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Estimation of Substitution Parameter in Indian Industries

A Disaggregated Approach

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1. Introduction

In the past, growth models have been constructed and analyzed with the help of a production function subject to certain restrictive features. For quite some time, the Cobb-Douglas production function (CD) with its input exponents adding upto unity and a unitary elasticity of substitution were mostly used by the economists for analysis. In recent times, the constant elasticity of substitution production function (CES) which includes CD, as well as Leontif production function as its special case has been widely used in various studies [see Arrow, Chenery, et al (1961)]. One major limitation of this production function is that the elasticity of substitution parameter is not variable along an isoquant, though it can take different values for different industries. This constraint on the index of technology is inappropriate in the sense that available data must have wide choice so that the formulation of a structural hypothesis is plausible, relevant and free from any specification bias [see Clemhout (1968) and Lovell (1968)]. The variable

* We would like to thank Ms. Sujata Mishra for the research assistance that she has provided during the course of the study.

elasticity of substitution production function (VES) or homothetic production function overcomes this defect of the CES, as it explicitly permits the capital-labour ratio to be an explanatory variable of productivity which is missing in the theoretical/empirical specification of the CES production function. This implies an upward specification bias in the estimates of the parameters of the CES production function. Recently there has been a greater surge of interest in the substitution parameter (σ) for three reasons:

(1) Full absorbtion of surplus labour.

(2) Higher productivity with new techniques for production in modern sector.

(3) Computable general equilibrium (CGE) model for analysing intersectoral/interregional shift in resources typically requires estimates of substitution parameter between labour and capital for various industry groups.

The last need has primarily motivated us to estimate the elasticity of substitution parameter between capital and labour in 23 sectors of Indian industries classified as in Stern and Deardorff (1990). These include 21 three-digit manufacturing sectors which have been aggregated from 29 three-digit sectors of International Standard Industrial Classification (ISIC, Rev. 2) and 2 one-digit sectors (electricity, gas and water supply, and transport, storage and communications). The estimated values of elasticities would be used as one of the various sets of parameter inputs into a computable general equilibrium (CGE) model of India's trade policy reforms in a global framework. This would help overcome one of the major criticisms of the CGE models regarding the use of little known major parameters such as elasticities which in many CGE models are little more than best guesses (Mansur and Whalley, 1984).

We have made an attempt to test whether the estimated values of elasticity of substitution between labour and capital for a sector tend to change from one year to another and also whether it is CD or CES production function that characterises a particular sector.

Lastly, we also examined whether VES type of model is more appropriate for various industry groups in the Indian context.

The plan of the paper is as follows. In Section 2, we briefly survey literature in this area. Section 3 postulates the methodology of our study. The findings of our study are discussed in Section 4 while Section 5 provides some concluding remarks.

2. Survey of Earlier Studies

Nerlove (1967) reported that even slight variations in the period of analysis would tend to produce drastically different estimates of elasticity between capital and labour. However, Zarembka (1970), using data for 13 two-digit sectors of US manufacturing for two years (1957 and 1958), showed that use of different time periods did not produce different estimates of the elasticity. He also showed that the elasticity of substitution between capital and labour did not depart significantly from one for the two-digit sectors under consideration.[1] Thus, he concluded that for most empirical purposes CD production function should be used rather than the CES function. This conclusion was again upheld in Zarembka and Chernicoff (1971). They also showed that the result remained generally valid for three-digit data.

In the Indian context, the earlier studies primarily concentrated on fitting CD production function to investigate the returns to scale parameter. Murty and Shastry (1957) and Dutta (1955) estimated CD function for some firms and found negative evidence of constant returns to

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1 Minasian (1961) pointed out that, to the extent wage rate differentials across observations were due to differences in labour skills, any estimate of elasticity of substitution between capital and labour obtained from factor demand equation for labour would be biased towards unity. Zarembka (1970), while estimating the elasticities, had used a correction on the measurement of the labour input and the wage rate for varying quality of workers across states.

scale. On the other hand, Divan and Gujrati (1968) used CES formulation for sample period 1946–58 and found that the substitution index was close to unity in most of the cases under study. Similar estimates have also been obtained by Shanker (1970) using time series data and Kazi (1976) for cross section studies.

