATION ACROSS VARIOUS SECTORS AND ZONES OF UTTAR PRADESH (2001-02)

Zone/Sector	Crushing capacity (TCD)	Crushing duration (Days)	No. of mills (per cent)
(1)	(2)	(3)	(4)
	Eastern		
Public	23 %	129	43 %
Private	58 %	137	43 %
Co-operative	19 %	132	15 %
Total (TCD)	86808		47
	Central		
Public	19 %	135	18%
Private	47 %	142	47 %
Co-operative	34 %	139	35 %
Total	107636		41
	Western		
Public	18 %	154	32 %
Private	67 %	162	44 %
Co-operative	16 %	161	24 %
Total	86829		25

The crushing duration of the various factories across the zones varied between 129 days to 162 days in the year 2001-02 with the maximum in the western zone followed by the central and eastern zones. The private sector generally crushed the cane for longer period followed by co-operative and public sectors, contrary to the popular belief that the private sector is whimsical in their opening and closing dates of the cane crushing coupled with lesser duration of operation.

Analytical Methods

Stochastic frontier production function was fitted for the sugar industry in the state of Uttar Pradesh to assess the efficiency of various factories under different sectors across various regions of the state.

The stochastic frontier production function is defined as:

$$y_i = (x_{i\,;}\,\beta)\exp(v_i - u_i) \quad i = 1\ldots.N \qquad \ldots.(1)$$

Where, v_i is the random error having zero mean and is associated with random factors not under the control of the firm. The model is such that the possible production, y_i is bounded above by the stochastic quantity of $(x_{i;}\,\beta)\exp(v_i)$, hence the term stochastic frontier (Jondrow *et al.*, 1982, Russel and Young, 1983). The random errors, v_i =1…N were assumed to be independently and identically distributed as N

(0, σ_v^2) random variables, independent of u_i's, which were assumed to be non-negative truncations of the N(0, σ_u^2) distribution (i.e., half normal distribution or having exponential distribution).

Through maximum-likelihood estimator (MLE) approach, the source of the difference between the farmer's yield and that estimated by the frontier production function was examined by calculating the variance ratio parameter (γ).

Now, let $\sigma^2 u$ and $\sigma^2 v$ to be the variances of the parameters one sided (u) and symmetric (v). Therefore,

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

and the ratio of the two standard errors is

$$\lambda = \sigma_u / \sigma_v \quad \ldots.(3)$$

Then variance ratio parameter (γ), which related the variability of $\sigma^2 u$ to the total variability σ^2 is

$$\gamma = \sigma^2_u / \sigma^2 \quad \ldots.(4)$$

γ is defined as the total variation of output from the frontier and can be attributed to technical efficiency. Hence, on the assumption that u_i and v_i are independent, the variance ratio from frontier (γ) has two important characteristics,

(i) When σ_v tends to zero, then u is the predominant error in equation (1) and γ tends to one. This indicates the differences in the technical efficiency, and
(ii) When σ_u tends to zero, then the symmetric error is the predominant error in equation (1), so tends to zero.

Thus based on the value γ, it is possible to identify whether the differences between a firm's output and efficient output is principally due to statistical errors or firm's less efficient use of technology. The u_i and v_i parameters of the production frontier equation were estimated using maximum-likelihood method. Further, given a multiplicative production frontier for which, the Cobb-Douglas production frontier was specified, the technical efficiency of the individual farm was estimated by using expectations of u_i conditional on the random variable E_i

$$TE_i = \text{Exp}(-u_i); \quad 0 < TE_i < 1 \quad \ldots.(5)$$

Economic Efficiency

The economic efficiency is the product of TE and AE. In classical economic theory it is equal to AE itself as TE is presupposed to be one. In the ensuing analysis

various cost components in the sugar industry are converted with prices of each inputs, to directly estimate the economic efficiency.

Empirical Model

The empirical model used in the present study was

$$\ln y_j = \ln B_o + \sum_1^5 B_i \ln x_{ij} + v_i\text{-}u_i$$

(i = number of observations)
(j = number of variables)

where,

y_j = value of sugar production,
x_{1j} = value of raw material,
x_{2j} = wages and salaries,
x_{3j} = manufacturing costs,
x_{4j} = depreciation,
x_{5j} = interest payments.

