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An Analysis of Production Relations in the Large-scale Textile Manufacturing Sector of Pakistan

SOHAIL J. MALIK, MOHAMMAD MUSHTAQ and HINA NAZLI*

This paper attempts to determine econometrically the underlying production relations for the large-scale textile manufacturing sector of Pakistan, based on data available from the six most recent censuses of large-scale manufacturing industries. The covariance model is used for pooling the provincial data. Testing for alternative forms reveals that the CES production function with constant-returns-to-scale most adequately explains the underlying production structure. The estimates of the elasticity of substitution are significantly different from zero in all cases, implying significant and efficient employment generation possibilities.

INTRODUCTION

The strategy underlying Pakistan's development during the earlier decades was based on the concept of "industrial fundamentalism". A host of fiscal, trade, financial and technological policies were implemented to encourage the process of growth through industrialization. However, it was observed that the process of industrialization brought in increasingly capital-intensive techniques of production. There are two schools of thought as to why this occurs. The "technological determinists" believe that technical efficiency alone determines the eventual choice of technique and since the technically efficient techniques are also the capital-intensive ones, the norms of efficiency dictate continuous capital-deepening in production. No choice of technique is possible, in this view, because the elasticity of factor-substitution is zero or near zero. On the other hand, the "neo-classicists" maintain that factor-substitution is possible, and that it is the factor-price distortions created by a host of incentive policies pursued which generate an inoptimal choice of capital-intensive techniques. The large-scale textile manufacturing industry in Pakistan is a prime example of such an "industrial fundamentalism". A host of Government incentives were directed at promoting the growth of this sector. However, the growth in em-

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ployment did not keep pace with the growth in output. Moreover, a continuing process of capital-deepening was observed. Which of the two diverse theoretical propositions outlined above explain this phenomenon?

This study seeks to evaluate these two points of view, through an in-depth investigation of the possibilities of factor-substitution in the large-scale textile manufacturing sector of Pakistan. The study sets out to test a number of other hypotheses that have a direct bearing on the eventual estimate of the elasticity of substitution. Since the data are available at the provincial level, initially we test the hypothesis of the similarity of provincial functions. Only if such functions are similar can we pool the data to obtain estimates for Pakistan as a whole. If the provincial functions are different, it implies a difference in the underlying production relations in this sector across the provinces. Having determined if pooling of data is possible or not, we then proceed to test the hypothesis of the similarity of functions over time. The results of this test also, in addition to providing possible validity for pooling the successive cross-sections, provide us with an insight into the changes in the production relations over time. The basic thrust of the paper is a series of tests designed to show which functional form best fits the data or, in other words, adequately explains the underlying production relations. As is well known, various generalizations of the basic (indirect) estimating forms of the CES production function are available, which permit testing for the existence of variable-returns-to-scale. Moreover, extensions that permit variable elasticities of substitution as well as variable returns to scale are also available, and are estimated. These forms and the testing procedure are described in detail in the section on methodology.

The large-scale textile manufacturing sector is of considerable importance to Pakistan not only because it is the predominant industrial sub-sector, but also because of its backward linkages with the key agricultural sector. The results of this study could be of considerable interest for policy-making. In a labour-abundant, capital-scarce economy like Pakistan's, the existence of significant factor-substitution possibilities in textile manufacturing will imply increased employment generation without sacrificing efficiency (i.e., without loss of output).

To date, there has been very little work done in this area. Three previous studies of note, however, must be mentioned. The first, by Kazi *et al.* (1976), using the constant elasticity of substitution production function, found the possibilities of labour capital substitution to be limited in the large-scale textile manufacturing sector. The second study, by Kemal (1981), using an adjusted or "consistent" time-series data, also found limited possibilities of factor-substitution in this sector. However, a recent study, by Battese and Malik (1987), has found significant possibilities of factor-substitution using aggregative data for selected key industries. This study has highlighted the need for disaggregated analysis of the key industries, including textiles.

