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Determinants of Technical Efficiency in Garments Industry of Nepal

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Abstract:

Factors associated with technical efficiency were included as endogenous variables to obtain stochastic production frontier for the garment industry of Nepal. The empirical result using 1992 and 1997 census data indicates that about 36 percent potential output was lost due to technical inefficiency. Some of the factors to influence TE positively are export orientation, production scale, production uncertainty and proportion of family members involved in the firms. Efficiency level in general is found improved from 1992 to 1997.

Introduction

Several studies of industry in developing countries have highlighted the importance of technical efficiency as a means of increasing total output (Hill & Kalirajan, 1993). Many of the studies are directed to estimate industry wide average technical efficiencies (Wu 1993); Battese, G.E. and Corra, G.S. (1977); Pack, J.M. Jr. (1980)). Many others have estimated firm level technical efficiency (Bagi, F.S. and Huang, C.J. (1983); Kalirajan, K.P. and Tse, Y.K. (1989); Pitt, M.M. and Lee, L.F. (1981); Tyler, M.G. and Lee, L.F. (1979)). But merely presenting efficiency indices will not be able to help policy makers who are looking for the ways to provide help in the direction to improve efficiency in the industry. Finding the relevant determinants that help explain the variation in efficiency may be complicated but once known it will obviously have some benefits to understand so that the controllable factors can be directed to improve the efficiency level of the firms.

First let us focus on what do we mean by technical efficiency. The idea is simple. It is based on pioneering work of Farrel (1957). A production function indicates the maximum amount of output that can be produced using a given level of inputs. In other words, whatever amount of inputs a firm is using, given the technology, the firm can produce only up to certain level of output indicated by production function. The maximum possible output is calculated

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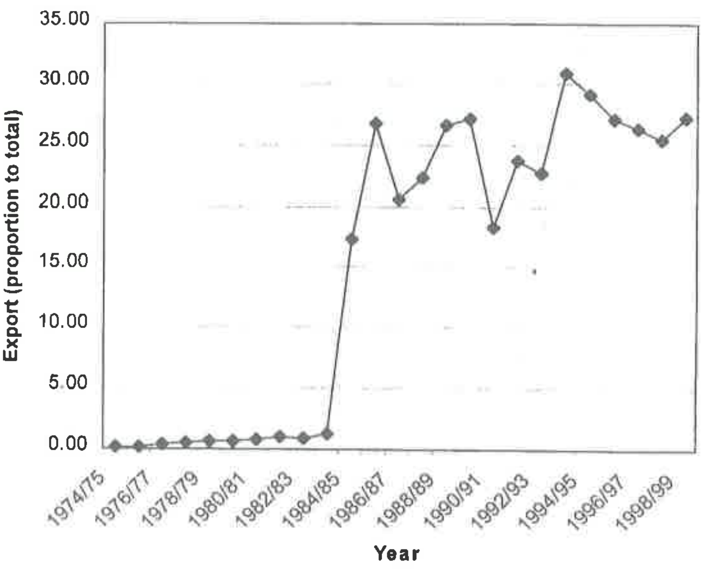
by applying the method of frontier production. If the firm is 100% efficient, or if it does not loose efficiency, then it should be able to produce the amount indicated by the frontier production function. But rarely any firm can reach that level of efficiency. If a firm produces say only 75% of the level the production function (technology) indicates, then it has lost about 25% of total efficiency. No firms can produce more than what the production function indicates at any given level of inputs. All firms will be producing between 0 to 100 % efficiency (or inefficiency).

Once the level of efficiency is known, the next question would be to answer why some firms are able to produce at higher level of efficiency than the others? To understand this we try to look at some of the visible characteristics of the firms and analyze their association with the efficiency level of the firms. The characteristics may vary with the type of industry. Garment industry of Nepal is picked up here for this analysis.

Nepal is one of the least developed countries of the world. Industrialization is considered to be the key for economic development. In the process of industrialization, garment industry can play a significant role for Nepal. Production of garments in Nepal got its boost in the mid eighties primarily as a result of Indian producers who entered Nepal to bypass the quota imposed by the United States to Indian garments. At that time, Indian producers brought nearly finished product to export with the label 'made in Nepal'. An immediate jump of garment exports is then observed (See Fig. 1). Labors, raw materials and capital (mainly sewing machines) were brought into Nepal. Nepal basically provided warehouse and other facilities to these producers. Nepalese also started being trained by working with Indian entrepreneurs and the Indian workers.