This was the broad methodological framework employed to analyse the data for fulfilling the objective of the study.

RESULTS AND DISCUSSION

General Characteristics of the Processing Units

The historical review of the cane processing industry presented so far brings into the sharp focus need to ensure optimal distribution of the available cane output among the three competing sectors of cane processing industry. Two elements that have direct bearing on the efficiency of processing plants are 'load factor' and the ‘scale factor’. The former is related to the utilisation of available capacities and the latter is associated with the scale of operation. In this context, it would be imperative to take a brief review of the general characteristics of the processing units in the study area.

Average Crushing Capacity

It is apparent from Table 3 that the average crushing capacity of the sugar mills in the private sector of the western zone of the state was maximum to the level of 5255 tonnes crushing per day (TCD), followed by the central and eastern zone in the same sector. This clearly indicates predominance of large sized sugar mills in the western zone of the state. The co-operative sector mills in the eastern zone had recorded highest average crushing capacity than the western and eastern zones.

The average crushing capacity of the public sector mills in the eastern zone was the lowest (1005 TCD) as compared to average crushing capacity in the western and central zones which shows that a large proportion of sugar mills in the co-operative and private sectors fall in the capacity size group of 1250 TCD. Sen Enquiry Commission (Government of India, 1965), and Tariff Commission (1969 and 1973), have suggested that the sugar units should have a minimum crushing capacity of 1250 TCD to derive the benefits of economies of scale. But, Government of India in 1988 had stipulated the norm of 2500 TCD as minimum economic size. Judging by this standard, the sugar units in the private sector are at an advantageous position to derive the benefits of economies of scale.

TABLE 3. GENERAL CHARACTERISTICS OF SUGAR PROCESSING UNITS IN UTTAR PRADESH

Sectors (1)	Average crushing capacity (TCD) (2)	Average crushing capacity utilisation (per cent) (3)	No. of operating days during season (4)	Average recovery percentage (5)
		Western		
Private	5255	96	162	9.58
Public	1908	90	154	9.40
Cooperative	2291	88	161	9.32
		Central		
Private	3651	94	142	9.49
Public	2252	84	135	9.35
Cooperative	2013	82	139	9.25
		Eastern		
Private	2523	93	137	9.15
Public	1005	85	129	9.22
Cooperative	2322	80	132	9.60

Average Capacity Utilisation

The important factor, which has a direct bearing on the benefits of economies of scale, is the utilisation of available capacity, which in turn is determined by the availability of cane. The average capacity utilisation figures presented in Table 3 point to some curious trends. It is noteworthy here that the three sectors of processing units in the eastern zone had experienced very low capacity utilisation ranging between 80-93 per cent. The reason could be very well attributed to the possible shrinkage in the cane acreage and hence limiting the responsiveness of cane supply to price. However, the average capacity utilisation in the Western and Central regions was at satisfactory levels. In the case of sugar units, the capacity utilisation was around 96 and 94 per cent in private sector, 90 and 84 per cent in public sector and 88 and 82 per cent in the co-operative sectors of western and central regions, respectively.

Number of Operating Days During Season

The sugar mills showed a higher average capacity utilisation than other sweeteners processing units, but the total number of days of crushing or number of operating days during season was the least in sugar mills as compared to khandsari and gur processing units. The number of operating days in the sugar units ranged from 129 to 137 days in the eastern region, 135 to 142 days in central region and from 154 to 162 days in the western region. However, the number of operating days for khandsari and gur processing was 150-200 days, as they enjoy the relative price advantage owing to mismatch between demand and supply of cane in the region. As pointed out earlier, high crushing capacity utilisation for longer operational days has an influence in deriving the benefits of economies of scale. It is important to note that the net number of operating days and capacity utilisation together determines the total turnover or total quantity of finished product manufactured during the operating season.

The competition is felt very much only when there is shortage as well as high gur prices, whereas during times of bounty, both the gur units and khandsari units cannot absorb the excess quantity of the cane and hence the farmers supply cane to the sugar mill. But the sugar mills cannot reduce the price of sugarcane unlike their counterparts to take advantage of the surplus production. The implication is that the government can implement certain regulatory measures wherein it can restrict the variation in prices offered by the khandsari units in an operating season so that they do not pose a stiff competition to sugar units during times of scarcity. By such a policy induced mechanism, the farmers will also be benefited, because at the time of glut they need not sell cane to khandsari units at throw away prices.