The decline over time of relative importance of the textile industry in Pakistan can be gauged from the following statistics. During the period from 1970-71 to 1980-81 the mean value of the proportion of value added in large-scale industries combined was 0.22. This proportion declined from a maximum of 0.30 in 1970-71 to 0.16 in 1980-81. The mean value of employment in this industry as a proportion of total large-scale industrial employment was 0.46. This proportion ranged from a maximum of 0.48 in 1970-71 to a minimum of 0.41 in 1980-81. The trend value of the regression of time variable on the log of real value added[1] in this sector shows that it declined at a rate of 0.48 percent. Moreover, employment in this sector declined at a rate of 0.71 percent while real capital employed declined at a rate of 1.04 percent. Employment cost as a proportion of value added in this industry, however, grew at a rate of 2.90 percent. This was due partly to the growth of wages of 3.13 percent and partly because of the decline in value added.

An examination of the sub-sectors within the large-scale textile manufacturing sector reveals that, in terms of the value added generated and the capital and labour employed, it is heavily dominated by cotton-spinning and weaving and finishing of cotton textiles. These categories together account for over seventy percent of the value added, seventy-five percent of the capital employed, and nearly the same percentage of the labour employed. However, spinning of cotton is a more capital-intensive industry requiring a higher proportion of capital per unit of labour to produce the same proportion in value added. It is the trends in these two categories that have dominated the trends in the overall textile sector. The growth rates of different key variables in the constituent categories and in overall textile manufacturing can be seen in Table 1.

The study is divided into five sections. Details of the methodology and the procedures followed are described in the next section. The data used are described in the third section, while the results are presented in the fourth section. The summary of conclusions makes up the last section.

METHODOLOGY[2]

We start by specifying a simple Constant Elasticity of Substitution (CES) production function with only two factors, of production capital and labour.[3] It can be shown easily that when the elasticity of substitution is one, the function represents a

[1] The growth rates are computed from the following regressions: Log $(Y) = \alpha + \beta T$, where β is the trend coefficient, and T denotes time. All estimated coefficients, unless otherwise stated, are significant at 5 percent level. The growth rates are based on the available Census of Manufacturing Industries data for the period 1969-70 to 1980-81.

[2] This section relies heavily on Battese, Malik and Babar (1988).

[3] It is possible, of course, to include a number of inputs and/or types of labour and capital in the specification. However, data availability constrains us to use the simple specification.

Table 1

Growth Rates of Different Sub-sectors within the Textile Industry of Pakistan from 1970-71 to 1980-81

(1959-60 prices)

	S	W	SWWSE	CRW	MT	DBF	SWFN	SWJE	Overall
N	1.05	–2.61	4.80	–3.93	2.67	5.59	–1.34	2.40	2.58
L	3.13	–5.19	0.96	0.09	–2.47	1.70	–1.25	1.96	–0.71
W	2.84	3.64	1.60	–1.36	1.46	3.18	2.12	5.46	3.13
K	1.76	–4.56	–0.09	4.51	–2.59	–3.45	2.30	0.17	–1.04
EC	5.96	–1.55	2.56	–1.28	–1.01	4.88	0.87	7.42	2.42
VA	2.60	–7.01	3.90	8.37	4.77	1.23	6.38	7.96	–0.48
EC/VA	3.36	5.46	–1.34	–9.65	–5.78	3.64	–5.50	–0.54	2.90
VA/L	–0.52	–1.82	2.94	8.29	7.24	–0.46	7.62	6.00	0.23

Source: Based on Census of Manufacturing Industries (Various Issues).

Notes: Growth rates of VA, EC, W and K based on deflated data.

S = Spinning of cotton.

W = *Weaving* and *Finishing* of cotton textiles.

SWWSE = (i) *Spinning, Weaving* and *Finishing* of woollen textiles except hand-looms.
(ii) Spinning, Weaving and Finishing of silk and art-silk and synthetic textiles except hand-looms.

