PRODUCTION UNCERTAINTY AND TECHNICAL INEFFICIENCY OF TEXTILE MANUFACTURING AND EXPORTING FIRMS IN PAKISTAN

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Abstract

The textile industry of Pakistan has shown progress not only in production but it has also performed well in export over the last five decades. We estimated technical inefficiency (T.I.E) and production uncertainty (P.U) due to (T.I.E) of Pakistan's textile exporting firms. The data was derived from 99 companies' annual reports for the year 2008-09. We used stochastic production frontier with half normal distribution of u_i and calculated the inefficiencies with confidence intervals. Inefficiencies u_i / ε_i, are statistically significant at 5 % level of significance. The mean $T.I.E_i$ is 0.107 and the mean $P.U_i$ is 0.06647.

Key Words: Production uncertainty, technical inefficiency, Pakistan's textile exporting firms, stochastic production frontier, confidence intervals.

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1. Introduction

Firms are worried about utilizing their resources optimally to ensure maximum profit as well as high quality of their product so that it could compete successfully with rival firms. Textile industry of Pakistan is the largest industry of Pakistan and like other industries it is facing not only the high cost of escalating electricity and gas tariff but also volatile law and order situation. This adversely impacts the textile exporters' ability to meet their commitments. This production uncertainty also influences the ability of the firms to accept orders from retailers. Enterprises must understand and identify sources of production uncertainty and respond quickly in order to remain competitive with other firms.

Production uncertainty may be due to different factors and sources. Based on production inefficiency, Bera and Sharma (1999), for first time, introduced the concept of production uncertainty and presented analytical expression for estimating firm level production uncertainty by stochastic frontier function.

The purpose of the paper is to measure production uncertainty and technical inefficiency of textile manufacturing and exporting firms of Pakistan as no other study in Pakistan has addressed this crucial issue.

The rest of the paper is structured as follows. Section 2 highlights the significance of Pakistan's textile industry. Section 3 provides brief review of studies. Section 4 concisely discusses the methodology and data. Empirical results are given in section 5 and section 6 carries the conclusions.

2. Significance of Pakistan's Textile Industry

Pakistan is desperately dependent on cotton textile and clothing for industrial base and exports that account for almost 60% of the total exports. Textile industry of Pakistan uses cotton as basic raw material and Pakistan is the fourth largest producer and third largest consumer of cotton in the world. Textile industry of Pakistan is a labour-intensive industry and Pakistan is the sixth country in the world regarding population and has the low cost of labour force.

Table 1: Textiles Exports of Pakistan (%)

Commodities	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
Cotton manufactures	63.3	62.3	57.4	59.4	59.7	51.9	52.2
Synthetic textiles	5.1	3.8	2.1	1.2	2.5	2.1	1.6

Source: Government of Pakistan (GOP), Economic Survey 2009-10, 13

Because of favourable factor endowment in cotton production and relatively cheap labour, Pakistan enjoys a comparative advantage vis-à-vis her competitors in Textile exports, though its share has declined more recently from 66.1 % 2003-04 to 53.8% 2008-09 (Table 1).

The textile sector specially the clothing sector has also significance in Pakistan's economy because this is the second largest sector which provides considerable job opportunities to women outside the house. Approximately $6.4 billion has been invested in the Textile industry of Pakistan during the 1999-2007 (GOP 2007-08, 39). The cotton textile industry has played a crucial role in the progress of Pakistan's economy. The cotton manufacturers got 59.7 percent share of total export of Pakistan in 2006-07. It was 51.9 percent in 2007-08 and 52.6 percent in 2008-09 (GOP 2011-12).

Table 2 Significance of Textile Industry (%)

	2006-07	2007-08	2008-09
Total exports	62.1	54	53.8
Manufacturing	46	46	46
Manufacturing employment	38	39	39
GDP	8.5	8.5	8.5
Textile exports	$ 6.6 billion	$ 7.8 billion	$7.2 billion

	2006-07	2007-08	2008-09
Import of textile machinery	\$502.89million	\$438.27million	\$212.0million

Source: GOP (various issues)

Table 2 indicates the significance of textile industry in Pakistan's economy. The reliance on textile export has been declining, however, the Pakistan's textile sector has played vital role in earning foreign exchange and jobs in the economy for over the last more than five decades. It is expected to play a significant role in the growth of the economy as there is no other sector that has the same potential to benefit the economy.

3. Review of Studies

Review of frontier literature reveals that the researchers have taken interest to estimate technical efficiency and factors which affects the technical inefficiency of a firm but to analyze the behavior of different measures of technical inefficiency remains neglected.

Jondrow et al. (1982) suggested E $[u_i/\varepsilon_i]$ as a measure of firm level technical inefficiency. Based on this, Bera and Sharma (1999) introduced the concept of production uncertainty and presented analytical expression to estimate it by stochastic frontier function with inefficiency term (u_i) distributed as half normal, truncated normal and exponential. They also illustrated their concepts using the model and data set of the U.S. electric utility industry given in Greene (1990) on page 154 and in appendix.