Kazi (1980) pointed out that the use of a CES production function restricted the elasticity of substitution between labour and capital to be constant along an isoquant. He preferred the use of the variable elasticity of substitution (VES) production function since it explicitly permits the capital-labour ratio to be an explanatory variable of productivity along with wage rate. He observed that the elasticity of substitution got overestimated if he used CES than if he used VES. However, he found that the overestimation was less for three-digit classification than for two digit classification. Many of the estimated values of elasticity of substitution are close to unity though Kazi did not test the null hypothesis that each value was equal to one.

3. Methodology

Consider two inputs, capital (K) and labour (L) and value added (V), which are related by:

$$V = \gamma\,[\delta K^{-\rho} + \eta X^{-\mu(1+\rho)}\,(1-\delta)\,L^{-\rho}]^{-1/\rho}\,\nu \quad \ldots\ldots. (1)$$

where γ, η, δ, and ρ are efficiency, intensity, distribution and substitution parameters respectively, X = K/L and ν is random term. Now letting Y = V/L, assuming perfect competition and differentiating (1) with respect to L and equating it to W, we get[2]

$$Y = AW^{\beta}\,X^{\mu}\,e^{u} \quad \ldots\ldots\ldots. (2)$$

$$\text{where } u = \nu^{\rho/1+\rho},$$

$$A = [-\rho\gamma^{-\rho} / \{(1-\delta)\,\eta\,(\mu + \mu\rho - \rho)\}\,]^{-1/(1+\rho)}$$

Now from (1) and (2) using text book definition of σ, we obtain

$$\sigma = \beta/(1 - \mu f/Xf') \quad \ldots\ldots\ldots. (3)$$

$$= \beta / [1 - \mu\,(1 + S/X)]$$

$$\text{where } S = W/r,\ r = f'(X)$$

The elasticity of substitution[3] given by (3) and derived

[2] Following Wallies (1973), we consider that represents technical imperfections and takes into account deviation from the profit maximising condition in factor market.

[3] See Lu and Flatcher (1968) for derivation of σ from equation (1).

from (2) is a function of X and hence (1) is called a production function with the variable elasticity of substitution [see Lovell (1968) and Lu (1968)]. Now from (2) we get[4]

$$\log Y = \log A + b \log W + m \log X + u \quad \text{..........} \quad (4)$$

where u refers to a normally and independently distributed error term with zero mean and constant variance and is independent of W.

It is clear from (1) that the production function reduces to the CES function when $\mu = 0$ and to CD function when $\sigma = 0$ in addition to μ being to zero.

It is obvious from above that under perfect competition, the elasticity of substitution for CES function can be obtained by estimating the following equation:

$$\log Y = \log A + b \log W + z \quad \text{..........} \quad (5)$$

where z is the error term following the usual earlier specified assumptions.

[4] All logs refer to natural logarithms.

4. Empirical Findings

In the present study, the state level data from Annual Survey of Industries (ASI) for two years (1988-89 and 1989-90) have been used to estimate the substitution index for various industries. The data for the year 1988-89 are available according to National Industrial Classification (NIC), 1970 whereas the data for 1989-90 are available according to NIC, 1987. The data have been duly concorded to the required three-digit ISIC sector codes. The elasticities for 23 sectors have been computed for each of the two years using the cross-sectional state level data.

The estimated results for each of the 23 ISIC sectors for the CES function using equation (5) are given in Tables 1 and 2 for the years 1988-89 and 1989-90, respectively. A look at the tables show that the statistical fits of equation (5) for some of the industries are quite poor. So, for the rest of the paper, we will discuss results only for industries (i.e. ISIC sectors) for which the values of the adjusted R^2 in the fitted equations (4 or 5) are more than 0.1. This criterion is satisfied for 19 ISIC sectors for the year 1988-89 and 16 ISIC sectors for the year 1989-90.

It is interesting to note that for all the equations satisfying this criteria, the estimated elasticity values pass the statistical significance test[5]. However, as we have used cross section data for estimating the parameter, one needs to check whether error term has constant variance or not.