Fig. 1: Garments export as a percentage of total export in Nepal



There was a requirement that Nepalese partners be associated with the foreigners to start a business in Nepal. That requirement helped Nepalese entrepreneurs to establish their own garment factories in later years. Today, instead of just being labeled 'made in Nepal', most of the garments are being produced in entirety in Nepal with Nepalese workers. However, one still has to wait to see the development of manufacturing of textiles to substitute the imported cloth, a major raw material for garment. So far, textile industry in Nepal has not been developed in pace to the demand from garment industry.

Export of garments from Nepal jumped from a mere 1% of the total export in 1983/84 to 17% in 1984/85 and to 27 % in 1985/86 (See Appendix 1). In 1993/94 it reached a peak of about 31% of the total export. Then it actually started to decline a bit. By 2000/01 garment export is still lingering at 23 % of total export. Garment production in Nepal is mainly for exports. Therefore, understanding the industry and analyzing the factors associated with efficiency of the firms would help to achieve efficiency in production. This is especially significant to the producer of garments in Nepal who must compete with the producers of other countries in the world.

The export base in Nepal has been eroding down to fewer and fewer items. Garments industry is one of those few industries that Nepal is relying on for its exports. Of course, the country is rolled downed to focus fewer items for export not because of its choice but compulsion. This means that the Nepalese economy is more vulnerable by relying on fewer items for export. This also implies that it has to be ahead of competition in the world market. This makes the focus on garment industry to be of particular interest for Nepal. This study is focused to understand the determinants of technical efficiency in garment industry of Nepal.

Present study is organized as follows: models and their implications are discussed in section 2 followed by the discussion of the nature of data in section 3. The results of the analysis will be presented in section 4 and conclusion follows in section 5.

Theoretical Model

To estimate the technical efficiency of individual firms, a model is developed based on frontier production function first proposed by Aigner, Lovell and Schmidt (1977), Meeusan and Vanden Brooeck (1977) and Battese and Corra (1977). The model has been used since then for a numerous studies with various refinements. The basic principle has remained the same. The underlying principle of the frontier production function is that the entrepreneur obtains maximum output if he uses the production technology available to him in the best way and if not, he would obtain output levels below the maximum output. Accordingly a firm specific error term u is introduced. These u_i's take the value of zero or greater than zero depending on whether the producer uses the technology in the best way or not. But this specification excludes statistical and measurement errors. These shortcomings are overcome by including a random disturbance term, v, to the specification that has a normal distribution. Thus, a stochastic production frontier is obtained.

Let the stochastic frontier production function be as follows:

$$Y = f(X, \beta) + \varepsilon \qquad (1)$$

Where X is the vector of inputs entering into the production function, and β is the vector of parameters to be estimated for a specific production function.

For i^{th} firm, the model contains the error structure $\varepsilon_i = v_i - u_i$. The error component v_i represents the symmetric disturbance. $\{v_i\}$ are assumed to be independently and identically distributed as $N(0, \sigma_v^2)$. The error component u_i is technical inefficiency that varies across firms.

Given a normal distribution for v and a half normal distribution for u_i, the density function of u_i and v_i respectively may be written as follows:

$$f(u_i) = \frac{2}{\sqrt{2\pi}}.\frac{1}{\sigma_u}\exp(-\frac{u_i^2}{2\sigma_u^2}) \qquad u_i \geq 0 \qquad (2)$$

$$f(v_i) = \frac{1}{\sqrt{2\pi}}.\frac{1}{\sigma_v}\exp(-\frac{v_i^2}{2\sigma_v^2}) \qquad -\infty \leq v_i \leq +\infty \qquad (3)$$