Koirala and Koshal (2004) followed this approach to find firm level production uncertainty using the census of manufacturing establishment data for 1992, 1997 separately and also for combined data. Production function was applied to find firm level production uncertainty by the standard error of technical efficiency. Although they did not give firm level value of production uncertainty in their paper but in Table 3 on page 363, they have written 32.46 and 17.56 as the average production uncertainty for 1992 and 1997 data respectively. They also found average production uncertainty 257.13 for the combined data. These results are ambiguous as technical efficiency has range in a [0, 1] interval so mean, variance and the standard error of it cannot exceed one. How average production uncertainty has so big value?

Bandyopadhyay and Das (2006) have made an attempt to estimate production uncertainty by assuming a stochastic frontier model whose error components (statistical noise (v_i) and inefficiency term u_i) are jointly distributed as truncated bivariate-normal. They derived the analytical expressions for the firm level technical inefficiency and the production uncertainty; and their confidence intervals but they imposed the condition that the distribution of ε_i should be negatively skewed.

This brief review of existing literature depicted that the researchers have not given much attention to an interesting and significant area of production uncertainty. So this study will add a humble contribution to the literature on firm level technical inefficiency and production uncertainty.

4. Model and Data

We follow Bera and Sharma (1999) to measure production uncertainty and technical inefficiency of textile manufacturing and exporting firms of Pakistan. We also calculate the confidence intervals for technical inefficiency of each firm and use the hypothesis tests for the significance of inefficiency ui / ε_i.

Bera and Sharma (1999) has defined the production uncertainty due to technical inefficiency as the conditional variance of inefficiency term u_i on the given entire compose error term $\varepsilon_{i..}$ The stochastic frontier model (SFM) introduced by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977) independently is given by the following expression:

$$OP_i = f(X_i, b) + \varepsilon_i \qquad (1)$$

Where "OP_i" represents output, "X_i" shows the vector of non-stochastic inputs and "ε_i" denotes the stochastic error term of the ith firm. "f" denotes the production function and "b" represents the vector of parameters to be estimated. For production function, they assume the error term ε_i as:

$$\boldsymbol{\varepsilon_i} = v_i - u_i \quad , (i=1, 2, 3 \ldots . \; N)$$

The v_i and the u_i are independent component of ε_i and the v_i is normally distributed random error having zero mean and σ_v^2 variance ($v_i \sim N[0, \sigma_v^2]$). The v_i shows effects on production due to external factors which are outside the control of the firm (e.g. climate, natural disasters, luck and measurement error). They also assume that the u_i is one-sided ($u_i \geq 0$) and a firm specific which measures deviation from the best practiced frontier due to internal factors. It represents technical inefficiency effects which are behavior factors and can be controlled by a firm. It reflects the managerial capability.

Here we assumed that the u_i had a half-normal distribution ($u_i \sim N(0, \sigma_u^2)$).

So the probability density function (p.d.f) of u_i is

$$k(u_i) = \frac{2}{\sqrt{2\pi}} \frac{1}{\sigma_u} \exp\left\{-\frac{{u_i}^2}{2\sigma_u^2}\right\} \quad , \text{ui} \; \square \; 0 \qquad (2)$$

And the p.d.f. of u_i / $\boldsymbol{\varepsilon_i}$ is

$$f\left(\frac{u_i}{\varepsilon i}\right) = \frac{1}{\{1-\emptyset(r_i)\}} \frac{1}{\sqrt{2\pi}} \frac{1}{\sigma^*} \exp\left\{-\frac{(u_i-\mu_i^*)^2}{2\sigma^*}\right\}, \text{ui} \geq 0 \qquad (3)$$

Here $\mu_i^* = -\varepsilon_i\sigma_u^2/\sigma^2$, $\sigma_*^2 = \sigma_u^2\sigma_v^2/\sigma^2$

$\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $z_i = -\mu_i^*/\sigma^*$

Bera and Sharma (1999) extended the idea of Jondrow *et al*.,(1982), that the E (u_i / ε_i) is the expression for technical inefficiency (T.I.E.) and can be derived from equation (3) as

$$E[u_i/\varepsilon_i] = \mu_i^* + \sigma_* h(r_i) \qquad (4)$$

They suggest that production uncertainty due to technical inefficiency can be measured by variance of (u_i / ε_i) given by

$$\text{Var}[u_i/\varepsilon_i] = \sigma_*^2\{1 + z_i h(z_i) - h^2(z_i)\} \qquad (5)$$

Here $h(z) = \frac{\Phi(z_i)}{1-\phi(z_i)}$, while Φ (.) represents the c.d.f. and ϕ (.) denotes the p.d.f. of a standard normal random variable.

Bera and Sharma (1999, 197) have proposed production uncertainty regarding technical inefficiency, for empirical research purpose and conducting hypothesis tests, as the standard errors for firm level technical inefficiency estimates. Hence

$$\text{Production Uncertainty} = \text{P.U}_i = \sqrt{\text{Var}[ui/\varepsilon i]} \qquad (6)$$

When firm has a higher level of production uncertainty, there is larger space for improvement.

