Measurement of Factors' Productivity and Intensity in Tanning Industry of Bangladesh

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Abstract

Bangladesh is enjoining a better environment for leather production due to available hides and skins and cheap labor. Leather is highly demanded both for domestic utilization and for export. Economic performance depends on factors (labor and capital) activities in tanning industry. Our results show that marginal products- both of labor and capital are lower than average products. Labor intensities are higher both in wet-blue and crust stages, but low in finished stage. It means that finished stage is capital intensive stage and wet-blue and crust stages are labor intensive. The more efficient firm will have a larger A (efficiency) than the less efficient one. We observe from the results that the production efficiency is increasing and it is in highest position in finished stage. The production efficiency is in the best position in finished stage due to skilled labor involvement in production process.

Introduction

The main strengths in the leather industry are accessibility of raw material (hides and skins), cheap manpower, and salts. Moreover in the contemporary years the tanning industries in developed countries have been shrinking due to pollution problem and high labor cost. The tanning industries are now shifting from developed countries to developing countries. Bangladesh can be benefited from this shifting. Leather and leather products significantly contribute both to domestic consumption and to export. The leather sector of Bangladesh has earned a special status in the national economy. Being the fifth largest export-earning source, this sector plays a vital role in export as well as in the overall economic performance of Bangladesh. Raw materials and factors (labor and capital) are available and cheap in Bangladesh. Now we are to examine the present situation about factors' productivity and intensity in the tanning industry of Bangladesh.

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Objectives

The purpose of the Cobb-Douglas Production Function (CDPF) is to measure factors' productivity and intensity in tanning industries in Bangladesh. The study is carrying the following objectives.

- To have a deeper understanding about the contribution of factors in the tanning industries
- To use CDPF to measure factors' productivity and intensity to examine the economic performances of the tanning industries in Bangladesh

Data and Methodology

About 206 tanneries are in Bangladesh, among them 187 tanneries are at Hazaribagh, Dhaka. Besides, there are a few tanneries in Chittagong (9), Jessore (1), Khulna (1), Rangpur (1), Jamalpur (1), and greater Dhaka (6). The larger coverage of the tanneries is within Dhaka (Hazaribagh) city. The study undertakes an empirical analysis of primary level cross section data from 38 different tanneries for intensive study. From the existing 206 registered (Ahmed 2002) tanneries units, 38 firms were selected randomly that includes all types of tanneries. A structured questionnaire was used for the field survey. The collected raw data was then processed and analyzed up to the requirement. We measured factors' productivity and intensity by using Cobb-Douglas Production Function (CDPF).

Review of Literature and Theoretical Discussion

A method of production (process, activity) is a combination of factor inputs required for the production of one unit of output. Usually a commodity may be produced by various methods of production. The production function is a purely technical relation, which connects factor inputs and outputs. It describes the laws of proportion, that is, the transformation of factor inputs into products (output) at any particular time period (Koutsoyiannis 1979 p-67).

Any firm's managers and engineers must decide how to produce the firm's product. To maximize profit, they must endeavour to produce the product efficiently and at minimal cost. This means that they must constantly keep abreast of new methods and compare their productive performance with those of their rivals. (Mansfield p-203).

The starting point for the theory of the firm usually assumes profit-maximizing business operating in a competitive market and producing only a single good (Harbury 1968 p 37). The firm is the basic production unit, producing goods and services, such as transporting, financing, wholesaling and retailing using certain inputs called 'factors of production' such as labor and capital (Intriligator 1980 p 251).

Production functions are the most basic econometric relationships, and ideally express the technical relationships between physical quantities of inputs to the production process, and the physical quantity of output produced. This description should be applied at the micro-economic level, for a single firm or a single homogeneous product, and a few homogeneous inputs. Production function, in this sense, shows up a one-way relationship in the causal flow.

It is, therefore, important in theories of economic growth and in theories of distribution. At the micro-economic level it is of interest because of its usefulness in the analysis of such problems as the degree of which substitution between the various factors of production is possible and the extent to which firms experience decreasing or increasing returns to scale as output expands. At both the macro and micro-levels, the production function has been used as a tool for assessing whether production of any increase in output over time can be attributed to, firstly, increases in the inputs of factors of production:, secondly, to existence of increasing returns to scale:, and thirdly, to what is commonly referred to as technical progress (Thomas 1985 p208).

