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AN ANALYSIS OF PRODUCTION RELATIONS IN THE
LARGE-SCALE TEXTILE MANUFACTURING SECTOR OF
PAKISTAN

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INTRODUCTION

The strategy underlying Pakistan's development during 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 occurred. The "technological determinists" believed that technical efficiency alone determined the eventual choice of technique and since the technically efficient techniques were also the capital-intensive ones, the norms of efficiency dictated continuous capital deepening in production. No

choice of technique was possible, in this view, because the elasticity of factors substitution was zero or near zero. On the other hand, the neoclassicists maintained that factor substitution was possible and it was the factor price distortions created by the host of incentive policies pursued that generated an inoptimal choice of capital-intensive techniques.

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 upon 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 overtime. The results of this test also, in addition to providing possible validity for pooling the successive cross-sections,

Provide us with insight into the changes in the production relations overtime. 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. 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 the existence of significant factor substitution possibilities in textile manufacturing will imply increased employment generation without sacrificing efficiency (without loss of output).

There has been very little work done in this area to date. Only two studies of note bear to 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. This second study by Kemal (1981) using an adjusted or "consistent" time-series data also found limited possibilities of factor substitution in this sector.

The declining relative importance of the textile industry overtime in Pakistan can be gleaned from the following statistics. During the period from 1954 to 1980-81 the mean value of the proportion of value-added in large-scale textile manufacturing to value-added from all large-scale industries combined was 0.32. This proportion declined from a maximum of 0.47 in 1954 to 0.16 in 1980-81. The mean value of employment in this industry as proportion of total large-scale industrial employment was 0.48. This proportion ranged from maximum of 0.53 in 1954 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* in this sector shows that it declined at a rate of 8.46 percent. Moreover, employment in this sector declined at a rate of 6.21 percent while real capital employed declined at a rate of 2.28 percent. Employment cost as a proportion of value added in this industry, however, grew at a rate of 3.58 percent. This was due partly to the growth of wages of 2.80 percent and partly because of the rapid decline in value-added.

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

An examination of the sub-sectors within the large-scale textile manufacturing sector reveals that in terms of value-added generated, and 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 labour. 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 gleaned from Table 1.

The study is divided into five sections. Details of the econometric modelling and procedures followed are described in the next section. There are several theoretical and estimation considerations hitherto ignored by the earlier studies that are elaborated below. The data used are described in the third section, while the results are presented in the fourth section. The summary of conclusion makes up the last section.

Table 1

Growth Rates of different sub-sectors within the
Textile Industry of Pakistan at Constant
Prices (1954-1981)

	S	W	SWWSE	CRW	MT	DBF	SWFN	SWJE	Overall
N	1.05	-2.61	4.49	-3.01	3.17	5.23	-1.81	5.61	2.61
L	3.13	-5.19	0.69	0.53	2.01	3.05	-2.07	-3.82	-6.21
W	2.83	3.64	1.17	-1.37	0.50	2.15	3.31	4.15	2.80
K	1.76	-4.56	-5.13	2.50	1.98	-3.32	-3.59	-2.45	-2.28
EC	5.96	1.55	1.86	-0.89	2.50	5.20	1.24	7.97	2.74
VA	2.60	-7.01	3.20	7.03	10.44	2.80	6.43	5.49	-8.46
EC/VA	3.36	5.45	-1.34	-7.87	-7.94	2.40	-5.19	2.50	3.58
VA/L	-0.52	-1.82	2.51	6.50	8.44	-0.25	8.51	1.67	-7.84

Source: Based on Census of Manufacturing Industries (various issues)

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

Foot Note: S = Spinning of Cotton

W = weaving and Finishing of Cotton Textiles

SWWSE = i) Spinning, Weaving and Finishing of Woolen 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) Make up textile goods except wearing apparel
ii) Knitting mills.

DBF = Dyeing, bleaching and finishing of textiles only.

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

----- Continued -----

Table 1 continued

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

Methodology

We start by specifying a simple Constant Elasticity of Substitution (CES) production function with only two factors of production capital and labour*. It can easily be shown that when the elasticity of substitution is one the function represents a Cobb-Douglas type production function and moreover when it is zero the function represents a Leontief type fixed factors situation [Chiang (1984)].