The joint density function of ($v_i - u_i$) is then given by:

$$f(\varepsilon_i) = \frac{2}{\sigma}.f\left(\frac{\varepsilon_i}{\sigma}\right)\left[1 - F\left(\frac{\varepsilon_i\lambda}{\sigma}\right)\right], \qquad -\infty \leq \varepsilon_i \leq +\infty \qquad (4)$$

while the conditional density function of u_i given e_i can be presented as

$$f(u_i / \varepsilon_i) = \frac{1}{\{1 - F(r_i)\}}\frac{1}{\sqrt{2\pi}}.\frac{1}{\sigma_*}\exp(-\frac{(u_i - \mu_{i*})^2}{2\sigma_*^2}) \quad (5)$$

Where, $\mu_{i*} = \frac{-\varepsilon_i\sigma_u^2}{\sigma^2}$

$$\sigma_* = \frac{\sigma_u\sigma_v}{\sigma}$$

$$\sigma^2 = \sigma_u^2 + \sigma_v^2$$

$$r_i = -\frac{\mu_{i*}}{\sigma_*} = \frac{\varepsilon_i\lambda}{\sigma}$$

$$\lambda = \frac{\sigma_u}{\sigma_v}$$

and f(.) and F(.) are the standard normal density and distribution functions, respectively (See Bera and Sharma (1999)).

There may be many observed and unobserved factors that affect the technical efficiency across the firms. The stochastic frontier production function in (1) does not indicate determinants of technical efficiency. So following Kumbhakar, S. Ghosh & J. Thomas McGuckin [1991] u is assumed to consist two components: (1) a deterministic component explained by a vector of observable factors Z and (2) a random component, θ given by

$$u = Z'\delta + \theta \qquad (6)$$

Alternatively, we are assuming that u_i is derived from a $N(Z'\delta, \theta_u^2)$ distribution truncated at zero from above. The variables in vector Z are introduced to explain the difference in technical efficiency across firms.

While the density function of v_i is still given by equation (3), the density function of u_i

now may be written as:

$$f(u_i) = \frac{1}{\{1 - F(-\mu/\sigma_u)\}} \frac{1}{\sqrt{2\pi}} \cdot \frac{1}{\sigma_u} \exp(-\frac{(u_i - \mu)^2}{2\sigma_u^2}) \qquad u_i > 0 \qquad (7)$$

Where, $\mu = Z'\delta$ is the mean and F(.) is distribution function of the standard normal distribution. (Stevenson, 1980).

2.1 Technical Efficiency

If production function is defined for the logarithm of production, Battaese & Coelli (1988) have suggested that the estimated measure of technical efficiency for individual firm i be obtained as

$$TE_i = E[\exp(-(u_i) / \varepsilon_i] \qquad (8)$$

And, given that the frontier production function is defined in terms of the logarithm of production, a predictor for the technical efficiency of the ith firm is given by

$$E[\exp(-u_i) / \varepsilon_i] = \frac{1 - F(\sigma_* + r_i)}{1 - F(r_i)} e^{-\mu_{i*} + \frac{1}{2}\sigma_*^2} \qquad (9)$$

Technical efficiency is measured in a [0, 1] interval. u takes the value zero on the production frontier and greater than zero beneath the frontier, when the observed output produced from a given set of inputs is not the maximum possible output. Within this frame work a measure of technical efficiency will be produced here.

2.2 Production uncertainty

Bera & Sharma (1999) suggest that as the firms move toward the frontier production, it also reduces the production uncertainty. The production uncertainty can be captured by var [exp($-u_i / \varepsilon_i$] just as the technical efficiency is given by E[exp($-u_i$)/ε_i].

The variance of technical efficiency measure can then be derived from the conditional normal distribution (5) as:

$$Var[\exp(-u_i) / \varepsilon_i] = \frac{e^{-2\mu_{i*} + \sigma_*^2}}{1 - F(r_i)} \left[\{1 - F(2\sigma_* + r_i)\} e^{\sigma_*^2} - \frac{\{1 - F(\sigma_* + r_i)\}}{1 - F(r_i)} \right] \qquad (10)$$

The standard error of technical efficiency (SETE) of ith firm is then given by

$$SETE_i = \sqrt{Var[\exp(-u_i) / \varepsilon_i]} \qquad (11)$$

The frontier program from TSP will be used for estimation. The results, however, will also be checked using computer program, FRONTIER 4.1 written by Coelli (1996).