CRW = Carpet and rugs – *wool.*

MT = (i) Made up textile goods except wearing apparel.
(ii) Knitting mills.

DBF = Dying, bleaching and finishing of textiles only.

SWFN = (i) Spinning, weaving and finishing of narrow fabrics.
(ii) Spooling and thread-ball making.

SWJE = (i) Spinning, weaving and finishing of jute textiles except hand-looms.
(ii) Cordage, rope and twine.
(iii) Manufacture of textiles n.e.c.
(iv) Others.

N = Number of firms.

L = Labour employed.

W = Wage rate.

K = Capital employed.

EC = Employment cost.

VA = Value-Added.

EC/VA = Employment cost as a proportion of Value-Added.

VA/L = Value-Added per worker.

Cobb-Douglas type production function; moreover, when it is zero, the function represents a Leontief type fixed factors situation [Chiang (1984)].

Parameters of the constant – or variable-elasticity-of-substitution – production functions are estimated by considering their indirect forms, which are derived under the assumption that the marginal productivity of labour is equal to the wage rate. These functions are specified for firms in different asset-size categories. Given that the input levels of firms within these different asset-size categories are the same [see Battese and Malik (1986)], the appropriate indirect form of the variable-returns-to-scale, constant-elasticity-of-substitution (CES) production function is:

$$\text{Log}\,(\bar{Y}_i/L_i) = \beta_0 + \beta_1 \text{ Log } W_i + \beta_2 \text{ Log } L_i + \text{Log } \bar{V}_i \quad \ldots \quad (1)$$

$$i = 1, 2, \ldots\ldots, n;$$

where $\beta_1 \equiv \nu(\nu+\rho)^{-1}$ and $\beta_2 = \rho(\nu-1)(\nu+\rho)^{-1} = (\nu-1)(1-\beta_1)$;

- ν is the homogeneity (return-to-scale) parameter;
- ρ is the substitution parameter;
- $\bar{Y}_i$ represents the sample mean of value added for the firms in the ith asset-size category;
- L_i represents the number of labourers employed by firms in the ith asset-size category; and
- W_i represents the wage rate for labourers in firms within the ith asset-size category.

Log $\bar{V}_i$ has an approximately normal distribution with variance inversely proportional to the number of firms within the ith asset-size category represented by T_i, provided that the number is sufficiently large; and n represents the number of asset-size categories involved.

It is readily verified that the elasticity of substitution, σ, is expressed in terms of the coefficients of the logarithms of wages and labour in (1) by

$$\sigma = \beta_1 (1 + \beta_2)^{-1}$$

Thus, if the constant-returns-to-scale CES production function applies (i.e. $\nu = 1$), then the coefficient of the logarithm of labour, β_2, is zero and so the coefficient of the logarithm of wages, β_1, in the indirect form (1), is equal to the elasticity of substitution. In this case the estimable indirect form is

$$\text{Log}\,(\bar{Y}_i/L_i) = \beta_0 + \beta_1 \text{ Log } W_i + \text{Log } \bar{V}_i \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

$$i = 1, 2, \ldots\ldots, n.$$

The indirect form of the variable-returns-to-scale VES production function is

$$\text{Log}\,(\bar{Y}_i/\bar{L}_i) = \beta_0 + \beta_1 \text{ Log } W_i + \beta_2 \text{ Log}\,(K_i/L_i) + \beta_3 \text{ Log } L_i + \text{Log } \bar{V}_i \quad (3)$$

$$i = 1, 2, \ldots\ldots n;$$

where $\beta_1 \equiv \nu(\nu+\rho)^{-1}$, $\beta_2 \equiv c$ and $\beta_3 \equiv \nu - 1$

If the returns-to-scale parameter, ν, is one (i.e., constant-returns-to-scale applies), then it is clear from the above that β_3 is zero and the indirect form is

$$\text{Log}\,(\bar{Y}_i/L_i) = \beta_0 + \beta_1 \text{ Log } W_i + \beta_2 \text{ Log}\,(K_i/L_i) + \text{Log } \bar{V}_i \quad \ldots \quad (4)$$

$$i = 1, 2, \ldots\ldots n;$$

Further, if $\beta_2 = 0$ in model (4) or $\beta_2 = 0$ and $\beta_3 = 0$ in model (3), then the indirect form of the constant-returns-to-scale CES production function (2) is obtained.