The Constant Elasticity of Substitution (CES) Production functions with returns-to-scale parameter, v is defined, for each province and census year, by

$$Y_{ij} = \gamma \{ \delta K_i^{-\rho} + (1-\delta) L_i^{-\rho} \}^{-v/\rho} e^{u_{ij}} \quad \dots \quad [1]$$

where Y_{ij} represents the value-added for the j -th reporting firm in the i -th asset-size category; K_i and L_i represent the amount of capital and labour employed by firms in the i -th asset-size category**; the random errors, u_{ij} , $j = 1, 2, \dots, r_i$, $i = 1, 2, \dots, n$, are assumed to be independent and identically distributed normal random variables with means zero and variances, σ_u^2 ; r_i represents the number of reporting firms in the i -th asset-size category; and n represents the number of asset size categories for textiles in the given province and census year involved (see Table 2).

* 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.

** It is assumed that the quantities of capital and labour for firms in a given asset-size category are the same. While this is likely to be only an approximation for any given empirical situation, it is a sufficient condition for the identification and estimation of the elasticities of substitution for CES production function, defined in terms of firm-level data [see Battese and Malik (1986)].

Given that the product and factor markets are perfectly competitive, then it follows that the elasticity of substitution for the CES production function \bar{Y}_i , $\sigma = (1+\rho)^{-1}$, can be estimated from the associated indirect form \bar{Y}_i see Behrman (1982, p.161) and Battese and Malik (1986) \bar{Y}_i :

$$\log (\bar{Y}_i / L_i) = \beta_0 + \beta_1 \log w_i + \beta_2 \log L_i + \log \bar{v}_i \dots \bar{Y}_i$$

$$i = 1, 2, \dots, n$$

where

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

\bar{Y}_i represents the sample mean of value-added for the firm in the i-th asset-size category;

w_i represents the wage rate for labourers in firms within the i-th asset-size category; and

$$\bar{v}_i \equiv \frac{1}{r_i} \sum_{j=1}^{r_i} v_{ij} \quad \text{where} \quad v_{ij} \equiv e^{u_{ij}}$$

It is readily verifiable that the elasticity of substitution, σ , is expressed in terms of the coefficients of the logarithms of wages and labour in \bar{Y}_i by

$$\sigma = \beta_1 / (1+\beta_2)$$

Thus, if the constant-returns-to-scale CES production function applies (i.e., $v=1$), 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 \bar{Y}_i

is equal to the elasticity of substitution.

It follows from standard asymptotic method that if the number of reporting firms within the l -th asset-size category r_l , is large enough, then the random variable, $\log \bar{v}_l$, in the Indirect form $\underline{[2]}$ has approximately normal distribution with mean, $\frac{1}{2}\sigma_u^2$, and variance, $(e^{\sigma_u^2}-1)/r_l$. Further, given appropriate regularity conditions*, it follows that consistent and asymptotically efficient estimators for the coefficients of the logarithms of wages and labour in the Indirect form $\underline{[2]}$ are obtained by applying weighted least-squares regression to the Indirect form $\underline{[2]}$ where the observations are weighted by the square roots of the numbers of reporting firms in the corresponding asset-size categories.

Theoretically there is no reason for the elasticity of substitution to be constant and in the middle to late 1960's a number of functional forms were developed that permitted the elasticity of substitution to vary.

The stochastic variable elasticity of substitution (VES) production function, with returns to scale parameter v , is defined by:

$$Y_{ij} = \gamma \{ \delta K_{ij}^{-\rho} + (1-\delta) \eta L_{ij}^{-\rho} (K_{ij}/L_{ij})^{-c(1+\rho)} \}^{-v/\rho} e^{u_{ij}} \underline{[3]}$$

where the variables and parameters are the same as for $\underline{[1]}$ above. Given the condition** that wages, labour and capital

* The number of firms, r_l , within the asset-size category and the number of asset-size categories, n , must approach infinity. Further the matrix of transformed values of the independent variables in the Indirect form $\underline{[2]}$ must be regular $\underline{[}$ see, e.g., Theil (1971)p.363].