Confidence Intervals for (u_i / ε_i) and Hypothesis Testing

From the conditional mean, E (u_i / ε_i) and variance, Var (u_i / ε_i) Bera and Sharma (1999) suggested (1-α) 100% confidence interval for the inefficiency u_i / ε_i.

The lower confidence bound for ith firm (LCB_i) was simplified as

$$LCB_i = \mu_i^* + \Phi^{-1}[\alpha/2 + (1-\alpha/2)\,\Phi(z_i)]\,\sigma^* \qquad (7)$$

And the upper confidence bound for ith firm (UCB_i) was simplified as

$$UCB_i = \mu_i^* + \Phi^{-1}[1 - \alpha/2\{1 - \Phi(z_i)\}]\,\sigma^* \qquad (8)$$

Bera and Sharma (1999) have also proposed the procedure for researcher to conduct hypotheses tests for the significance for the firm level inefficiency.

If the null hypothesis is

H_O: E [u_i/ε_i] = 0

And alternative hypothesis for one sided test is

Ha: E [u_i/ε_i] □ 0

Then one should use E [u_i/ε_i] □□ $\sqrt{\text{Var}\,[ui/\varepsilon i]}$ = ($T.I.E_i$) / ($P.U_i$) and compare it for accepting or rejecting the null hypothesis with only the upper critical value defined as

$$\int_{cu}^{\infty} f(wi)\,dwi = \alpha \qquad (9)$$

Here $$Wi = \frac{ui - E\,[ui/\varepsilon i]}{\sqrt{\text{Var}\,[ui/\varepsilon i]}}$$

DATA

Availability of necessary and relevant data of Pakistan's textile manufacturing firms, due to some limitations, is the crux of problem. In this study, we made an attempt to obtain a consistent dataset. The data used in this study was collected from the annual reports of ninety nine (99) textile manufacturing and exporting firms for the year 2008-2009. The names of these firms are given in Appendix. Some of the annual reports were downloaded from Karachi stock exchange and companies' websites, and the others were copied from Lahore stock exchange personally.

We could not find Information's about labour force employed from all firms' reports. Thus in the empirical model we used all variables in terms of thousands rupees (we used wages, salaries and other benefits of labours instead of the total number of employees). We used the data of those textile manufacturing firms of Pakistan that had exported their products during the year 2008-09.

5. Empirical Results

We use Cobb-Douglas production functions with the normal- half normal distributions for Pakistan textile manufacturing and exporting firms.

A standard log-linear Cobb-Douglas Stochastic Production Frontier model is:

$$\ln OP_i = b_0 + b_1 \ln OFA_i + b_2 \ln MC_i + b_3 \ln EC_i + b_4 \ln S_i + V_i - U_i \quad \text{....... (10}$$

Where, Subscript i denote 1, 2, 3... 99

ln = natural logarithm

b_i = Parameters of variables, Subscript i denotes 1, 2, 3, 4

OP= Output of the firm= Net Sale – distribution cost+ Change in finished goods + Change in work in process – Purchase for resale

OFA= Net value of Operating fixed assets of the firm

MC= Total expenditures spent on [Raw & Packing material + Stores and spare + Chemical+ dyes] consumed+ Processing /stitching /weaving /knitting charges etc.

EC= Total expenditures spent on Fuel and power and water charges

SW= Total expenditure on Salaries, wages and other benefits

V= Random error

U= Technical inefficiency

Maximum Likelihood estimation (MLE) technique was applied to obtain consistent parameters estimates and σ_v, σ_u, σ^2 by using the Stata software. The likelihood function was parameterized in terms of $\sigma^2 = \sigma_u^2 + \sigma_v^2$ and $\lambda = (\sigma_u / \sigma_v) \geq 0$ and estimation was shown in Table 3.

The results of estimated model in table 3 shows that all variables have expected sign and **λ □ 0** i.e. 1.602646, therefore our model is fitted well. All dependent variables have positive sign and are significant at 1 % level of significance except OFA (Operating fixed asset), which is significant at 10 % level of significance. Further MC (material consumed) has maximum elasticity of production i.e. 0.7187 than other inputs. SW (Salaries, wages and other benefits) has the second maximum elasticity of production i.e. 0.154.

Table 3: The MLE Results of Cobb-Douglas (Normal-Half Normal) Model

Dependent Variable = OP, Number of observation = 99

Log likelihood function = 66.686248

Variables	Parameter Estimated	Standard-error	Value of "Z"	Value of "P"	[95% confidence Interval]	
Intercept	0.93468	0.19041	4.91	0.000	0.56149	1.30786
OFA	0.03925	0.02329	1.68	0.092	-0.00641	0.08490
MC	0.71866	0.02796	25.70	0.000	0.66386	0.77347
EC	0.09568	0.02427	3.94	0.000	0.04811	0.14326
SW	0.15405	0.03124	4.93	0.000	0.09281	0.21528
σ_v	0.08964	0.01772			0.06085	0.13205
σ_u	0.14366	0.03500			0.08911	0.23159
σ^2	0.02867	0.00785			0.01332	0.04403
λ	1.60265	0.05007			1.50452	1.70078