[5] That is, the hypothesis $\sigma = 0$ is rejected.

For this reason, for each of the equations for the two years, we have performed White's test for homoscedasticity. The data in Tables 1 and 2 show that, by and large (19 for the year 1988-89 and 21 for the year 1989-90), the error terms in the equations are homoscedastic. Thus, OLS technique is valid for estimating substitution index in most of the ISIC sectors[6]. The substitution parameter, as the Tables 1 and 2 show, appears to vary between 0.580 and 1.620, and 0.569 and 1.504 for the years 1988-89 and 1989-90 respectively.

So far, we have assumed production in each of the industries is carried out by CES production technology. One needs to check whether some other form of production function can be used instead of CES function for a particular sector. In Tables 1 and 2, we also report the results of test whether CD function is the appropriate production technology to be used for a particular ISIC sector. This is done by testing the null hypothesis that value of the elasticity parameter is equal to unity for the corresponding ISIC sector.

It may be observed from Table 1 that for sectors for which adjusted R^2 of the fitted equations is more than 0.1 and the test for homoscedasticity is accepted (15 in all), the alternative hypothesis that elasticity of substitution is not equal to unity gets accepted only in three ISIC sectors (viz. 321, 311 and 38A). For the year 1989-90 subject to the above specified twin criteria, Table 2 shows that the alternative hypothesis gets accepted only in the following of 5 ISIC viz. 322, 331, 35B, 382 and 383.

We have also tested if there has been some structural change in 1989-90 over 1988-89. In order to do this we

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[6] Given the small size of our sample, we have not made any attempt to reestimate any equation correcting for heteroscedasticity.

have tested the null hypothesis that the elasticity of substitution parameter between capital and labour estimated for a particular sector for 1988-89 is equal to its corresponding value estimated for 1989-90. It may be observed from Table 3 that only two ISIC sectors indicate some structural change.

We have estimated parameters of the reduced form equation (4) using OLS technique. The results for the years 1988-89 and 1989-90 are presented in Tables 4 and 5, respectively. Essentially, the tables show findings for the VES production function for the various ISIC sectors.

Table 4 presents the results for VES production function for the year 1988-89. We find that for industries for which statistical fit (measured by adjusted R^2) of the equation is more than 0.1 and White's test for homoscedasticity is accepted, the coefficients of capital per man labour are statistically significant in 8 out of 14 cases. So far as the coefficients of wage are concerned, we have 9 out of 14 of them passing the significance test. It can be seen that overall improvement in adjusted R^2 has occurred compared to the results (reported in Table 1) obtained without K/L variable. The substitution index in this case varies from 0.515 to 1.629 for fitted sectoral equation with all significant coefficient and passing the above specified twin criteria.

The results for VES production function for the year 1989-90 are reported in Table 5. Again, we find that inclusion of K/L variables produced an overall improvement in adjusted R^2 as compared to the results reported in Table 2. Table 5 shows that for industries for which statistical fit of the equation is more than 0.1 and White's test for homoscedasticity is accepted, the coefficients of capital per man labour are statistically significant in 9 out of 14 sectors whereas the coefficients of wage are significant in 11 out of 14 cases. The value of elasticity of substitution parameter that we have estimated varies from 0.517 to 1.593 for fitted sectoral equation with all coefficient being significant and passing the above specified twin criteria.

For clarity of observation, we have presented in Table 5 a brief summary of results. As Table 5 shows, we have been unable to obtain econometrically correct estimates of the substitution parameter in the following two ISIC sectors, viz. 310 and 7. The table also indicates that VES function is more appropriate in the following ten ISIC sectors, viz. 324, 331, 342, 355, 36A, 372, 381, 383, 384 and 38A.

5. Conclusion

This study has been motivated by the need to provide meaningful estimates of substitution parameter for various industry groups so as to reduce the scope of 'guess estimates' in CGE models. While doing so, we have been concerned with both theoretical and empirical issues involved with specification and estimation of aggregate production functions. Understandably all production functions are not identical. Our study shows that some gain can be obtained in adjusted R^2 by including capital per worker as an argument along with two usual factors of production in the VES type of model (Table 5).