** See Battese and Malik (1986).

inputs are the same for all firms in a given asset-size category, i.e., $w_{ij} = w_i$, $L_{ij} = L_i$ and $K_{ij} = K_i$ for all $j=1, 2, \dots, n$ and for all $i=1, 2, \dots, n$, it follows that the estimable

$$\log (\bar{Y}_i/L_i) = \beta_0 + \beta_1 \log w_i + \beta_2 \log K_i/L_i + \beta_3 \log L_i + \log \bar{v}_i, \quad i=1, 2, \dots, n,$$

where $\beta_1 \equiv v(v\alpha)^{-1}$; $\beta_2 \equiv c$; and $\beta_3 \equiv v-1$

If the returns-to-scale parameter, $v=1$, i.e., constant-to-scale apply, then it is clear from the above that $\beta_3=0$ and;

$$\log (\bar{Y}_i/L_i) = \beta_0 + \beta_1 \log w_i + \beta_2 \log K_i/L_i + \log \bar{v}_i \dots \dots \dots /5/$$

provides a convenient indirect estimable form of the constant returns-to-scale VES production function. Further, if $\beta_2=0$ in model /5/ or if $\beta_2=0$ and $\beta_3=0$ in model /4/ then the indirect form of the constant-returns-to-scale CES production function /2/ is obtained.

Given that the random variables, $\log \bar{v}_i$, $i=1, 2, \dots, n$ in models /4/ and /5/ have approximately normal distribution with mean $\frac{1}{2} \sigma_u^2$ and variance $(e^{\sigma_u^2}-1)/r_i$, and appropriate regularity conditions on the observations apply, it follows that

- (a) the t-statistics associated with the weighted least-squares estimator of β_2 in model /5/ has approximately t_{n-3} distribution if the CES production function applies;
- (b) the F-statistics associated with the weighted least-squares estimators of β_2 and β_3 in model /5/ has approximately $F_{2,n-4}$ distribution if the model /2/ applies; and

- (c) the t-statistics associated with the weighted least-squares estimator of β_3 in model /4/ has approximately t_{n-3} distribution if the VES production function /5/ applies.

A consistent estimator of the elasticity of substitution for the constant-returns-to-scale VES production function in terms of the parameters of its indirect form /5/ is defined by

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

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

Often empirical studies involve the estimation of elasticities of substitution using aggregative time-series data. 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*. Additionally if firm-level data are not available for the T time periods, but only totals of value-added, wages, capital and labour are available for each

* 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.

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.

$$w_{t+ij} = w_t \text{ and } L_{t+ij} = L_t, \text{ for all } j = 1, 2, \dots, r_{t+1}; i = 1, 2, \dots, n_t; t = 1, 2, \dots, T;$$

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

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

$$\log (\bar{Y}_{t+i}/L_{t+i}) = \beta_{t0} + \beta_{t1} \log w_{t+i} + \log \bar{v}_{t+i}, \dots /6:/$$

$$i = 1, 2, \dots, n_t; t = 1, 2, \dots, T,$$

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

number of reporting firms in the i -th asset-size category in the t -th time period is sufficiently large.

Given the indirect form /6/, the hypothesis that the slope parameters are equal (i.e., $\beta_{t1} = \beta_1$ for all $t = 1, 2, \dots, T$) is testable by traditional regression methods, which do not require that the intercept parameters, β_{t0} , $t = 1, 2, \dots, T$, 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 $t = 1, 2, \dots, T$), given the indirect form /6/.

Suppose that, for a given industry, the constant-returns-to-scale VES production function [eqn. 5] holds for the different time periods involved. Then the estimable indirect forms of the VES production functions involved are defined by:

$$\log(\bar{Y}_{ti}/L_{ti}) = \beta_{t0} + \beta_{t1} \log w_{ti} + \beta_{t2} \log(K_{ti}/L_{ti}) + \log \bar{v}_{ti}, \dots \text{ /7/}$$

$$i = 1, 2, \dots, n_t; \quad t = 1, 2, \dots, T,$$

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 /7/ are

constant over time. Test procedures can be devised for this hypothesis, using traditional regression methods for the estimation of the Indirect form / 7 /.

Suppose that the elasticity of substitution for the constant-returns-to-scale VES production function is constant over time. It is 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 evident that similar difficulties to those indicated above apply for the estimation of elasticities when related products are aggregated to obtain a composite product, such as textiles. This emphasises the desirability of obtaining data at the firm level, for well-defined products, at 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 censuses cover all firms registered under Sections 2 (j) and 5 (i) of the Factories Act 1934. The first census was conducted in 1954. The latest one available in published form pertains to 1980-81. The census was not taken or the data were not made available in published form in a number of years. The published census reports contain data on written-down values of fixed assets, gross value of production, employment and wages. These data form the only source of any comprehensive statistics on the large-scale manufacturing firms in Pakistan. However, the census data suffer from three main defects: (Kemal, 1976).