The estimated value of $\gamma = \sigma_u^2/\sigma^2 = 0.719768$ implied that approximately 71.98% of the variations in firms' production are due to difference in technical efficiency. For technical inefficiency and production uncertainty, first we calculated the value of ε□$_i$ by the difference of observed OP and fitted OP of our model (10). Then using the value of σ_v, σ_u, and σ^2 from the Table 3 and calculated ε_i, we obtained the value of μ_i^*, σ_*^2, z_i and $\Phi(z_i)$ by the Microsoft Excel and $\phi(z_i)$ with the help of Z table - Normal Distribution Calculator. We put these values in equation 4 and obtained the values of firm level technical inefficiency [$T.I.E_i = E(u_i/\varepsilon_i)$]. We obtained the values of production uncertainties for each firm corresponding to two different definitions given by equation (5), production uncertainty= Var (u_i/ε_i) and equation (6), production uncertainty for empirical purpose = $P.U_i = \sqrt{\mathrm{Var}\left[\frac{ui}{\varepsilon i}\right]}$]. We calculated the lower confidence bound (LCB) and upper confidence bound (UCB) from equation (7) and (8) for each firm. We performed test for the null hypothesis to accept or reject it by comparing

$$E[u_i/\varepsilon_i] / \sqrt{\mathrm{Var}\,[ui/\varepsilon i]} = (T.I.E_i) / (P.U_i) \text{ with the value } \alpha = 0.05$$

And found that the value of inefficiency for each firm was statistically significant at 5 % level of significance (Table 4).

The graph of estimated technical inefficiency [$T.I.E_i = E(u_i/\varepsilon_i)$] against estimated ε_i is shown in Figure 1. It is obvious that when ε_i has negative value then the relationship with technical inefficiency $T.I.E_i$ and ε_i is monotonically decreasing but when ε_i has positive value then the relationship does not hold good for our data set.

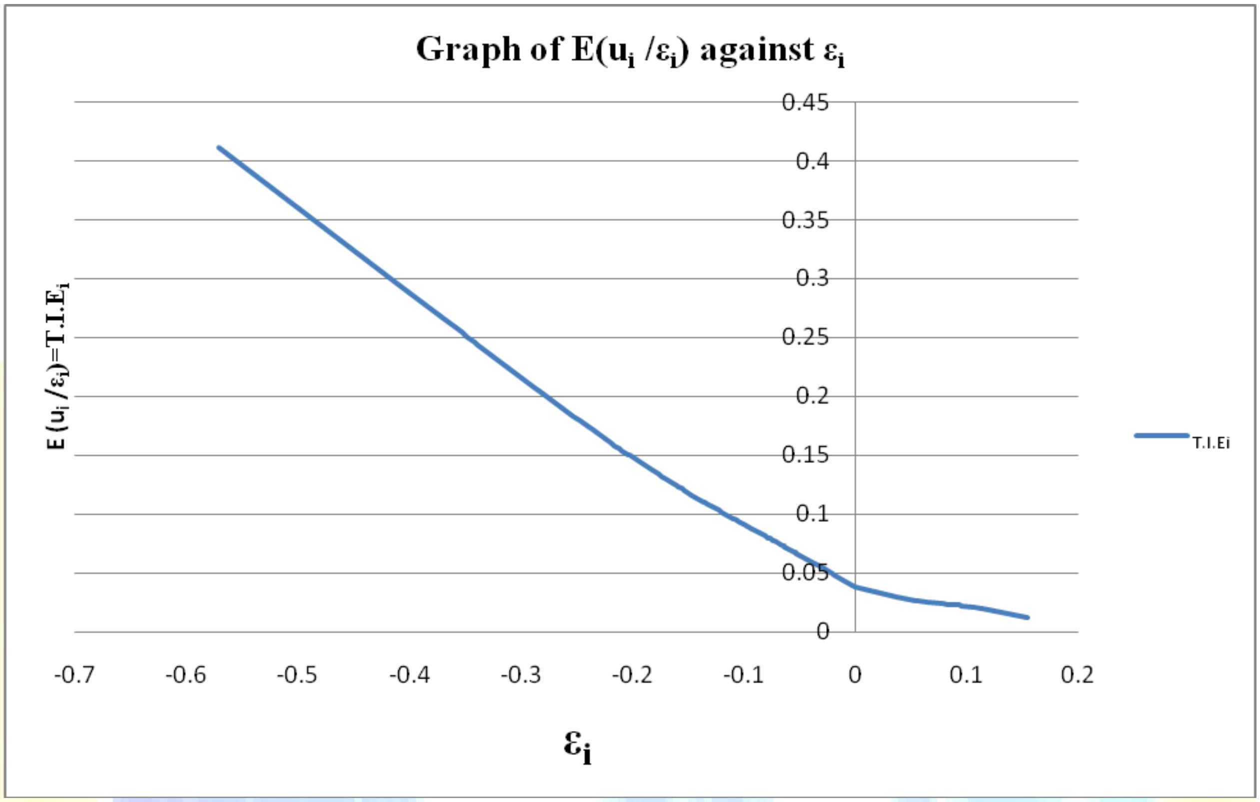

Figure 1

Similarly the relationship with estimated production uncertainty ($P.U_i$) and estimated ε_i is not monotonically decreasing when ε_i has the value near zero and positive. When $T.I.E_i$ is the largest i.e. 0.41088 then $P.U_i$ is the largest i.e. 0.07605. But when $T.I.E_i$ is smallest then P.U. has not the smallest value (See Table 4).