Given that the random errors, Log $\bar{V}_i$, $i = 1, 2, \ldots . n$, in the indirect forms, (1) – (4), are heteroscedastic and the variances are proportional to the number of firms within the corresponding asset-size categories, then the parameters are most efficiently estimated by weighted least-squares regression. In fact, the generalized least-squares estimators for the parameters are obtained by ordinary least-squares regression after the values of the variables in the indirect forms are multiplied by the square root of the corresponding number of firms within the given asset-size category (i.e., the ith observations of the variables in the appropriate indirect form are multiplied by $r_i^{½}$).

Given that appropriate regularity conditions are satisfied [see Battese and Malik (1986)], it follows that:

(i) The t-statistic associated with the weighted least-squares estimator of β_2 in model (1) has approximately $t_{(n-3)}$ distribution if the constant-returns-to-scale CES production function applies;

(ii) The F-statistic associated with the weighted least-squares estimators of β_2 and β_3 in model (3) has approximately $F_{(2,\ n-4)}$ distribution if the constant-returns-to-scale CES production function applies; and

(iii) The t-statistic associated with the weighted least-squares estimator of β_3 in model (3) has approximately $t_{(n-4)}$ distribution if the constant-returns-to-scale VES production function (4) applies.

A consistent estimator of the elasticity of substitution for the constant-returns-to-scale VES production function is defined by

$$\hat{\sigma} = \hat{\beta}_1(1 - \epsilon\hat{\beta}_2)^{-1}$$

where $\hat{\beta}_1$ and $\hat{\beta}_2$ represent the generalized least-squares estimators for the parameters, β_1 and β_2, in the indirect form (4): and

$\epsilon \equiv (wL + rK)/rK$ is the ratio of total factor costs to the cost of capital.

If the econometric models considered above are defined for several time-periods, then the most general situation, for which a particular model applies, involves the variables *and* parameters being indexed by the time-periods involved. It can be shown that it is meaningless to discuss the estimation of *the* elasticity of substitution on the basis of aggregative time-series data unless we assume that the elasticities are the same for all time-periods.[4] Additionally, if firm-level data are not available for the T time-periods and only totals of value added, wages, capital and labour are available for each time-period, then the elasticity of substitution is estimable from aggregative time series data, if the following restrictive conditions on the original production functions hold:

(1) Wages and labour inputs are the same for all firms at any given time-period, i.e., $w_{tij} = w_t$ and $L_{tij} = L_t$, for all $j = 1, 2, \ldots\ldots r_{ti}$; $i = 1, 2, \ldots\ldots n_t$; $t = 1, 2, \ldots\ldots T$;

(2) The substitution parameters, ρ_t, $t = 1, 2, \ldots\ldots\ldots T$, are the same and hence the elasticity parameters, $(1 + \rho)^{-1}$, $t = 1, 2, \ldots\ldots\ldots T$, are the same over time.

Given that the above conditions are satisfied for the aggregative cross-sectional data for each time-period, the relevant indirect forms, associated with the CES production functions [Equation: 2 with $\beta_2 = 0$] are defined by:

$$\text{Log}\,(\bar{Y}_{ti}/L_{ti}) = \beta_{t0} + \beta_{t1}\ \text{Log}\,w_{ti} + \text{Log}\,\bar{v}_{ti}, \qquad \ldots \qquad \ldots \qquad (5)$$

$$i = 1, 2, \ldots\ldots n_t; \qquad t = 1, 2, \ldots\ldots T,$$

where $\bar{Y}_{ti} \equiv \sum_{j=1}^{r_{ti}} Y_{tij}/r_{ti}$ is the sample mean of value added for the reporting firms in the ith asset-size category in the tth time-period; and log $\bar{v}_{ti}$ has an approximately normal distribution with mean $\frac{1}{2}\sigma_u^2$ and variance $(e^{\sigma_u^2} - 1)/r_{ti}$, if the number of reporting firms in the ith asset-size category in the tth time-period is sufficiently large.