The Neo-classical Production Function

The production function is nothing but the relationship between output Q in one hand and both labor (L) and capital (K) on the other hand. We can show it mathematically,

$$Q= f (K, L)$$

Where Q refers to gross output, K refers to capital stock. Capital input should be the flow of capital services or capital utilization, but in practice this is too difficult to measure, and instead capital stock, an aggregate of heterogeneous types, must be used. (If this is adjusted for some general level of utilization, one is assuming a constant rate of capacity.)

We, as econometricians, try to estimate the form of this theme; it would have many welcome features: it would be unambiguously one-way in the causal flow. It is expected from given inputs to the resultant output; it would stand independent of other economic relationships such as input supply functions and output demand functions. Its parameters, when estimated, would describe the technological features of a well-defined productive process, and would be given concrete interpretation.

Through aggregation the causal direction has gone from one extreme (inputs⊠outputs) to the other (outputs⊠inputs). However the truth lies between these, and makes added complications: outputs and inputs are usually decided upon together by the producer, or at least some degree of feedback from outputs to inputs occurs, either directly or via the ancillary relationships of supply and demand functions (Hebden 1983 pp87-88).

This feedback makes it incorrect to regard output as the dependent variable and inputs as exogenous variable in the production function, at whatever level of aggregation. So when production functions are estimated in isolation by simultaneous equation (least-squares methods), their estimates are all subject to bias because the simultaneous context of the production function has been ignored. However, this does not appear to have deterred many distinguished researchers (Hebden 1983 pp87-88).

The Cobb-Douglas Production Function (Homogeneous function)

The production function, which has been used for most empirical work, is the Cobb-Douglas production function. The two Americans C.W. Cobb and D.H. Douglas, working in the late 1920s, observed that the share of total output going to labor had remained approximately constant over time. They have estimated it after studying different industries in the world, so it is used as a fairly universal law of production.

The general form of the Cobb-Douglas production function (CDPF) is multiplicative. CDPF is the most popular in applied research, because it is easiest to handle mathematically.

$$Q = AK^{\alpha}L^{\beta}e^{u} \qquad \alpha>0, \beta>0 \text{ --- } (1)$$

Where A, α and β are fixed positive parameters

Q= output

K= Capital input

L= Labor input

u = Stochastic disturbance term

e= base of natural logarithm

From the above equation it is clear that the relationship between output and the two inputs is non-linear. However, if we log-transform the above model, we obtain

$$\ln Q = \ln A + \alpha \ln K + \beta \ln L + u$$

$$= c + \alpha \ln K + \beta \ln L + u \qquad (2)$$

Where $c = \ln A$,

Thus written, the model is linear in the parameters c, α and β and is therefore a linear regression model. Notice though, it is nonlinear in the variables Q, K and L but linear in the natural logarithms of these variables. In short, (2) is a log-log, double-log or log-linear model.

The properties of the Cobb-Douglas Production Function are quite well known, they are as follows. (Hebden 1983 pp 91-93 and Gujarati 1998 pp-214-216,)

1. α is the(partial) elasticity of output with respect to the capital input, that is, it measures the percentage change in output for say, a one percent change in the capital input holding the labor input constant.
2. Like this, β is the (partial) elasticity of output with respect to labor input, that is, it measures the percentage change in output for, say, a one percent change in the labor input holding the capital input constant.

3. The sum $(\alpha + \beta)$ gives information about the returns to scale, that is, the response of output to a proportionate change in the inputs. If this sum is 1, then there is a constant return to scale that is doubling the inputs will double the output, tripling the input will triple the output and so on. If the sum is less than 1, there is decreasing returns to scale- doubling the inputs will less than double the output. Finally if the sum is greater than 1 means there is increasing returns to scale- doubling the input will more than double the output.

4. $\frac{\alpha}{(\alpha - \beta)}$ Measures the capital share of inputs.