Table 4: Estimated error ε_i, Technical inefficiency $T.I.E_i$, Production uncertainty $P.U_{i,}$ 95% Confidence intervals for ui/ εi,

Firm No.	ε_i	$T.I.E_i$	$Variance_i$	$P.U_i$	LCB_i	UCB_i	$T.I.E_i/P.U_i$
33	0.15542	0.01199	0.00430	0.06556	0.00100	0.10998	0.18297
95	0.11554	0.01984	0.00374	0.06115	0.00120	0.12246	0.32447
44	0.11369	0.02010	0.00373	0.06111	0.00121	0.12309	0.32893
63	0.10802	0.02081	0.00373	0.06109	0.00124	0.12503	0.34069
75	0.09619	0.02215	0.00376	0.06131	0.00132	0.12922	0.36127
57	0.09458	0.02233	0.00376	0.06136	0.00133	0.12980	0.36385
5	0.08643	0.02316	0.00381	0.06169	0.00139	0.13281	0.37539

Firm No.	ε_i	$T.I.E_i$	$Variance_i$	$P.U_i$	LCB_i	UCB_i	$T.I.E_i/P.U_i$
7	0.08473	0.02334	0.00382	0.06177	0.00140	0.13345	0.37780
99	0.07913	0.02379	0.00384	0.06199	0.00143	0.13515	0.38385
25	0.06525	0.02544	0.00394	0.06278	0.00156	0.14106	0.40521
42	0.05785	0.02634	0.00399	0.06319	0.00163	0.14408	0.41691
74	0.05553	0.02664	0.00401	0.06331	0.00165	0.14504	0.42083
10	0.03875	0.02918	0.00412	0.06417	0.00183	0.15225	0.45478
94	0.00952	0.03542	0.00429	0.06547	0.00222	0.16578	0.54099
96	0.00062	0.03784	0.00433	0.06583	0.00237	0.17014	0.57482
6	-0.00973	0.04358	0.00419	0.06472	0.00257	0.17537	0.67333
13	-0.01628	0.04726	0.00410	0.06406	0.00270	0.17875	0.73776
37	-0.01755	0.04797	0.00409	0.06394	0.00273	0.17941	0.75030
86	-0.01905	0.04881	0.00407	0.06380	0.00276	0.18020	0.76505
34	-0.02831	0.05391	0.00398	0.06305	0.00298	0.18513	0.85500
70	-0.02958	0.05460	0.00396	0.06296	0.00301	0.18581	0.86716
54	-0.03092	0.05533	0.00395	0.06287	0.00304	0.18654	0.88010
56	-0.03770	0.05900	0.00390	0.06248	0.00322	0.19024	0.94439
90	-0.05207	0.06664	0.00384	0.06196	0.00366	0.19831	1.07552
50	-0.05256	0.06690	0.00384	0.06195	0.00368	0.19859	1.07992
81	-0.05414	0.06773	0.00383	0.06193	0.00374	0.19949	1.09373
23	-0.05600	0.06871	0.00383	0.06190	0.00380	0.20056	1.11004
66	-0.06261	0.07216	0.00383	0.06187	0.00405	0.20439	1.16628
15	-0.06313	0.07243	0.00383	0.06187	0.00407	0.20470	1.17059
91	-0.06448	0.07313	0.00383	0.06188	0.00412	0.20548	1.18182
27	-0.06623	0.07404	0.00383	0.06190	0.00419	0.20652	1.19618
35	-0.06653	0.07419	0.00383	0.06190	0.00420	0.20669	1.19857
2	-0.06656	0.07421	0.00383	0.06190	0.00420	0.20671	1.19884
53	-0.07009	0.07603	0.00384	0.06195	0.00435	0.20880	1.22733
39	-0.07194	0.07699	0.00384	0.06199	0.00443	0.20990	1.24206
98	-0.07315	0.07762	0.00385	0.06201	0.00449	0.21062	1.25171