The estimates of σ derived from VES hypothesis and that from CES function suggest that σ is variable across industries, besides that the K/L is statistically significant and theoretically relevant arguments in production function in many ISIC sectors (Table 5).

One weakness of our study is that for some of the industry groups, our study fail to obtain econometrically meaningful estimates of substitution parameter. We hope to take care of this weakness in future.

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Table 1: Elasticity of Substitution Between Labour and Capital

Sl. No.	*Sector Code*	*Sector Name*	*Sigma 0*†	*Test for Sigma 0=1*	*Adj R-Sq*	*df*	*White's Test for Homoscedasticity*
1.	310	Food, Beverages & Tobacco	0.629 (2.916)*	Reject (-1.723)*	0.29	17	Reject (6.42)‡
2.	321	Textiles	0.580 (1.855)*	Reject (-1.342)*	0.13	16	Accept (1.07)
3.	322	Wearing Apparel	1.022 (6.205)*	Accept (0.136)	0.74	12	Accept (0.51)
4.	323	Leather Products	1.076 (1.691)*	Accept (0.119)	0.14	10	Accept (2.67)
5.	324	Footwear	-0.481 (-0.402)	Accept (-1.238)	-0.09	9	Accept (3.04)
6.	331	Wood Products	0.797 (3.224)*	Accept (-0.822)	0.36	16	Accept (3.38)
7.	332	Furniture and Fixtures	-0.514 (-0.564)	Reject (-1.660)*	-0.06	12	Accept (1.97)
8.	341	Paper and Paper Products	0.911 (6.885)*	Accept (-0.674)	0.72	17	Accept (0.21)
9.	342	Printing & Publishing	0.962 (6.614)*	Accept (-0.263)	0.72	16	Reject (5.67)
10.	35A	Chemicals	-0.184 (-0.249)	Reject (-1.605)*	-0.06	17	Accept (0.65)
11.	35B	Petroleum & Related Products	1.620 (2.062)*	Accept (0.789)	0.21	11	Accept (0.35)
12.	355	Rubber Products	1.200 (3.247)*	Accept (0.542)	0.37	15	Accept (2.12)
13.	36A	Non-metallic Mineral Products	0.906 (3.321)*	Accept (-0.343)	0.37	16	Accept (1.21)

(Continued)

Table 1 – *(Contd.)*

Sl. No.	*Sector Code*	*Sector Name*	*Sigma 0*†	*Test for Sigma 0=1*	*Adj R-Sq*	*df*	*White's Test for Homoscedasticity*
14.	362	Glass & Glass Products	0.658 (2.468)*	Accept (-1.284)	0.34	9	Accept (0.28)
15.	371	Iron & Steel	0.566 (1.975)*	Reject (-1.515)*	0.14	17	Accept (0.96)
16.	372	Non-ferrous Metals	0.960 (2.884)*	Accept (-0.119)	0.34	13	Accept (0.79)
17.	381	Metal Products	0.627 (2.077)*	Accept (-1.237)	0.16	17	Accept (0.16)
18.	382	Non-electrical Machinery	0.896 (3.915)*	Accept (-0.456)	0.44	17	Accept (1.71)
19.	383	Electrical Machinery	0.829 (3.436)*	Accept (-0.710)	0.38	17	Reject (5.56)
20.	384	Transport Equipment	0.916 (1.164)	Accept (-0.106)	0.02	17	Accept (0.13)
21.	38A	Miscellaneous Manufacturing	0.590 (3.538)*	Reject (-2.458)*	0.39	17	Accept (1.37)
22.	4	Electricity, Gas & Water Supply	1.051 (1.804)*	Accept (0.870)	0.14	13	Reject (8.33)
23.	7	Transport, Storage & Communi-cation	0.881 (4.412)*	Accept (-0.596)	0.51	17	Accept (0.24)

* Denotes Significance at 10% level based on t - test.
† Sigma 0 is the Elasticities of Substitution for CES Production Function.
‡ Indicates the value of Chi-Square Statistics.
Source of Data: *ASI, 1988-89.*