Recovery Percentage

This is an important indicator of technical efficiency with regard to the conversion of sugarcane to sugar. The recovery percentage in the case of sugar processing units of the state ranged from 9.15 to 9.60 per cent and does not have any distinct trend with regard to the region or sector of sugar processing in Uttar Pradesh.

Production Function

The estimates of Cobb-Douglas production function for the sugar industry are presented in Table 4. The coefficient of determination (R^2) was 0.73 indicating that 73 per cent of the variation in the sugar output was explained by the explanatory variables included in the model for all the sugar factories included in the sample. All the variables had expected signs. Among the explanatory variables, raw material and manufacturing costs had a positive and significant influence on the production of sugar. The coefficient of raw materials and stores (x_1) was 0.71 and it implied that a one per cent increase in the raw material will result in 0.71 per cent increase in total

sugar production keeping other factors constant at their mean level. Similarly, the coefficient for depreciation cost (x_4) of the plant showed that for every one per cent increase in the depreciation cost, production will increase by 0.22 per cent. The variable wages and salaries (x_2) were negative and came out to be non-significant. This might be due to the over employment of labour in the industry.

TABLE 4. RESULTS OF OLS AND FRONTIER PRODUCTION FUNCTION OF SUGAR INDUSTRY

Variables	OLS		Frontier	
	Coeff.	't' value	Coeff.	't' value
(1)	(2)	(3)	(4)	(5)
Constant	0.48	4.67	0.55	4.46
Raw material and stores	0.71*	8.52	0.68*	6.66
Wages and salaries	-0.24	-0.47	-0.24	-0.38
Manufacturing costs	0.86*	2.08	0.91*	2.25
Depreciation	0.22*	4.97	0.24*	5.61
Interest on loan	-0.14	-0.22	-0.11	-1.17

*Significant at 1 per cent level of significance.

R^2= 0.73	R^2=0.71
Returns to Scale= 1.69	Returns to Scale= 1.48
	Log-likelihood = 81.419
	σ^2 (u) = 0.0246
	σ^2 (v) = 0.0401
	γ = 0.619
	λ = 1.2767

The regression coefficients in the Cobb-Douglas production function are the production elasticities and their sum indicates the returns to scale. The estimates for returns to scale were much higher and significantly different from unity, indicating increasing returns to scale. Returns to scale for sugar industry were estimated at 1.69 showing overall efficiency of resource use in the sugar units of the state. This showed that an increase in use of selected variables would result in more than adequate increase in total sugar production of the state.

Frontier Production Function

The maximum likelihood estimates of the frontier production function are shown in Table 4. The R^2 and maximum likelihood estimate of the frontier production function had shown good fit for the selected model. The OLS function could narrate the response of the average units/firms while the frontier function reflects the responses of the best and efficiently managed firm/unit. 'λ' which is the ratio of variance of the factory specific production behaviour $\sigma^2(u)$ to the variance of the statistical noise $\sigma^2(v)$. This was 1.27 and it is significant at one per cent level indicating that one-sided error component had dominated relatively to symmetric error component.

The variance ratio 'λ' showed that firm specific variability contributed more to the variation in production among firms/units, which means that the total variation in output from the frontier is attributable to the technical efficiency. The estimate 'γ' which is the ratio of the variance of the firm specific performance of economic efficiency to total variance of output was 0.62. This would mean that 62 per cent of the variation in output among the firm/units is due to the difference in efficiencies.

The constant term in stochastic frontier function was higher than that of the OLS method by 15 per cent. Thus, compared to the OLS model, the frontier production could shift vertically upwards. In the case of coefficients of the inputs used, the OLS and frontier was different indicating that the frontier function was different from OLS in terms of slopes also. The raw materials, manufacturing costs and depreciation costs were significant at 1 per cent level, indicating that one per cent increase in raw materials would result in change in sugar output by 0.68 per cent, keeping all other variables constant. The wages and salaries of the labourers and the interest on loan had negative sign and were non-significant also. This might be due to the over employment of the labour force and the huge amount of loan taken by some of the units, especially in the co-operative and private sectors.