Given the indirect form (5), the hypothesis that the slope parameters are equal

[4]This is not to deny the importance of analysis from time-series data but simply to highlight a basic assumption, often forgotten, when estimating from this type of data.

(i.e., $\beta_{t1} = \beta_1$ for all $t = 1, 2, \ldots . T$) is testable by traditional regression methods, which do not require that the intercept parameters, β_{t0}, $t = 1, 2, \ldots \ldots T$, satisfy any functional relationship. Further, it is possible to test the hypothesis of Hicksian neutral technological change (i.e., $\beta_{t0} = \beta_0 + \delta_0 t$ and $\beta_{t1} = \beta_1$ for all $t = 1, 2, \ldots . T$), given the indirect form (5).

Suppose that, for a given industry, the constant-returns-to-scale VES production function [Equation 4] holds for the different time-periods involved. Then the estimable indirect forms of the VES production functions involved are defined by:

$$\text{Log}\,(\overline{Y}_{ti}/L_{ti}) = \beta_{t0} + \beta_{t1} \log w_{ti} + \beta_{t2} \log (K_{ti}/L_{ti}) + \log \overline{v}_{ti}, \quad \ldots \quad (6)$$

$$i = 1, 2, \ldots . n_t : \quad t = 1, 2, \ldots \ldots T.$$

Given the definition of the elasticity of substitution for this VES model, it follows that if the ratio of factor costs, ϵ, is constant for the time-periods involved, then the elasticity is only constant over time if the coefficients β_{t1} and β_{t2} of the logarithms of wages and the capital-labour ratio in the indirect form (6) are constant over time. Test procedures can be devised for this hypothesis, using traditional regression methods for the estimation of the indirect form (6).

Suppose that the elasticity of substitution for the constant-returns-to-scale VES production function is constant over time. It is, then, evident that the estimation of the elasticity by use of aggregative time-series data requires that the wages and labour and capital inputs be the same for all firms at any given time-period. Such conditions are obviously very unrealistic.

It is also evident that difficulties similar to those indicated above apply to the estimation of elasticities when related products are aggregated to obtain a composite product, such as the textiles. This emphasises the desirability of obtaining data at the firm level, for well-defined products, within the time-periods of interest.

DATA

Data on the different aspects of Pakistan's large-scale manufacturing firms can be obtained from the census of large-scale manufacturing industries. The census data suffer from three main defects:

1. There is serious undercoverage of the firms involved;
2. They are not available on a yearly basis; and
3. The definitions of some variables have changed over time.[5]

[5] An example of the changing definitions of key variables in different censuses is the fixed assets. Prior to 1962-63, the censuses reported the written-down values of capital at the end of the year as fixed assets. Since 1962-63, the censuses have used written-down values at the beginning of the year, plus any investments during the year, but with no deductions made for any depreciation during the year.

They are discussed in detail in Kemal (1976).

However, in the absence of an alternate data set, we use the original published data from the census of large-scale firms within the large-scale textile industry for each year for the years 1969-70, 1970-71, 1975-76, 1976-77, 1977-78 and 1980-81 [Government of Pakistan (1973), (1977), (1980), (1982), (1983) and (1984)]. These years are the six most recent years for which data are available in published form. These data in aggregate form are available in cross-tabulations, across asset-size categories for the provinces of Punjab and Sind. Our analysis, therefore, concentrates only on the data from these two provinces. The total number of observations for each province in the respective year are presented in Table 2.