Table 2: Elasticities of Substitution Between Labour and Capital

Sl. No.	*Sector Code*	*Sector Name*	*Sigma 0*†	*Test for Sigma 0=1*	*Adj R-Sq*	*df*	*White's Test for Homoscedasticity*
1.	310	Food, Beverages and Tobacco	0.371 (1.451)*	Reject (-2.462)*	0.06	17	Reject (7.82)‡
2.	321	Textiles	0.337 0.922	Reject (-1.811)*	-0.01	16	Accept (1.88)
3.	322	Wearing Apparel	2.467 (3.500)*	Reject (2.081)*	0.46	12	Accept (2.21)
4.	323	Leather Products	0.735 (0.968)	Accept (-0.349)	-0.01	10	Accept (0.84)
5.	324	Footwear	0.491 (1.299)	Reject (-1.446)*	0.06	9	Accept (2.28)
6.	331	Wood Products	0.621 (2.623)*	Reject (-1.602)*	0.26	16	Accept (0.36)
7.	332	Furniture and Fixtures	0.019 (0.047)	Reject (-2.449)*	-0.08	12	Accept (4.16)
8.	341	Paper and Paper Products	1.233 (2.962)*	Accept (0.560)	0.30	17	Accept (1.4)
9.	342	Printing & Publishing	0.953 (4.691)*	Accept (-0.231)	0.55	16	Accept (0.5)
10.	35A	Chemicals	1.409 (3.200)*	Accept (0.929)	0.34	17	Accept (0.82)
11.	35B	Petroleum & Related Products	2.269 (3.490)*	Reject (1.952)*	0.48	11	Accept (0.59)
12.	355	Rubber Products	0.973 (1.427)*	Accept (-0.040)	0.06	15	Reject (5.08)
13.	36A	Non-metallic Mineral Products	1.095 (3.829)*	Accept (0.332)	0.45	16	Accept (2.09)

(Continued)

Table 2 – (*Contd.*)

Sl. No.	*Sector Code*	*Sector Name*	*Sigma 0*†	*Test for Sigma 0=1*	*Adj R-Sq*	*df*	*White's Test for Homoscedasticity*
14.	362	Glass & Glass Products	0.931 (3.511)*	Accept (-0.260)	0.53	9	Accept (2.97)
15.	371	Iron & Steel	0.557 (0.866)	Accept (-0.690)	-0.01	17	Accept (2.03)
16.	372	Non-ferrous Metals	1.504 (3.528)*	Accept (1.182)	0.45	13	Accept (1.49)
17.	381	Metal Products	0.796 (3.240)*	Accept (-0.830)	0.35	17	Accept (0.86)
18.	382	Non-electrical Machinery	0.645 (3.306)*	Reject (-1.819)*	0.36	17	Accept (1.34)
19.	383	Electrical Machinery	0.569 (2.341)*	Reject (-1.776)*	0.20	17	Accept (3.26)
20.	384	Transport Equipment	1.081 (3.485)*	Accept (0.260)	0.38	17	Accept (1.54)
21.	38A	Miscellaneous Manufacturing	0.801 (3.140)*	Accept (-0.782)	0.33	17	Accept (0.51)
22.	4	Electricity, Gas & Water Supply	0.913 (3.044)*	Accept (-0.289)	0.37	13	Accept (3.46)
23.	7	Transport, Storage & Communi-cation	0.598 (0.866)	Accept (-0.582)	0.01	17	Accept (2.3)

* Denotes Significance at 10% level based on t - test.
† Sigma 0 is the Elasticities of Substitution for CES Production Function.
‡ Indicates the value of Chi-Square statistics
***Source of Data** : ASI, 1988-89.*