Data

Firm level data is used from the Nepalese census of manufacturing establishments, collected by the Central Bureau of Statistics (CBS) in two census periods 1992 and 1997. The firm level data include the money value and quantity of output, the money value and quantity of material inputs, total wage bill, the number of employees (technical, administrative and labors by sex) and money value of capital stock by type of capital (e.g., buildings, equipments and machinery). Only the firms for which the quantities of products by their product names (product codes) are available, have been included in this study. Leaving aside the incomplete information, total number of firms in the garment industry turned out to be 136 in 1992-census and 113 in 1997-census.

Empirical Results

To allow for a flexible functional form, the specific model estimated is a translog production function for (1) is written as follows:

$$\ln Q = b_0 + b_1 \ln L + b_2 \ln M + b_3 \ln K + b_{11}(\ln L)^2 + b_{12} \ln L.\ln M + b_{13} \ln L.\ln K + b_{22}(\ln M)^2 + b_{23} \ln M.\ln K + b_{33}(\ln K)^2 + \nu - u \qquad (12)$$

The variables are L (number of employees), M (Raw material variable, major raw material input in meters), K (capital variable, value of physical assets), and Q (Output in pieces of garments). u & v are the error components.

As mentioned earlier, $v \sim N(0,\sigma_v^2)$ and $u \sim N(Z'\delta,\sigma_u^2)$ truncated at zero,where vector Z consists of exogenous explanatory variables affecting technical efficiency (TE). With restriction of $b_{ij}=0$ production function (9) would be Cobb-Douglas and a further restriction of $\sum b_i = 1$ will lead to constant returns to scale technology.

The choice of exogenous explanatory variables is rather arbitrary. We expect following variables to affect TE.

1. Export orientation:

The firms that could penetrate the world market might have achieved higher efficiency so as to compete with them. That is, export orientation can be expected to be highly positively related to TE. The findings of Caves (1974) point in this direction.

2. Female participation in production:

Citing some anthropological and related literatures, Hill & Kalirajan (1993) have indicated towards the positive role of women participation in production, we also expect that the female participation in the workforce to be positively correlated to TE.

3. Ability to raise capital:

Given an efficiently working financial market, sole proprietary or partnership firms are expected to be more constrained than corporations to raise capital and are limited to produce at lower inefficient level of production. Hence, financial sources and technical efficiencies are assumed to be positively correlated (Hill & Kalirajan, 1993).

4. Production uncertainty:

Bera & Sharma (1999) have argued that when a firm attempts to move towards its frontier, it not only increases technical efficiency, but also reduces its production uncertainty. Thus, production uncertainty is expected to be positively related to TE.

5. Factor intensity:

Even though we do not have any a priori expectation about the relation of factor intensity to efficiency, whether labor intensive or capital intensive firms are more efficient, factor intensity is assumed to be correlated with efficiency. Wu, 1993 has found labor intensive firms to have higher technical efficiencies in Chinese coal industry.

6. Participation of unpaid family members:

We also do not have any a priori expectation about the relation of the use of unpaid family workers and technical efficiency. It can be argued both ways: a higher proportion of unpaid workers might confer greater flexibility and competitiveness on firms, while, it might be that a firm struggling to survive uses its non-paid family members as its last resort. Hill & Kalirajan [1993] have observed that a higher proportion of unpaid members was associated with lower technical efficiency in Indonesian garment industry.

7. Overstaffing:

Overstaffing and/or unnecessary manpower use is expected to hurt firms in achieving higher efficiency level.

8. Production scale:

Production may contribute to achieve learning curve effect and may be expected to have a positive impact on technical efficiency.