Efficiency of Sugar Industry

The efficiency of sugar processing industry across various regions and sectors in Uttar Pradesh was estimated by pooling the factory/firm-specific efficiencies. It is seen from Table 5 that the private sector factories in the western region belonged to the most efficient category, i.e. 84.29 per cent, while the co-operative sector mills in the eastern region were least efficient with an efficiency level of around 60 per cent.

TABLE 5. EFFICIENCY OF SUGAR PROCESSING INDUSTRY ACROSS REGIONS AND SECTORS

Zone/Sector (1)	Private (2)	Public (3)	Co-operative (4)	Total (5)
Central	79.37 (70.42-88.25)	73.87 (63.79-80.72)	66.31 (58.72-79.39)	73.18
Western	84.29 (78.89-92.06)	75.28 (64.50-82.94)	70.63 (62.65-80.63)	76.73
Eastern	80.30 (75.75-86.97)	70.83 (61.87-77.57)	60.82 (45.24-72.99)	70.65
Total	81.32	73.33	65.92	73.52

Figures in parentheses indicate efficiency range.

The average efficiency of the co-operative sector was low due to the presence of few factories, operating at less than 50 per cent of the efficiency level. However, the public sector sugar factories had almost similar efficiency range in all the three regions, the highest being in the western region, i.e., 75.28 per cent. Thus, the public sector is about 10 per cent more efficient than the co-operative sector. The overall efficiency of the sugar industry was 73.5 per cent, the highest being recorded in the

western region followed by central region (73.18 per cent) and eastern region (70.65 per cent).

Factory/Firm Specific Efficiency

The factory/firm specific efficiencies were estimated and are shown as frequency distribution in Table 6. It was found that the efficiencies ranged from 45.24 per cent to 92.06 per cent. It was also found that, 14 factories belonged to the most efficient category (81 to 95 per cent) and 13 factories in the least efficient group (45 to 65 per cent) out of the total of 63 factories taken for observation.

TABLE 6. FREQUENCY DISTRIBUTION OF ECONOMIC EFFICIENCY AMONG SUGAR FACTORIES

Economic efficiency (per cent)	Western			Central			Eastern		
	Private	Public	Co-operative	Private	Public	Co-operative	Private	Public	Co-operative
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
45-50									1 (14.28)
51-55									1 (14.28)
56-60						2 (28.57)			
61-65		1 (14.28)	1 (14.28)		1 (14.28)	2 (28.57)		2 (28.57)	2 (28.57)
66-70			2 (28.57)	1 (14.28)	1 (14.28)	1 (14.28)		2 (28.57)	2 (28.57)
71-75		2 (28.57)	2 (28.57)	1 (14.28)	2 (28.57)	1 (14.28)	1 (14.28)	1 (14.28)	1 (14.28)
76-80	1 (14.28)	3 (42.86)	1 (14.28)	1 (14.28)	3 (42.86)	1 (14.28)	4 (57.14)	2 (28.57)	
81-85	4 (57.14)	1 (14.28)	1 (14.28)	3 (42.86)			1 (14.28)		
86-90	1 (14.28)			1 (14.28)			1 (14.28)		
> 90	1 (14.28)								
Total	7 (100)	7 (100)	7 (100)	7 (100)	7 (100)	7 (100)	7 (100)	7 (100)	7 (100)

* Figures in parentheses indicate percentage to total.

In general, it was observed from the table that almost half of the mills in the state are operating above 75 per cent level of efficiency, out of which 18 belonged to private sector and only 3 belonged to the co-operative sector.

From the preceding sections, it is discerned that only through comparative organisational analysis it becomes possible to determine whether the co-operative and public sectors can really compete in the liberalised scenario and how far they are useful in providing economic advantage. Given the present constraints in sugarcane production system and its interface with the sugar industry, it becomes more imperative to analyse the sugarcane economy and its related policy mix.