Firm No.	ε_i	T.I.E$_i$	Variance$_i$	P.U$_i$	LCB$_i$	UCB$_i$	T.I.E$_i$/P.U$_i$
67	-0.07581	0.07899	0.00385	0.06208	0.00461	0.21221	1.27232
24	-0.07753	0.07988	0.00386	0.06213	0.00469	0.21325	1.28553
38	-0.07753	0.07988	0.00386	0.06213	0.00469	0.21325	1.28554
71	-0.07880	0.08052	0.00387	0.06218	0.00475	0.21401	1.29509
11	-0.07886	0.08056	0.00387	0.06218	0.00475	0.21405	1.29561
62	-0.08022	0.08126	0.00387	0.06223	0.00482	0.21487	1.30588
59	-0.08463	0.08353	0.00389	0.06241	0.00505	0.21756	1.33836
93	-0.08709	0.08479	0.00391	0.06252	0.00518	0.21906	1.35613
80	-0.09370	0.08819	0.00395	0.06288	0.00556	0.22314	1.40253
8	-0.09507	0.08890	0.00396	0.06296	0.00564	0.22400	1.41196
65	-0.09644	0.08960	0.00397	0.06304	0.00573	0.22485	1.42121
92	-0.09750	0.09015	0.00398	0.06311	0.00579	0.22551	1.42834
82	-0.09912	0.09098	0.00400	0.06322	0.00590	0.22652	1.43921
69	-0.10389	0.09345	0.00404	0.06355	0.00622	0.22952	1.47059
72	-0.10398	0.09350	0.00404	0.06355	0.00623	0.22958	1.47117
30	-0.10548	0.09427	0.00405	0.06366	0.00633	0.23053	1.48081
83	-0.10762	0.09539	0.00407	0.06382	0.00649	0.23189	1.49454
1	-0.10774	0.09545	0.00407	0.06383	0.00650	0.23196	1.49531
47	-0.10882	0.09601	0.00409	0.06392	0.00658	0.23265	1.50218
4	-0.11900	0.10135	0.00419	0.06475	0.00741	0.23919	1.56520
52	-0.12000	0.10188	0.00420	0.06484	0.00750	0.23983	1.57126
55	-0.12209	0.10299	0.00423	0.06502	0.00769	0.24119	1.58389
29	-0.12375	0.10387	0.00425	0.06517	0.00784	0.24227	1.59385
61	-0.13073	0.10760	0.00433	0.06580	0.00854	0.24683	1.63525
22	-0.13305	0.10885	0.00436	0.06602	0.00879	0.24835	1.64886
16	-0.13420	0.10948	0.00437	0.06612	0.00891	0.24912	1.65569
28	-0.13534	0.11010	0.00439	0.06623	0.00904	0.24987	1.66235
89	-0.14527	0.11556	0.00451	0.06717	0.01025	0.25647	1.72045
31	-0.15210	0.11940	0.00460	0.06782	0.01120	0.26105	1.76057

IJRSS Volume 2, Issue 4 ISSN: 2249-2496

Firm No.	ε_i	T.I.E$_i$	Variance$_i$	P.U$_i$	LCB$_i$	UCB$_i$	T.I.E$_i$/P.U$_i$
78	-0.15368	0.12029	0.00462	0.06796	0.01143	0.26211	1.76989
26	-0.15541	0.12128	0.00464	0.06813	0.01169	0.26328	1.78012
45	-0.15791	0.12270	0.00467	0.06836	0.01208	0.26497	1.79497
32	-0.15950	0.12362	0.00469	0.06851	0.01234	0.26605	1.80443
40	-0.15981	0.12380	0.00470	0.06854	0.01239	0.26626	1.80629
51	-0.16520	0.12693	0.00477	0.06903	0.01331	0.26992	1.83870
97	-0.17107	0.13039	0.00484	0.06955	0.01440	0.27394	1.87461
68	-0.17344	0.13179	0.00487	0.06976	0.01487	0.27556	1.88926
84	-0.17601	0.13333	0.00490	0.06998	0.01539	0.27733	1.90525
77	-0.18508	0.13884	0.00500	0.07073	0.01741	0.28359	1.96289
87	-0.20221	0.14956	0.00518	0.07200	0.02200	0.29551	2.07719
20	-0.20293	0.15001	0.00519	0.07205	0.02221	0.29601	2.08210
18	-0.20344	0.15034	0.00520	0.07208	0.02237	0.29637	2.08563
14	-0.20351	0.15038	0.00520	0.07209	0.02239	0.29642	2.08615
76	-0.20847	0.15357	0.00524	0.07241	0.02395	0.29990	2.12083
17	-0.21121	0.15534	0.00527	0.07258	0.02485	0.30182	2.14018
49	-0.21528	0.15799	0.00530	0.07282	0.02624	0.30468	2.16940
73	-0.21710	0.15918	0.00532	0.07293	0.02689	0.30597	2.18266
19	-0.21793	0.15972	0.00533	0.07298	0.02719	0.30655	2.18864
12	-0.23568	0.17154	0.00546	0.07387	0.03426	0.31910	2.32226
9	-0.23903	0.17380	0.00548	0.07401	0.03574	0.32148	2.34837
41	-0.24711	0.17930	0.00552	0.07433	0.03951	0.32723	2.41238
43	-0.25229	0.18286	0.00555	0.07451	0.04205	0.33092	2.45419
46	-0.27598	0.19932	0.00565	0.07515	0.05492	0.34784	2.65214
3	-0.27993	0.20209	0.00566	0.07524	0.05724	0.35067	2.68616
48	-0.28058	0.20255	0.00566	0.07525	0.05763	0.35113	2.69176
85	-0.28827	0.20797	0.00568	0.07539	0.06228	0.35664	2.75866
21	-0.33816	0.24350	0.00576	0.07588	0.09520	0.39247	3.20895
64	-0.34153	0.24592	0.00576	0.07590	0.09754	0.39490	3.24015