1. 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*.

* An example of the changing definitions of key variables in different censuses is 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, with no deductions made for any depreciation during the year.

Kemal (1976) estimated that the extent of gross under-coverage of the censuses in various years ranged from about eight to forty-six percent. Following the census in 1963-64, a sample survey, covering ten percent of the non-respondent firms, was carried out. It showed that sixty percent of the non-respondent firms had ceased to exist. It was estimated that the employment data in the census suffered from eighteen percent under-coverage. Based on this figure, the data on fixed assets, value-added and other variables were appropriately inflated. However, because of the small sample size, the range of industries involved was restrictive and, as such, the data from all the industries could not be adjusted. In view of these limitations use of the census data for any time-series analysis encounters significant difficulties*.

In this paper, however, 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 & 1984)]. These years are the six most recent years for

* Kemal (1976) attempted to adjust the census data to make it more consistent. The method used involved projecting an adjusted series of capital over time and then obtaining estimates of output, value-added, industrial cost, employment and wages by using ratios of capital to the individual variables obtained from the different census of manufacturing industries. These data obtained by Kemal have been the subject of severe criticism e.g., Meekal (1982) and Norbye (1978a and b) and ongoing debate, Kemal (1978).

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 in each province in each year are presented in Table 2.

Table 2

No. of Observations In Different Years for Textile Industry In the Various Censuses of 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 stepwise 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 hypothesis for both the constant-returns-to-scale and variable-returns-to-scale version of the CES and VES production functions. The hypotheses are that:

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

The relevant test statistics have approximate F distribution and are presented in Table 3 to 6. 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, i.e.

Table 3

Test Statistics for the Similarity of Province Functions-
the case of the CES Production Function with Constant
Returns to Scale

Years	F_1	F_2	F_3	n
1969-70	1.434	1.567	0.818	25
1970-71	0.207	1.792	2.961	19
1975-76	1.599	5.352**	2.482	14
1976-77	2.965	0.079	2.877	14
1977-78	4.211	0.098	3.359	14
1980-81	1.715	1.137	1.452	14

** Denotes significant at five percent level.

Note: F_1 = The statistics in this column are values of approximate F Statistics with d.f. 1 and n-3 on the assumption that the intercepts are different but slopes are the same.

F_2 = The statistics in this column are values of approximate F Statistics with d.f. 1 and n-3 on the assumption that the intercepts are the same but the slopes are different.

F_3 = The statistics in this column are values of approximate F Statistics with d.f. 2 and n-4 on the assumption that the functions are different.

Table 4

Test Statistics for the Similarity of Province-Functions -
The case of CES Production Function with
variable-returns-to-scale.

Years	F_1	F_2	F_3	n
1969-70	3.429	0.973	2.262	25
1970-71	0.226	4.612**	4.666**	19
1975-76	3.017	2.397	1.646	14
1976-77	1.624	0.835	0.907	14
1977-78	0.759	0.339	0.577	14
1980-81	0.056	4.499**	2.625	14

** Denotes significant at five percent level

Note: F_1 = The statistics in this column are values of approximate F statistics with d.f.1 and n-4 on the assumption that the intercepts are different but the slopes are the same.

F_2 = The statistics in this column are the approximate F statistics with d.f.2 and n-5 on the assumption that the intercepts are the same but slopes are different.

F_3 = The statistics in this column are the approximate F statistics with d.f.3 and n-6 on the assumption that the functions are different.

Table 5

Test Statistics for the Similarity of Province Function -
The case of VES Production Function
with Constant Returns-to-scale

Years	F ₁	F ₂	F ₃	n
1969-70	1.499	0.736	0.488	25
1970-71	0.109	4.487**	3.374	19
1975-76	0.827	1.032	1.789	14
1976-77	3.601	1.736	5.163**	14
1977-78	3.371	1.439	3.768	14
1980-81	0.666	2.901	1.698	14

** Denotes significant at five percent level

F₁ = The statistics in this column are in values of approximate F statistics with d.f. 1 and n-4 on the assumption that intercepts are different but slopes are same.

F₂ = The statistics in this column are the values of approximate F statistics with d.f. 2 and n-5 on the assumption that the intercepts are the same but the slopes are different.

F₃ = The statistics in this column are the values of approximate F statistics with d.f. 3 and n-6, on the assumption that functions are different.