5. $\frac{\beta}{(\alpha + \beta)}$ Measures the labor share of inputs.

For multi factor inputs the production is,

$Q = AF1\alpha1\ F2\alpha2\ F3\alpha3$ ------ $Fn\alpha n$

$\text{Log } Q = \text{Log } A + \alpha1\text{LogF1} + \alpha2\text{LogF2} +$ ---- $+ \alpha n\text{LogFn}$

On the other hand we can see more properties such as

Property-1

Given the linear homogeneous production $Q = f(K, L)$, the average product of labor (APL) and capital (APk) can be expressed as a function capital-labor ratio $\acute{K} = K/L$ alone.

$Q/L = f(K/L, L/L) = f(K/L, 1) = f(\acute{K}, 1) = \varphi(\acute{K})$………(1)

$APL = Q/L = \varphi(\acute{K})$

$APK = Q/K = Q/L, L/K = \varphi(\acute{K})/\acute{K}$

Property-2

Given $Q = f(K, L)$, MPL and MPK can be expressed as a function of $\acute{K}$ above.

$Q = L\ \varphi(\acute{K})$ [using (1)]

$\partial/\partial K(\acute{K}) = \partial/\partial K(K/L) = 1/L$ and $\partial\acute{K}/\partial L = \partial/\partial L(K/L) = -K/L2$

The results of differentiation are

$$MPK = \partial Q/\partial K = \partial/\partial k[L\varphi(\acute{K})] = L\ \partial\varphi(\acute{K})/\partial K$$

$$= L\ \partial\varphi(\acute{K})/\partial\acute{K}\ .\ \partial\acute{K}/\partial K$$

$$= L\varphi'(\acute{K})1/L = \varphi'(\acute{K})$$

$$MPL = \partial Q/\partial L = \partial/\partial L[L\varphi(\acute{K})]$$

$$= \varphi(\acute{K}) + L\ \partial\varphi(\acute{K})/\partial L$$

$$= \varphi(\acute{K}) + L\ \partial\varphi(\acute{K})\partial\acute{K}/\partial K$$

$$= \varphi(\acute{K}) - L\ \varphi'(\acute{K}) - \acute{K}/L2$$

$$= \varphi(\acute{K}) - \acute{K}\ \varphi'(\acute{K})$$

This indeed shows that MPK and MPL are function of Ḱ above.

Property-3(Euler's Theorem):

If $Q = f(K, L)$ is linearly homogeneous, then

$$= K\boxtimes Q/\boxtimes K + L\boxtimes Q/\boxtimes L \boxtimes Q$$

Proof: $K\boxtimes Q/\boxtimes K + L\boxtimes Q/\boxtimes L$

$$= K\ \varphi'(\acute{K}) + L[\varphi(K) - K\ \varphi'(\acute{K})]$$

$$= K\ \varphi'(\acute{K}) + L\varphi(K) - K\ \varphi'(\acute{K})$$

$$= L\varphi(\acute{K})$$

$$= Q$$

Property-4

$$\partial = \frac{\textit{Relative change in the leass cost combination}}{\textit{Relative change in the input rice ratios}}$$

$$\partial = \frac{\textit{Relative change in } \frac{K^*}{L^*}}{\textit{Relative change in MRTSKL}}$$

$$\partial = \frac{\textit{Marginal Function}}{\textit{Average Function}}$$

$$\partial = \frac{d(\frac{K^*}{L^*}) \ \frac{K^*}{L^*}}{d(\frac{MPK}{MPL}) \ \frac{MPK}{MPL}} = 1$$

Where $\alpha+\beta \neq 1$

Then CES production function [(SMAC) Solow, Minhaj, Arrow & Channey, 1962]

Economic Significance of the Cobb-Douglas Production Function (CDPF)

CDPF provides important information regarding industrial and agricultural sectors through which we can make different policies (Singh 1977 pp276,). Since, we can determine the marginal productivity of capital as well as labor. It is helpful in wage determination principles (Singh 1977 pp276). The estimated elasticity of coefficient may be helpful in international or inter-sectoral comparisons. It helps us in the study of the different laws of returns to scale. It provides us information regarding the substitutability of the factors of production. It is used to determine the degree of homogeneity (Singh 1977 pp276).