9. Quality of inputs:

Input quality is expected to have a direct bearing on the production function and efficiency. But while formulating the production function, we could not distinguish the quality of inputs. We simply introduced the total amount used disregarding the qualitative aspect of inputs. However, the firms using more qualitative resources may be expected to be at higher level of technical efficiency. The quality of raw materials used maybe judged by the price that the firms have to pay to acquire it. Similarly wage rates may reflect the quality of labor. Firms paying attractive labor wages may be able to pull more qualitative workers and utilize resources more efficiently. Similarly, higher wage rates for technicians may reflect more qualitative manpower as well. So the price of resources may be expected to have positive correlation with efficiency. This should be true for capital as well. But the quality of capital may not be observed by the price particularly when government subsidizes the capital. Even when capital is not subsidized and is acquired from the free market conditions, price may not reflect the quality of capital mainly because of the ambiguity in its definition.

Assuming translog frontier production function given in equation (12) and including the factors affecting TE, the estimated parameters are presented in Table 1. We used frontier program from TSP for estimation.[1] Some of the factors are entered indirectly in the production function itself and hence are not seen in the efficiency function. But they are analyzed separately later. The definitions of the variables are provided in Appendix 2.

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[1]Results from Coelli's FRONTIER 4.1 are provided in Appendix 3 for comparison. Even though the signs of the coefficients are consistent, there are more disparities in the estimated coefficients of exogenous variables. There is not much difference, however, in the coefficients of production function itself, nor in the average technical efficiency

TABLE 1: The ML estimates of the frontier translog production function for Nepal's garment industry

Variables	Parameter	Estimate	P-value
		Frontier production function	
Constant	β_0	4.407120	[.002]
Ln(Labor)	β_1	1.318140	[.001]
Ln(Material)	β_2	0.144816	[.605]
Ln(Capital)	β_3	-0.341283	[.040]
Ln(Labor)2	β_4	0.084823	[.054]
Ln(labor)*Ln(Material)	β_5	-0.180299	[.000]
Ln(Labor)*Ln(Capital)	β_6	0.044823	[.180]
Ln(Material)2	β_7	0.061863	[.000]
Ln(Material)*Ln(Capital)	β_8	-0.020216	[.414]
Ln(Capital)2	β_9	0.034107	[.000]
		Efficiency function	
Constant	δ_0	-0.528388	[.180]
Export Orientation	δ_1	0.996338	[.001]
Wage of Production Workers	δ_2	0.003040	[.701]
Wage of non-production workers	δ_3	-1.008520	[.258]
Material Price	δ_4	-0.009169	[.141]
Female Participation	δ_5	-0.130392	[.723]
Staff intensity	δ_6	1.159110	[.250]
Status as Corporation	δ_7	-0.212466	[.183]
Proportion of Family members	δ_8	6.707100	[.000]
Census year	δ_9	0.314037	[.039]
	γ	0.816306	[.000]
	σ^2	0.498501	[.000]
	σ_u^2	0.406929	[.000]
	σ_v^2	0.091572	[.000]
	λ	2.108040	[.000]

Number of observations = 249 Log - likelihood = -324.664
Schwarz B.I.C. = 385.356
Mean technical efficiency, TE = 0.639

Most of the coefficients are found statistically significant. However, the parameter estimates of the translog production function do not convey any direct economic meaning. (Kalirajan & Tse 1989). The estimate of the variance ratio, λ is interpreted to be an indicator of the relative variability of the two sources of random error that distinguishes firms from one another. λ^2 –>0 implies σ_v^2 –> 4 and/or σ_u^2 –> 0, that is, the symmetric error dominates the determination of ε. The value of λ is found to be 2.108 and is statistically highly significant. This indicates that there is wider variation in firm specific error. The significance of λ thus indicates that firm specific technical efficiency- rather than random factors - is largely responsible for difference between the firm's potential and actual outputs.

Among the exogenous variables, as expected, the effect of export orientation to technical efficiency is positive and is highly statistically significant. Similarly of proportion family members working in the firms is also observed to have a positive effect on technical efficiency. The coefficient is statistically highly significant. The significance of dummy variable used for census year indicates that there was an increased efficiency in the firms observed in census year 1997 than in census year 1992.

The simple correlations of TE with variables that were not included directly in the efficiency function are presented in Table 2.

Table 2: Correlation estimates for variables that were not included directly in efficiency function

	TE	SETE	Q
Production Uncertainty (SETE)	0.230 (0.000)		
Production Scale (Q)	0.360 (0.000)	0.183 (0.004)	
Factor intensity (K/L Ratio)	-0.024 (0.707)	-0.008 (0.899)	0.064 (0.312)

P-Value in the parenthesis (Minitab was used for calculation).