Table 3: Testing for Structural Change in 1988-89 Over 1989-90*

Sl. No.	*Sector Code*	*Sector Name*	*F value (Computed)*	*df of F-test*	*F value (5%)*	*Decision*
1.	310	Food, Beverages and Tobacco	0.661	1.34	4.130	Accept
2.	321	Textiles	1.304	1.32	4.150	Accept
3.	322	Wearing Apparel	6.333	1.24	4.260	Reject
4.	323	Leather Products	0.133	1.20	4.350	Accept
5.	324	Footwear	2.428	1.18	4.410	Accept
6.	331	Wood Products	0.680	1.32	4.150	Accept
7.	332	Furniture and Fixtures	0.535	1.24	4.260	Accept
8.	341	Paper and Paper Products	0.537	1.34	4.130	Accept
9.	342	Printing & Publishing	1.587	1.32	4.150	Accept
10.	35A	Chemicals	4.118	1.34	4.130	Accept
11.	35B	Petroleum & Related Products	0.435	1.22	4.220	Accept
12.	355	Rubber Products	4.836	1.30	4.170	Reject
13.	36A	Non-metallic Mineral Products	0.302	1.32	4.150	Accept
14.	362	Glass & Glass Products	1.578	1.18	4.410	Accept
15.	371	Iron & Steel	1.515	1.34	4.130	Accept
16.	372	Non-ferrous Metals	1.242	1.26	4.220	Accept
17.	381	Metal Products	0.245	1.34	4.130	Accept
18.	382	Non-electrical Machinery	1.792	1.34	4.130	Accept
19.	383	Electrical Machinery	0.964	1.34	4.130	Accept

(Continued)

Table 3 – *(Contd.)*

Sl. No.	*Sector Code*	*Sector Name*	*F value (Computed)*	*df of F-test*	*F value (5%)*	*Decision*
20.	384	Transport Equipment	0.775	1.34	4.130	Accept
21.	38A	Miscellaneous Manufacturing	3.506	1.34	4.130	Accept
22.	4	Electricity, Gas & Water Supply	0.074	1.26	4.220	Accept
23.	7	Transport, Storage & Communication	4.133	1.34	4.130	Accept

*The null hypothesis is that there has been no structural changes in 1988-89 over 1989-90.
Source of Data: *ASI, 1988-89 and 1989-90.*

Table 4: Elasticity of Substitution Between Labour and Capital

Sl. No.	*Sector Code*	*Sector Name*	*Coeff of W #*	*Coeff of K/L*	*Adj R-Sq*	*df*	*White's Test for Homoscedasticity*
1.	310	Food, Beverages and Tobacco	0.351 (1.138)++	0.271 (1.242)++	0.32	16	Accept (6.25)+
2.	321	Textiles	0.471 (1.359)*	0.153 (-0.770)	0.10	15	Accept (5.59)
3.	322	Wearing Apparel	0.823 (2.837)*	0.122 (0.842)	0.74	11	Accept (0.63)
4.	323	Leather Products	0.657 (1.036)	0.456 (1.691)*	0.28	9	Accept (0.59)
5.	324	Footwear	-0.308 (-3.039)*	0.793 (2.157)*	0.22	8	Accept (6.88)
6.	331	Wood Products	0.835 (3.757)*	0.245 (2.210)*	0.48	15	Accept (3.92)
7.	332	Furniture and Fixtures	-0.483 (-0.511)	0.200 (0.488)	-0.13	11	Accept (2.64)
8.	341	Paper and Paper Products	0.904 (5.973)*	0.006 (0.098)	0.70	16	Accept (0.62)
9.	342	Printing & Publishing	0.792 (4.551)*	0.153 (1.610)*	0.74	15	Reject (12.22)
10.	35A	Chemicals	-0.181 (-0.238)	-0.026 (-0.062)	-0.12	16	Accept (1.23)
11.	35B	Petroleum & Related Products	1.610 (0.982)	0.007 (0.007)	0.13	10	Accept (1.34)
12.	355	Rubber Products	0.657 (2.450)*	0.408 (4.620)*	0.73	14	Accept (5.12)
13.	36A	Non-metallic Mineral Products	0.515 (2.806)*	0.359 (5.238)*	0.76	15	Accept (3.48)

(Continued)