Estimation of C-D production Function with labor Defined by Total Number of workers those who directly involve in Production process.

In this Segment we have gone through estimating the Cobb-Douglas Production Function by applying Ordinary Least Square (OLS) method in the common framework of multiple regression analysis. Here, information regarding total number of workers has been used to represent labor input while (fixed) capital is taken to be the value of mere machineries and equipments (ignoring the value of land and building), as more reasonable results have been obtain by using this definition of Capital. Dependant variable in each case has been taken to be the value of output in a year at different stages of leather manufacturing industries in Bangladesh.

VQWBS = f (KWBS, LWBS)
Here VQWBS = Value of Output in the Wet-Blue Stage
KWBS = Capital in the Wet-Blue Stage
LWBS = Labor in the Wet-Blue Stage

Using Cobb-Douglas Production function and taking Log (Ln) in both sides.

$$LnVQWBS = LnA + a1LnKWBS + b1LnLWBS \qquad (1)$$

$$LnVQWBS = 3.351 + .497\,LnKWBS + .5155\,LnLWBS$$

$$(3.621)^{***} \quad (2.493)^{**} \quad (2.471)^{**}$$

$R2 = .71$, Adjusted $R2 = .69$

$F = 19.45$ D. f. $= 35$

No of observation = 38 Returns to scale = 1.01

*** is used at 1% level of significant on a two tail distribution.
** is used at 5% level of significant on a two tail distribution.
* is used at 10% level of significant on a two tail distribution.

The above equation no (1) present the partial elasticities of output with respect to capital and labor input defined by total no. of workers (exhibited by the regression coefficients of the natural logarithm of the value of capital and labor inputs). A return to scale has been measured by simply adding the coefficients of labor and capital inputs.

Now we consider the result of equation no. (1) that exhibits the result of the estimation of C-D production function for Wet-Blue stage of manufacturing of leather. The estimated coefficients of labor and capital are moderately significant. The multicollinearity between the explanatory variables of capital and labor as is usual for cross-section data. The Coefficient of determination of the C-D model has been fitted well to the data can be known from the measures of 'goodness of fit' as indicate by R2, $\bar{R}2$ are reasonably significant and F statistics is highly significant. The partial elasticity of output with respect to capital (eq. No-1) is .497 reflects the fact that a 1% increase in the capital input holding the labor input constant leads to .49% increase in the output of wet-blue leather. On the other hand The partial elasticity of output with respect to Labor (eq. No-1) is .515 reflects the fact that a 1% increase in the labor input holding the labor input constant leads to .51% increase in the output of wet-blue leather.

For Crust Stage

VQCS = f (KCS, LCS)
Here
VQCS = Value of Output in the Crust Stage
KCS = Capital in the Crust Stage
LCS = Labor in the Crust Stage

Using Cobb-Douglas Production function and taking Log (Ln) in both sides.

$$LnVQCS = LnA + a1LnKCS + b1LnLCS \text{ ----(2)}$$

$$LnVQCS = 3.503 + .4389\ LnKCS + .5501\ LnLCS$$

$$(7.941)^{***} \quad (2.3268)^{**} \quad (2.751)^{***}$$

$R2 = .79$, Adjusted $R2 = .74$

$F = 29.33$ D. f. = 35

No of observation = 38 Returns to scale = .98

*** is used at 1% level of significant on a two tail distribution.
** is used at 5% level of significant on a two tail distribution.
* is used at 10% level of significant on a two tail distribution.

Now we consider the result of equation no. (2) that exhibits the result of the estimation of C-D production function for Crust stage of manufacturing of leather. The estimated coefficient of labor is highly significant and capital is moderately significant. The multicollinearity between the explanatory variables of capital and labor as is usual for cross-section data. The Coefficient of determination of the C-D model has been fitted well to the data can be known from the measures of 'goodness of fit' as indicate by R2 , $\bar{R}2$ are reasonably significant and F statistics is highly significant. The partial elasticity of output with respect to capital (eq. No-2) is .438 reflects the fact that a 1% increase in the capital input holding the labor input constant leads to .43% increase in the output of Crust leather. On the other hand the partial elasticity of output with respect to Labor (eq. No-2) is .550 reflects the fact that a 1% increase in the labor input holding the labor input constant leads to .55% increase in the output of Crust leather.