It can be inferred from the table that variation in the level of efficiencies was largely due to the systems of operation and managemental skills. As already mentioned, the private sector mills are mostly new, had a larger plant size and are better managed professionally, thereby reducing the expenditure on the manufacturing costs and other operating expenses. On the other hand the public and co-operative sectors have half the average crushing capacity of the private sector. This needs to be kept in view while formulating the strategies for the efficient management of the sugar industry.

CONCLUSIONS AND POLICY IMPLICATIONS

It is apparent from the study that the average crushing capacity of sugar mills in the private sector of western region was maximum followed by that of the central and eastern region of the state. This indicated the presence of more and larger sized sugar mills in the western region, which had a bearing on the responsiveness of cane supply, eventually affecting the capacity utilisation and number of operating days. As a whole, it was found that the installed capacities of sugar mills continue to be substantially below the cane processing requirements in almost all the regions of the state. The state had installed sugar mills capacities that could handle just about 50 per cent of the cane production, paving a way for diversion of cane to gur and khandsari units.

Although profitability and efficiency go side by side, but efficiency norms clearly reflect the operational and technological parameters of the processing units. The private sector factories in the western region belonged to the most efficient category, efficient owing to the higher capacity thereby benefiting from scale economies while the co-operative sector mills in the eastern region were least efficient. The overall efficiency of the sugar industry was 73.5 per cent, being highest in the western region followed by central and eastern regions, due to assured cane supply in the crushing season.

The firm/factory-specific efficiencies ranged from 45 per cent to 92 per cent. Further, 14 factories out of a total of 63 factories included in the sample belonged to the most efficient category and 13 factories to the least efficient group, i.e., below 50 percent level. However, almost half of the sugar units in the state were found operating above 75 per cent level of efficiency, mostly being private. The above variation in the level of efficiencies was largely due to the nature and scale of operation. The results in the preceding sections showed that even with the existing technology, potential exists for improving the efficiency of public and co-operative sector sugar processing units, by stabilising the sugar cane production, modernisation and capacity enhancement and more professional management of these two sectors. The government should develop a number of short and medium term strategies that would easily merge into a long-term policy framework solely guided by the emerging

economic parameters. The strategies to serve the overall policy objectives should incorporate the following:

(1) Strategies promoting stabilisation of sugarcane area at current levels.
(2) Restrain the state government from effecting increase in cane price through the system of state advised prices (SAPs).
(3) A package of measures for revival and modernisation of the sugar factories, especially in public and co-operative sectors.
(4) Gradual phasing out of khandsari units.
(5) Subjecting khandsari sector to duties/tax regimes at comparable rates to sugar mills.
(6) Sugar prices under the dual pricing system may be allowed to keep pace with the general price index.

This integrated approach of increasing sugarcane production, expansion of sugar industry and ensuring its cost effectiveness would benefit both the sugarcane growers and the sugar industry. The consumers would gain in terms of steady availability of sugar at reasonable prices.

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NOTE

1. Before selection of sugar factories, the 3 important parameters conforming to the homogeneity of sugar mills in different sectors viz., private, public and cooperative were considered. These parameters were:

Nature of Plant: There are four different types of plants currently in operation in the Indian Sugar Industry. But the most commonly used and widely acclaimed one is di-sulphitation process plant. Hence, the factories having di-sulphitation plant were considered for selection.

Installed capacity: The Government of India in 1993 has stipulated 1250 tonnes crushing capacity per day as the minimum size for licensing new sugar mills. Hence, the factories having 1250 TCD installed capacity or more were chosen for the detailed analysis.

Operational Condition: The factory having successfully operated in preceding five years were selected.

After taking into account the above-mentioned considerations, the factories were grouped in three categories and on the basis of stratified random sampling; seven factories from each category were selected for the detailed study.

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Formulation and estimation of stochastic frontier production function models*. Dennis AIGNER. University of Wisconsin, Madison, WI 53706, U.S.A. University of Southern Califbrnia, Los Angeles, CA 90007, U.S.A.Â Previous studies of the so-called frontier production function have not utilized an adequate characterization of the disturbance term for such a model. In this paper we provide an appropriate specification, by defining the disturbance term as the sum of symmetric normal and (negative) half-normal random variables. Various aspects of maximum-likelihood estimation for the coefficients of a production function with an additive disturbance term of this sort are then considered.