Table 2

Number of Observations in Different Years for the Textile Industry in Various Censuses of the Manufacturing Industries

Years	Punjab	Sind	Total
1969-70	12	13	25
1970-71	6	13	19
1975-76	7	7	14
1976-77	7	7	14
1977-78	7	7	14
1980-81	7	7	14
Total	46	54	100

Note: The observations are based on the asset-size categories for each province in the corresponding years.

RESULTS

The results reported in this section follow a systematic pattern, as we proceed step-wise to determine the functional form that most adequately explains the underlying data and then report the elasticity estimates based on this selected estimating form. It bears repeating that the form that most adequately represents the data is in fact portraying the underlying production relations in the large-scale textile manufacturing sector of Pakistan.

Initially we consider the possibilities of the similarity of the province functions. Tests are conducted on the basis of three hypotheses for both the constant-returns-to-scale and variable-returns-to-scale versions of the CES and VES production functions. Three hypotheses are considered, namely:

1. The province functions have the different intercepts but same slopes;
2. The province functions have the same intercepts but different slopes; and
3. The province functions are different, i.e., both intercepts and slopes.

The relevant test statistics have approximate F distribution and are presented in Tables 3 and 4. A perusal of these tables shows that the hypothesis of dissimilarity is accepted in only 7 of the 72 cases (i.e., approximately 10 percent of the cases). We, therefore, can proceed with reasonable confidence to pool the data of the two provinces. Next we consider the possibility that the yearly functions for each of the versions of the CES and VES production functions are similar. Here, again, we consider the three possibilities of each case:

1. Yearly functions have different intercepts but the same slopes;
2. Yearly functions have the same intercepts but different slopes; and
3. Yearly functions are different, i.e., both slopes and intercepts.

A perusal of Table 5 shows that the yearly functions are dissimilar. All the test statistics reported in this table are significant.

At the third stage we conducted tests to determine the adequacy of different functional forms, given that the constant-returns-to-scale CES production function applies. The relevant test statistics are presented in Tables 6 to 8. The tests reveal that in majority of cases the constant-returns-to-scale CES production function adequately explains the underlying data, because the null hypothesis that the CRS, CES production function applies is rejected in 4 of the 18 cases.

On the assumption that the CES-CRS production function applies, the computed elasticities of substitution are presented in Table 9. This table also presents t-statistics for the tests that the computed elasticities are different from unity. The estimated elasticities are in all cases significantly different from zero. There is an interesting pattern in which the estimated elasticity increases from 0.43 in 1969-70 to 2.37 in 1980-81. The estimates are not significantly different from One in 1975-76, 1976-77 and 1977-78. In all other cases the elasticities are significantly different from One.

The careful testing procedure adopted in this study has yielded several results. Firstly, the underlying production structures are similar in the two provinces in the

Table 3

Test Statistics for the Similarity of Province Functions – the Case of CES Production Function with Constant-Returns-to-Scale (CRS) and Variable Returns-to-Scale (VRS)

Production Function	1969-70	1970-71	1975-76	1976-77	1977-78	1980-81
CES-CRS						
F_1	1.43 (1,22)	0.21 (1,16)	1.60 (1,11)	2.97 (1,11)	4.21 (1,11)	1.72 (1,11)
F_2	1.57 (1,22)	1.79 (1,16)	5.35** (1,11)	0.08 (1,11)	0.10 (1,11)	1.14 (1,11)
F_3	0.82 (2,21)	2.98 (2,15)	2.48 (2,10)	2.88 (2,10)	3.36 (2,10)	1.45 (2,10)
CES-VRS						
F_1	3.43 (1,21)	0.23 (1,15)	3.02 (1,10)	1.62 (1,10)	0.76 (1,10)	0.06 (1,10)
F_2	0.97 (2,20)	4.61** (2,14)	2.40 (2,9)	0.84 (2,9)	0.34 (2,9)	4.50** (2,9)
F_3	2.26 (3,19)	4.67** (3,13)	1.65 (3,8)	0.91 (3,8)	0.58 (3,8)	2.63 (3,8)

Notes: **Indicates Significant at 5 percent level.
(i) The figures in parentheses are degrees of freedom.
(ii) The figures given in the rows F_1, F_2 and F_3 are the approximate values of F-statistics computed under three hypotheses reported on page 36.