For Finished Stage

VQFS = f (KFS, LFS)
Here
VQFS = Value of Output in the Finished Stage
KFS = Capital in the Finished Stage
LFS = Labor in the Finished Stage

Using Cobb-Douglas Production function and taking Log (Ln) in both sides.

$$LnVQFS = LnA + a1LnKFS + b1LnLFS \text{ ------------(3)}$$

$$\underset{(5.004)\,***}{LnQFS = 4.478} + \underset{(2.179)\,**}{.5146\,LnKFS} + \underset{(2.834)\,***}{.4642\,LnLFS}$$

R2 = .73, Adjusted R2 = .69

F = 18.10 D. f. = 24

No of observation = 27 Returns to scale = .97

*** is used at 1% level of significant on a two tail distribution.
** is used at 5% level of significant on a two tail distribution.
* is used at 10% level of significant on a two tail distribution.

Now we consider the result of equation no. (3) that exhibit the result of the estimation of C-D production function for Finished stage of manufacturing of leather. The estimated coefficients of labor and capital are moderately significant. The multicollinearity between the explanatory variables of capital and labor as is usual for cross-section data. The Coefficient of determination of the C-D model has been fitted well to the data can be known from the measures of 'goodness of fit' as indicate by R2 , $\bar{R}2$ are reasonably significant and F statistics is highly significant. The partial elasticity of output with respect to capital (eq. No-3) is .514 reflects the fact that a 1% increase in the capital input holding the labor input constant leads to .51% increase in the output of Finished leather. On the other hand the partial elasticity of output with respect to Labor (eq. No-3) is .464 reflects the fact that a 1% increase in the labor input holding the labor input constant leads to .46% increase in the output of Finished leather.

The marginal productivity of Labor (MPL):

$$\text{(a) MPL} = \frac{\partial Q}{\partial L} = A\beta L\beta\text{-}1K\alpha = \beta AL\beta K\alpha L\text{-}1$$

$$= \beta \frac{Q}{L} = \beta(\text{APL})\text{---------}(5) \quad \text{(Koutsoyiannis 1979, p-75)}$$

Where APL= Average productivity of Labor

Similarly the marginal productivity of Capital (MPk):

$$\text{(b) MPK} = \alpha \frac{Q}{K} = \alpha(\text{APK}) \text{----------}(6) \quad \text{(Koutsoyiannis 1979, p-75)}$$

Where APk= Average productivity of Capital

Factor intensity: In a Cobb-Douglas function factor intensity is measured by the ratio $\frac{\beta}{\alpha}$. The higher this ratio the more labor intensive the technique. Similarly the lower the ratio $\frac{\beta}{\alpha}$ the more capital intensive the technique. (Koutsoyiannis 1979, p-76)

The Efficiency of Production:

The production function is basically an engineering or technical relation showing how inputs are transformed or converted into output. It also shows the maximum amount of output that can be produced with a fixed amount of resources like land, labor, capital, raw materials, energy or even entrepreneurial talent. So it is also an efficiency relation. (Mukherjee 1996 p-547)

The efficiency in the organization of the factors of production is measured by the coefficient A. Intuitively it is clear that if two firms have the same K, L, α and β and still produce different quantities of output, the difference can be due to the superior organization and entrepreneurship of one of the firms, which results in different efficiencies. The more efficient firm will have a larger A than the less efficient one. (Koutsoyiannis 1979 p-76)

Efficiency of Allocative Resources:

We are able to calculate the average and marginal productivities at the mean level of inputs, considering labor by total number of workers. If we have average product, we can easily calculate marginal product after multiplying the average product by partial elasticity of output with respect to inputs (labor and capital input).