Table 6

Test Statistics for the Similarity of Province Functions -
The Case of VES Production Function
with Variable>Returns-to-Scale

Years	F_1	F_2	F_3	n
1969-70	3.724	1.742	1.731	25
1970-71	0.139	3.812**	3.402	19
1975-76	1.025	1.978	1.380	14
1976-77	2.396	2.693	2.201	14
1977-78	0.104	0.331	0.399	14
1980-81	0.141	2.703	2.015	14

** Denotes significant at five percent level

F_1 = The statistics in this column are the approximate F statistics with d.f. 1 and n-5 on the assumption that the intercepts are different but the slopes are same.

F_2 = The statistics in this column are the approximate F statistics with d.f. 3 and n-7, on the assumption that the intercepts are the same but the slopes are different.

F_3 = The statistics in this column are the approximate F statistics with d.f. 4 and n-8, on the assumption that the functions are different.

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

A perusal of Tables 7 and 8 shows that the yearly functions are dissimilar. All the test statistics reported in these tables 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 9 to 11. The tests reveal that in majority of cases the constant-returns-to-scale CES production function adequately explains the underlined data. The null hypothesis that the CRS CES production function is rejected in 4 of the 18 cases.

The computed elasticities of substitution on the assumption that the CRS CES production function applies are presented in Table 12. 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

Table 7

Test Statistics for the Hypothesis that the Yearly Constant- and Variable>Returns-to-Scale CES Production Functions have the same function

Functional Forms	F ₁	F ₂	F ₃
CES/VES d.f.(V ₁ ,V ₂)	2.945* (5,92)	9.956* (5,92)	5.842* (10,87)
CES/VRS d.f.(V ₁ ,V ₂)	3.578* (5,91)	7.641* (10,86)	6.063* (15,81)

* Denotes significant at one percent level

F₁ = The statistics in this column are approximately F random variables with degrees of freedom V₁ and V₂ given that production functions have the same intercepts.

F₂ = The statistics in this column are the approximately F random variable, with degrees of freedom V₁ and V₂ given that the elasticities are the same for different functions.

F₃ = The statistics in this column are the approximately F random variables with degrees of freedom V₁, V₂ given that the overall functions are same for different years.

Table 8

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Test Statistics for the Hypothesis that the Yearly Constant- and Variable>Returns-to-Scale VES Production Functions have the same function

Functional Forms	F ₁	F ₂	F ₃
VES/CRS d.f. (V ₁ , V ₂)	3.523* (5, 91)	5.680* (10, 86)	4.205* (15, 81)
VES/VRS d.f. (V ₁ , V ₂)	3.855* (5, 90)	5.121* (15, 80)	4.866* (20, 75)

* Denotes significant at one percent level.

F₁ = The statistics in this column are approximately F random variables with degrees of freedom V₁ and V₂ given that production functions have the same intercepts.

F₂ = The statistics in this column are the approximately F random variables with degrees of freedom V₁ and V₂, given that the elasticities are the same for different functions.

F₃ = The statistics in this column are the approximately F random variables with degrees of freedom V₁, V₂, given that the overall functions are same for different years.

Table 9

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	0.009	0.001	-0.003	-0.007	-0.009
T-Statistics	(1.51)	(0.18)	(0.47)	(-1.53)	(-3.12)**	(-1.86)

** Denotes significant at five percent level;

Table 10

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)

** Denotes significant at five percent level.

Table 11

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)

** Denotes significant at five 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 12

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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

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

* Denotes significant at one percent level.

** Denotes significant at five percent level.

*** Denotes significant at ten percent level.

T_1 The statistics in this column are absolute t-values null hypothesis that the estimate of elasticity is equal to unity.

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 different census years. However, there is significant dissimilarity across years. Secondly, the production relations are characterised 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 other hypothesis that have a direct bearing upon 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 overtime. The results of this test also, in addition to providing possible validity for pooling the successive cross-sections, provide us with insight into the changes in the production relations overtime. 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. As a 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.

There has been very little work done in this area to date. Only two studies of note bear to 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.

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 different census years. However, there is significant dissimilarity across years. Secondly, the production relations are characterised 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)]. However, the aggregate analysis hides a number of problems that would appear in an 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) 7 which highlighted the problems in different categories of the textile sector. These recommendations have not unfortunately been completely implemented. The consultants have noted that similar recommendations have been made as far back as the 1950's.

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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