Table 4

Test Statistics for the Similarity of Province Functions – the Case of VES Production Function with Constant-Returns-to-Scale (CRS) and Variable Returns-to-Scale (VRS)

Production Function	1969-70	1970-71	1975-76	1976-77	1977-78	1980-81
VES-CRS						
F_1	1.50 (1,21)	0.11 (1,15)	0.83 (1,10)	3.60 (1,10)	3.37 (1,10)	0.67 (1,10)
F_2	0.74 (2,20)	4.49** (2,14)	1.03 (2,9)	1.74 (2,9)	1.44 (2,9)	2.90 (2,9)
F_3	0.49 (3,19)	3.37 (3,13)	1.79 (3,8)	5.16** (3,8)	3.77 (3,8)	1.70 (3,8)
VES-VRS						
F_1	3.72 (1,20)	0.14 (1,14)	1.03 (1,9)	2.40 (1,9)	0.10 (1,9)	0.14 (1,9)
F_2	1.47 (3,18)	3.81** (3,12)	1.98 (3,7)	2.69 (3,7)	0.33 (3,7)	2.70 (3,7)
F_3	1.73 (4,17)	3.40 (4,11)	1.38 (4,6)	2.20 (4,6)	0.40 (4,6)	2.02 (4,6)

Notes: **Indicates Significant at 5 percent level.
(i) The figures in parentheses are degrees of freedom .
(ii) The figures given in the rows F_1, F_2 and F_3 are the approximate values of F-statistics computed under three hypotheses reported on page 36.

Table 5

Test Statistics for the Stability of Yearly Function – the Case of CES and VES Production Function with Constant-Returns-to-Scale (CRS) and Variable-Returns-to-Scale (VRS)

Production Function	F_1	F_2	F_3
CES-CRS	2.95* (5,92)	9.96* (5,92)	5.84* (10,87)
CES-VRS	3.58* (5,91)	7.64* (10,86)	6.06* (15,81)
VES-CRS	3.52* (5,91)	5.68* (10,86)	4.21* (15,81)
VES-VRS	3.86* (5,90)	5.12* (15,80)	4.87* (20,75)

Notes: *Indicates Significant at 1 percent level.

(i) The figures in parentheses are the degrees of freedom.

(ii) The figures in columns F_1, F_2 and F_3 are the approximate values of F-statistics computed under the three assumptions given on page 36.

Table 6

Test Statistics for the Adequacy of the Variable-Returns-to-Scale CES Production Functions, given that Constant-Returns-to-Scale CES Production Functions Apply

Years	1969-70	1970-71	1975-76	1976-77	1977-78	1980-81
Coefficient of Log (L)	0.006	0.0009	0.001	–0.003	–0.007	–0.009
T-statistics	(1.51)	(0.18)	(0.47)	(–1.53)	(–3.12)**	(–1.86)

Note: **Denotes Significant at 5 percent level.

Table 7

Test Statistics for the Adequacy of the Constant-Returns-to-Scale VES Production Functions, given that Constant-Returns-to-Scale CES Production Equations Apply

Years	1969-70	1970-71	1975-76	1976-77	1977-78	1980-81
Coefficient of Log (K/L)	–0.012	–0.023	–0.298	–0.102	–0.142	–0.253
T-statistics	(–0.19)	(–0.32)	(–2.99)**	(–0.11)	(–0.61)	(–0.95)

Note: **Denotes Significant at 5 percent level.