Firm No.	ε_i	$T.I.E_i$	$Variance_i$	$P.U_i$	LCB_i	UCB_i	$T.I.E_i/P.U_i$
58	-0.34785	0.25045	0.00576	0.07592	0.10195	0.39944	3.29872
60	-0.35291	0.25408	0.00577	0.07594	0.10549	0.40308	3.34570
79	-0.37024	0.26652	0.00577	0.07599	0.11773	0.41555	3.50748
88	-0.40652	0.29261	0.00578	0.07603	0.14362	0.44165	3.84854
36	-0.57084	0.41088	0.00578	0.07605	0.26182	0.55993	5.40285
Average		0.10716	0.00444	0.06647			

We notice that the mean production uncertainty ($P.U_i = \sqrt{Var\,[ui/\varepsilon i]}$) is equal to 0.0665 and its range is from 0.0656 to 0.0761. We also notice that the mean technical inefficiency ($T.I.E_i = E\,[u_i/\varepsilon_i]$) is equal to 0.107 and its range is from 0.012 to 0.411. From Figure 2, it is obvious that when the level of $T.I.E_i$ is small then the width of confidence intervals is small and also when the level of $T.I.E_i$ is high then the width of confidence intervals is large.

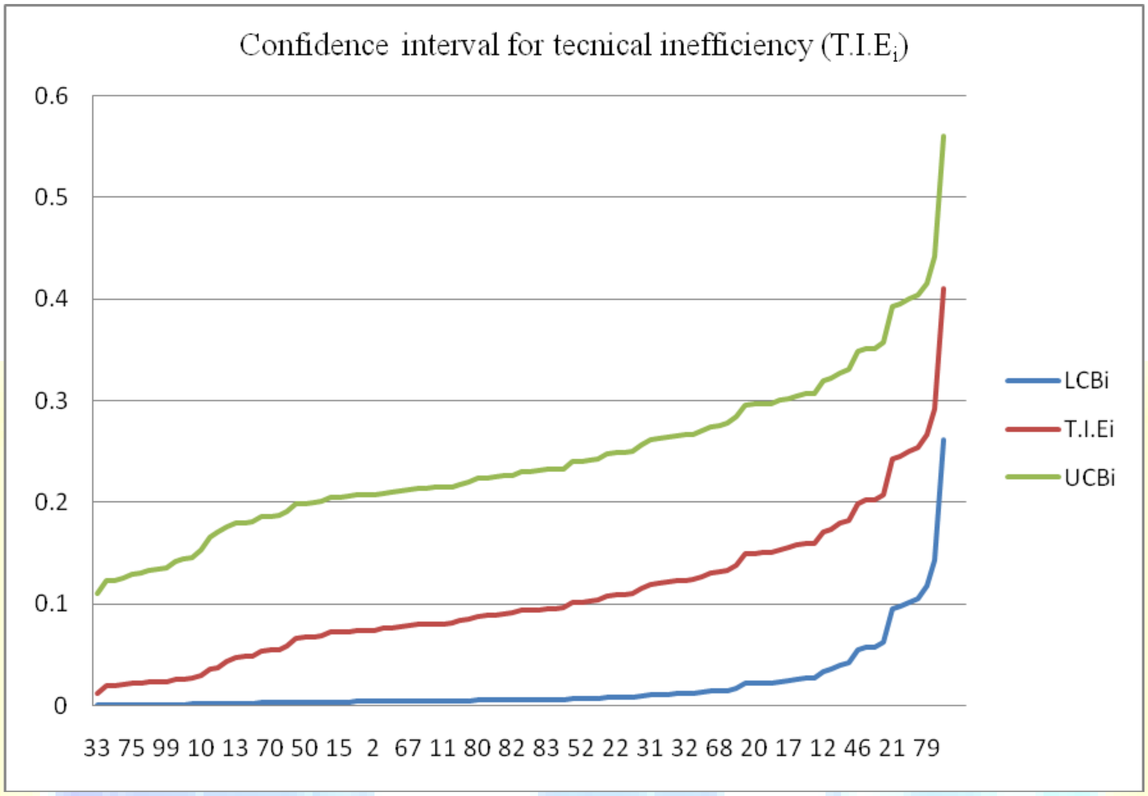

Figure 2

6. CONCLUSIONS

Pakistan's economy desperately relies on textile industry. We have estimated the technical inefficiency and production uncertainty of Pakistan's textile manufacturing and exporting firms for the year 2008-09. This was neglected area. We derived the data from the annual reports of 99 companies. MLE technique was applied to measure stochastic frontier production function. We assumed the half normal distribution of u_i.