Table1: Average, Marginal and Factor Intensity

Stage of Production	Average Production		Marginal Production		Factor intensity
	Capital	Labor	Capital	Labor	$(\frac{\beta}{\alpha})$
Wet-Blue Stage	40.32	62.16	20.04	32.05	1.03
Crust Stage	13.56	57.21	5.95	31.47	1.25
Finished Stage	5.65	24.42	2.91	11.34	.90

We can see from the Table-1, marginal products- both of labor and capital are lower than average products. Labor intensities are higher both in wet-blue and crust stages but low in finished stage. It means that finished stage is capital intensive stage and wet-blue and crust stages are labor intensive. The more efficient firm will have a larger A than the less efficient one. We can see from the above table that the production efficiency is increasing and it is in highest position in finished stage. The production efficiency is in the best position in finished stage due to skilled labor involvement in production process.

Findings

The average products of capital and labor in the Wet-blue are Tk 40.32 and Tk. 13.56, respectively. The average products of capital and labor in the crust stage are Tk 5.65 and Tk.62.16, respectively, while the average products of capital and labor were found to be Tk 57.21 and Tk 24.42, respectively in the finished stage. The marginal products of capital and labor in the Wet-blue; Crust and Finished stages are Tk 20.04 and Tk 5.95; Tk 2.91 and Tk 32.05; and Tk 31.47 and Tk 11.34, respectively. The production efficiency of capital and labor in the Wet-blue, Crust and

Finished stages are 3.351, 3.503, and 4.478, respectively. The factor intensities of capital and labor in the Wet-blue, Crust and Finished stages are 1.03, 1.25, and 0.90, respectively. This suggests that the marginal products- both of labor and capital are lower than average products. Labor intensities are higher both in Wet-blue and Crust stages but low in finished stage. It means that finished stage is capital intensive stage and Wet-blue and Crust stages are labor intensive. The above also suggests that the production efficiency increases as the production progress to the higher stages and it is the highest in finished stage. Since skilled labor are used for production in that stage.

Policy Recommendations

Following actions are recommended to help sustainable development and successful operation of the tanning process:

- The Government should introduce leather and leather product-related training programs in different institutions for skilled manpower for leather and leather products industries. Institutions should offer courses in leather tooling, designing of footwear, leather goods, leather garments, etc.

- The Government should encourage establishment of new units as well as BMRE of the existing units for value addition items viz.; finished leather, footwear and leather goods to enhance export earnings.

- An interim alternative program could be undertaken by way of import of wet-blue hides and skins and also raw wet salted to fulfill the deficiency raw hides and skins inside the country.

While various pragmatic policies were adopted by the government for bringing in qualitative changes in the performance of the sector, the following seem to be the current burning issues, which need to be resolved on a priority basis to help augment export earning of this sector:

- Significant financial support is needed for growth of new ventures, as leather goods project is very much capital intensive.

- Measures should be taken to pick up inadequate supply of skilled workforce for production of leather and leather goods.

Concluding Remarks of the Study

Leather industry in Bangladesh constitutes a vital sector of export and plays a very important role in socio-economic life of our country. It is mostly labor-intensive and has concentrated mainly at Hazaribagh area, Dhaka. There is co-existence of conventional and modern units, large, medium small, and cottage units with or without contemporary techniques of the production process. But it has enormous growth potential for sustainable development of the country. It is able to make significant contribution to foreign exchange earnings, economic restoration and prosperity of the economy. Moreover Bangladesh is at marked advantages in leather production since it has the large livestock population within the country.

However, it requires significant technical and marketing assistance for development and expansion of finished leather and leather products, which can be achieved through establishment of joint venture or technical collaboration with buy-back arrangements with potential foreign partner especially at market places. This would ensure a transfer of up-to-date knowledge, skill and understanding and would improve the quality of leather products. Without this kind of development support, the Bangladesh leather manufacturing industry will only be able to continue to produce low quality leather goods which will fail to compete in international market. To enable the leather sector in Bangladesh compete successfully in the international market, there is a need for both short-term and long-term technical input, and development is needed in factory floor production and management training. Investment climate including law and order situation of the country is needed to be improved to attract investors.

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