Firms with higher efficiency are found to have higher uncertainty of production. The uncertainty of production is measured by standard error of technical efficiency (SETE). Similarly, firms producing higher level of output have higher efficiency. This may be the effect of the type of learning curve. But there is no clear answer why higher uncertainty of production has lead to higher efficiency. A plausible explanation may be that the production uncertainty is the result of uncertainty in demand and the producers may have to compensate for the opportunity lost due to uncertainty of demand by increasing efficiency of production. Factor intensity is not found related to efficiency. Other variables in efficiency function are also found statistically insignificant to influence technical efficiency to the firms in garment industry.

The model is tested to see whether the Cobb-Douglas is an appropriate form of production function. The restriction on the parameters $B_{ij} = 0$ in translog model (9) leads to a Cobb-Douglas specification. A further restriction of $\Sigma B_i = 1$ will imply a constant returns to scale in a Cobb-Douglas model.

The likelihood ratio, ψ is obtained as , $\psi = \frac{L(\text{constrained model})}{L(\text{Unconstrained model})}$ where L denotes the value of likelihood function. The test statistic $-2\log\psi$, is asymptotically distributed as $\chi2(q)$, where q is the number of restrictions imposed on the unconstrained function (Theil, 1971). The values are presented in Table 3.

Table 3: χ^2 values to the restrictions on translog cost model

	Unrestricted Translog	Restricted Cobb-Douglas	Restricted Constant Returns to Scale
Value of likelihood	-221.86	-280.094	-280.095
Value of P^2 (-2logR)		12.747	12.750

The restricted models are rejected over general translog production model. We conclude that a general translog model of production technology is more appropriate than Cobb-Douglas or restricted Cobb-Douglas model for garment industry of Nepal.

For given level of inputs, the estimated level of output obtained from the production function is the maximum possible output for the firm at existing technology. The ratio of actual output to the maximum possible output is defined as the technical efficiency of the firm. This ratio can take the value between zero and one. The value one indicates the firm being 100% efficient.The firm specific technical efficiencies are presented in table 4 as a frequency distribution.

Applying equation (5) the mean technical efficiency is obtained to be 0.639. That is, on the average the firms in garment industry are only about 64 percent efficient.

Table4: Estimates of firm specific technical efficiencies of Nepal's Garment Industry

Efficiency levels %	*Frequency*	%	*Cumulative %*
0 - 10	2	0.80	0.80
10 - 20	4	1.61	2.41
20 - 30	2	0.80	3.21
30 - 40	12	4.82	8.03
40 - 50	30	12.05	20.08
50 - 60	79	31.73	51.81
60 - 70	74	29.72	81.53
70 - 80	37	14.86	96.39
80 - 90	9	3.61	100.00
Total	**249**	**100.00**	

Some firms are very inefficient, but about 80 percent of the firms have an efficiency level of higher than 50%. None of the firms are found to haved efficiency higher than 90%.

Conclusion

Using the concept of frontier production function, this paper investigated the levels of technical efficiency of Nepalese garment industry. The empirical result shows that on an average the garment industry has been achieving about 64% of its total potential output; 36% of the potential output is still lost due to technical inefficiency alone.

We also looked at the nature of the firms to answer the question of why some firms are more successful than the others. This understanding is crucial to move towards the successful implementation of policies and help the firms not only to achieve potential output but to compete in the world market as well. Many theoretical models emphasize on the material factors for the success or failure of the firms. In this study our attention was focused on technical efficiency and some of the factors expected to be associated with the level of technical efficiency of the firms.

Export oriented firms are found to have higher technical efficiency in garment industry of Nepal. Involvement of family members is also seen to have positive contribution towards technical efficiency. Similarly, production uncertainty and production scales are also observed to have positive impact on technical efficiency of the firms. But, other factors, such as factor intensity, staff intensity, proximity to financial source and female participation in the work force are not found to have any significant impact on technical efficiency in garment industry of Nepal.