Table 8

Test Statistics for the Adequacy of Variable-Returns-to-Scale VES Production Functions, given that Constant-Returns-to-Scale CES Production Functions Apply

Years	1969-70	1970-71	1975-76	1976-77	1977-78	1980-81
F_1	1.496	0.055	4.10**	1.247	5.933**	1.824
d.f. (V_1, V_2)	(2,21)	(2,15)	(2,10)	(2,10)	(2,10)	(2,9)

Notes: **Denotes Singnificant at 5 percent level.

F_1 = The statistics in this row are the approximately F random variables with d.f. V_1 and V_2 given that functions are not different from Constant-Returns-to-Scale CES Production Functions.

Table 9

Estimates of Elasticity of Substitution given that the Constant-Returns-to-Scale CES Production Functions Apply, and the Test Statistics for the Hypothesis that the Elasticity is Different from Unity

Years	$\hat{\sigma}$	T_1	d.f.
1969-70	0.43 (1.756)***	2.31**	23
1970-71	0.45 (1.932)***	2.360**	17
1975-76	0.89 (5.412)*	0.668	12
1976-77	1.30 (6.538)*	1.537	12
1977-78	1.28 (6.56)*	1.434	12
1980-81	2.37 (3.512)*	2.031**	11

Notes: The figures in parentheses are t-values of the given estimate.

*Denotes Significant at 1 percent level.

**Denotes Significant at 5 percent level.

***Denotes Significant at 10 percent level.

T_1 = The Statistics in this column are absolute t-values under null hypothesis that the elasticity of substitution is equal to unity.

different census years. However, there is significant dissimilarity across years. Secondly, the production relations are characterized by a constancy in the elasticity of factor substitution. Thirdly, for each of the census years examined, constant returns-to-scale applied generally. And, lastly, there are significantly greater possibilities of factor substitution in this sector than were thought possible on the basis of previous studies. [See Kazi *et al.* (1976) and Kemal (1981)].

CONCLUSIONS

The study sets out to test a number of hypotheses that have a bearing on the eventual estimate of the elasticity of substitution. Initially, we test the hypothesis of the similarity of provincial functions. Only if such functions are similar can we pool the data to obtain estimates for Pakistan as a whole. If the provincial functions are different, it implies a difference in the underlying production relations in this sector across the provinces. Having determined if pooling of data is possible or not, we then proceed to test the hypothesis of the similarity of functions over time. The results of this test also, in addition to providing a possibly valid step for pooling the successive cross-sections, provide us with an insight into the changes in the production relations over time. The basic thrust of the paper is a series of tests designed to show which functional form best fits the data, or, in other words, must adequately explain the underlying production relations.

There has been very little work done in this area to date. Previous studies had found the possibilities of labour-capital substitution to be rather limited in this industry. [See e.g., Kemal (1981) and Kazi *et al.* (1976)].

The testing procedure adopted in this study has yielded several useful results. Firstly, the underlying production structures are similar, in the two provinces in the different census years, although there is significant dissimilarity across years. Secondly, the production relations are characterized by a constancy in the elasticity of factor substitution. Thirdly, for each of the census years examined, constant-returns-to-scale applied generally. And, lastly, there are significantly greater possibilities of factor substitution in this sector than were thought possible on the basis of previous studies. However, the aggregate analysis hides a number of problems that would appear in analysis at a more disaggregate level. Such a study is highly warranted. There is a need, especially, to study the weaving and finishing of cotton textiles separately. This would require data at the firm-level. The Government of Pakistan had in 1978 commissioned a massive study of the cotton textile industry of Pakistan [Werner (1978)] which highlighted the problems in different categories of the textile sector. Unfortunately, these recommendations have not been implemented completely. The consultants have noted that similar recommendations were made as far back as the 1950s to the same end.

Our study highlights an important problem. At the aggregate level the elasticity of factor substitution is positive. Yet, for a labour-abundant capital-scarce economy like Pakistan, employment continues to decline in textile manufacturing. Does this say anything about relative factor prices? Is it not time that we focus our attention on the hitherto unforeseen effects of policies designed to distort factor prices.

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