We calculated the lower confidence bound (LCB$_i$) and upper confidence bound (UCB$_i$) for firm level. We performed test for the null hypothesis and found that the value of inefficiency for each firm was statistically significant at 5 % level of significance.

The technical inefficiency (T.I.E$_i$) has range from 0.012 to 0.411 and has mean 0.107. The production uncertainty (P.U$_i$ $=\sqrt{\text{Var }[ui/\varepsilon i]}$) has range from 0.0656 to 0.0761 and has mean0.0665. Therefore the textile exporting firms of Pakistan were not achieving 100 percent of production potential in 2008-09. This implies that, on average and in the short run, production of the firms might be increased at least 10.7% by using available resources more efficiently and also there was, on average, 6.65% risk (uncertainty) in production in textile exporting firms of Pakistan due to inefficiency.

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Z table - Normal Distribution Calculator Compatible with iPhone and iPad, http://davidmlane.com/normal.html

Appendix: The names of textile manufacturing and exporting firms

Firm No	Name of Firm	Firm No	Name of Firm
1	Ahamad Hassan Textile Mills Limited	51	Kohinoor Spinning Mills Limited
2	Al-Abid Silk Mills Limited	52	Kohinoor Textile Mills Limited
3	Ali Asghar Textile Mills Limited	53	Liberty Mills Limited
4	Al-Qadir Textile Mills Limited	54	Mahmood Textile Mills Limited
5	Apollo Textile Mills Limited	55	Maqbool Textile Mills Limited
6	Artistic Denim Mills Limited	56	Masood Textile Mills Limited
7	Aruj Garment Accessories Limited	57	Mian Textile Industries limited
8	Ashfaq Textile Mills Limited	58	Mohammad Farooq Textile Mills Limited
9	Ayesha Textile Mills Limited	59	Nadeem Textile Mills Limited
10	Azgard-9	60	Nagina Cotton Mills Limited
11	Bhanero Textile Mills Limited	61	Nakshbandi Industries Limited
12	Bilal Fibres	62	Nishat Mills Limited
13	Blessed Textile Limited	63	Nishat(chunian) Limited
14	Chakwal Spinning Mills Limited	64	Olymia Spinning and Weaving Mills Limited
15	Chenab Limited	65	Premium Textile Mills Limited
16	Colony Mills Limited	66	Prosperity Weaving Mills Limited
17	Crescent Fibres	67	Quality Textile Mills Limited
18	Dar Es Salaam Textile Mills Limited	68	Quetta Textile Mills Limited
19	Dewan Farooque Spinning Mills Limited	69	Redco Textiles limited
20	Dewan Mushtaq Textile Mills Limited	70	Reliance Cotton Spinning Mills Limited
21	Dewan Textiles Mills Limited	71	Reliance Weaving Mills Limited
22	Din Textile Mills Limited	72	Resham Textile Industries Limited
23	Ellcot Spinning Mills Limited	73	Ruby Textile Mills Limited
24	Faisal Spinning Mills Limited	74	Sadaqat Limited
25	Fateh Textile Mills Limited	75	Safa Textiles Limited
26	Fatima Enterprises Limited	76	Saif Textile Mills Limited
27	Fazal Cloth Mills Limited	77	Sajjad Textile Mills Limited
28	Fazal Textile Mills Limited	78	Salfi Textile Mills Limited
29	Gadoon Textile Mills Limited	79	Sally Textile Mills Limited

Firm No	Name of Firm	Firm No	Name of Firm
30	Gatron (Industries) Limited	80	Samin Textile Limited
31	Ghazi Fabric Industries Limited	81	Sapphire Fibres Limited
32	Glamour Textile Mills Limited	82	Sapphire Textile Mills Limited
33	Gul Ahmad Textile Mills Limited	83	Sargodha Spinning Mills Limited
34	Gulistan Spinning Mills Limited	84	Shadab Textile Mills Limited
35	Hala Enterprises Limited	85	Shadman Cotton Mills Limited
36	Hira Textile Mills Limited	86	Shah Taj Textile Limited
37	Husein Industries Limited	87	Shaheen Cotton Mills Limited
38	Hussain Textile Mills Limited	88	Shahzad Textile Mills Limited
39	Ibrahim Fibres Limited	89	Shams Textile Mills Limited
40	ICC Textiles Limited	90	Sitara Textile Industriese Limited
41	Indus Dying & Manufacturing Co. Ltd.	91	Sunrays Textile Mills Limited
42	International Knitwear Limited	92	Suraj Cotton Mills Limited
43	Ishaq Textile Mills Limited	93	Tata Textile Mills Limited
44	Ishaq Weaving Mills Limited	94	The Crescent Textile Mills Limited
45	Island Textile Mills Limited	95	The National Silk And Rayon Mills Limited
46	J.A. Textile Mills Limited	96	Towellers Limited
47	J.K. Spinning Mills Limited	97	Yousaf Weaving Mills Limited
48	Khalid Siraj Textile Mills Limited	98	Zahid Jee Textile Mills Limited
49	Kohat Textile Mills Limited	99	Zephyr Textile Limited
50	Kohinoor Mills Limited		