APPENDIX 1: Garment export from Nepal

Year	Nepal Total (Rs in Million)	Garment (Rs in Million)	% of total	Year	Nepal Total (Rs in Million)	Garment (Rs in Million)	% of total
1974/75	913.3	1.3	0.14	**1987/88**	4114.5	916.6	22.28
1975/76	1160.0	2.0	0.17	**1988/89**	4195.3	1117.8	26.64
1976/77	1142.9	4.0	0.35	**1989/90**	5156.2	1399.2	27.14
1977/78	1099.4	5.7	0.52	**1990/91**	7387.5	1350.3	18.28
1978/79	1499.6	8.5	0.57	**1991/92**	13706.5	3254.5	23.74
1979/80	1301.5	7.8	0.60	**1992/93**	17266.5	3930.3	22.76
1980/81	1596.5	13.0	0.81	**1993/94**	19293.4	5943.2	30.80
1981/82	1456.7	13.8	0.95	**1994/95**	17639.2	5139.3	29.14
1982/83	1133.0	10.0	0.88	**1995/96**	19881.1	5374.8	27.03
1983/84	1630.1	20.5	1.26	**1996/97**	22636.5	5955.0	26.31
1984/85	2720.7	470.9	17.31	**1997/98**	27513.5	7015.4	25.50
1985/86	3003.6	803.7	26.76	**1998/99**	35676.3	9701.9	27.19
1986/87	2966.4	611.2	20.60	**1999/00***	49822.7	13942.4	27.98
				2000/01*	55654.1	13124.7	23.58

* Provisional

Source: Economic Survey, 2002. His Majesty's Government of Nepal, Ministry of Finance.

APPENDIX 2: Definition of variables

Total production, Q
Total output in pieces of garments produced by a firm in a given year.

Wage rate of production workers
The total wage bill of production workers divided by the number of production workers.

Wage rate of non-production workers
The total wage bill for administrative and technical manpower divided by the number of the non-production workers.

Price of major raw material
Data for total cost of individual raw materials are provided in the census. Major raw material for garment industry is cotton textiles. Its price per meter is calculated by dividing the total cost of cotton thread by total amount (in meters) purchased.

Export orientation:
Proportion of export quantity to the total production quantity

Female participation in production
Proportion of female manpower in relation to total manpower

Staff intensity
Ratio of technicians and administrative staff to total manpower

Ability to raise capital
Ability is measured on the assumption that sole proprietary or partnership firms are expected to be more constrained than corporations to raise capital dummy variable, DCORP, is created such that

DCORP = 1 if the firm is of corporation status
= 0 otherwise.

Participation of family members
Proportion of family members in the total work force

Factor intensity
Ratio of capital to labor, K/L

Measure of production uncertainty
Standard Errors of Technical Efficiency (SETE) is considered as a measure of production uncertainty

APPENDIX 3: Results from Coelli's FRONTIER 4.1 program to compare with the results obtained using TSP program.

	coefficient	Standard-error	t-ratio
beta0	3.777018	0.977262	3.864898
beta1	2.036854	0.586493	3.472941
beta2	-0.027917	0.267591	-0.104326
beta3	-0.409296	0.235498	-1.738005
beta4	0.116906	0.077267	1.513013
beta5	-0.249217	0.080119	-3.110604
beta6	0.022492	0.049011	0.458913
beta7	0.078423	0.022129	3.543930
beta8	-0.006379	0.031560	-0.202128
beta9	0.034204	0.014660	2.333091
delta0	-8.908254	2.833738	-3.143641
delta1	7.457176	2.099317	3.552192
delta2	0.002816	0.022388	0.125785
delta3	-0.061412	0.021393	-2.870653
delta4	-4.152332	1.289604	-3.219851
delta5	-1.591467	1.347426	-1.181117
delta6	5.592798	1.604139	3.486481
delta7	-1.186325	0.517405	-2.292837
delta8	17.247180	4.136261	4.169751
delta9	0.989749	0.608327	1.627001
sigma-squared	2.491539	0.417509	5.967623
gamma	0.888482	0.028666	30.993842

mean efficiency = 0.698914

(FRONTIER 4.1 was downloaded from the web.)

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