Table 4 – *(Contd.)*

Sl. No.	*Sector Code*	*Sector Name*	*Coeff of W #*	*Coeff of K/L*	*Adj R-Sq*	*df*	*White's Test for Homoscedasticity*
14.	362	Glass & Glass Products	0.214 (1.140)	0.423 (4.256)*	0.77	8	Reject (7.85)
15.	371	Iron & Steel	0.481 (1.323)	0.107 (0.396)	0.09	16	Accept (1.31)
16.	372	Non-ferrous Metals	0.344 (1.211)	0.466 (3.806)*	0.68	12	Accept (0.74)
17.	381	Metal Products	1.100 (2.509)*	-0.497 (-1.449)*	0.21	16	Accept (2.08)
18.	382	Non-electrical Machinery	0.044 (0.169)	0.639 (4.147)*	0.71	16	Accept (5.64)
19.	383	Electrical Machinery	0.849 (3.488)*	-0.126 (-0.909)	0.37	16	Reject (12.63)
20.	384	Transport Equipment	1.629 (1.759)*	-0.503 (-1.374)*	0.07	16	Accept (4.22)
21.	38A	Miscellaneous Manufacturing	0.641 (4.689)*	0.296 (3.107)*	0.60	16	Accept (3.34)
22.	4	Electricity, Gas & Water Supply	1.732 (2.206)*	-0.534 (-1.261)	0.18	12	Reject (12.14)
23.	7	Transport, Storage & Communi-cation	0.917 (4.554)*	0.142 (1.087)	0.51	16	Accept (2.34)

* Denotes Significance at 10% level based on t - test.
+ Indicates the value of Chi-Square Statistics.
# Denotes Elasticities of Substitution for VES Production Function.
++ Denotes t-value at 10% level of significance.
Source of Data: *ASI, 1988-89.*

Table 5: Elasticities of Substitution Between Labour and Capital

Sl. No.	*Sector Code*	*Sector Name*	*Coeff of W #*	*Coeff of K/L*	*Adj R-Sq*	*df*	*White's Test for Homoscedasticity*
1.	310	Food, Beverages and Tobacco	-0.041 (-0.126)++	0.152 (1.021)++	0.18	16	Accept (3.47)+
2.	321	Textiles	0.454 (1.216)	0.166 (1.213)	0.02	15	Reject (9.52)
3.	322	Wearing Apparel	2.387 (3.174) *	0.168 (0.440)	0.43	11	Reject (7.83)
4.	323	Leather Products	0.651 (0.395)	0.323 (1.802) *	0.18	9	Accept (1.49)
5.	324	Footwear	0.621 (1.499) *	0.134 (0.839)	0.03	8	Accept (2.83)
6.	331	Wood Products	0.517 (2.762) *	0.238 (3.356) *	0.55	5	Accept (1.54)
7.	332	Furniture and Fixtures	0.165 (0.383)	0.176 (0.960)	-0.09	11	Accept (2.96)
8.	341	Paper and Paper Products	0.279 (0.641)	0.732 (3.338) *	0.56	16	Reject (10.73)
9.	342	Printing & Publishing	0.806 (4.585) *	0.249 (2.883) *	0.69	15	Accept (3.81)
10.	35A	Chemicals	1.173 (2.257) *	0.234 (0.868)	0.33	16	Accept (0.58)
11.	35B	Petroleum & Related Products	1.735 (1.638) *	0.454 (0.650)	0.45	10	Accept (2.62)
12.	355	Rubber Products	1.589 (2.014) *	-0.876 (-1.422) *	0.12	14	Reject (11.54)
13.	36A	Non-metallic Mineral Products	0.613 (3.876) *	0.403 (7.035) *	0.86	15	Accept (3.63)

(Continued)

Table 5 – (Contd.)

Sl. No.	Sector Code	Sector Name	Coeff of W #	Coeff of K/L	Adj R-Sq	df	White's Test for Homoscedasticity
14.	362	Glass & Glass Products	0.448 (1.286)	0.289 (1.877)*	0.63	8	Accept (2.7)
15.	371	Iron & Steel	1.593 (1.822)*	-0.916 (-1.660)*	0.08	16	Accept (1.83)
16.	372	Non-ferrous Metals	0.489 (1.593)*	0.585 (5.349)*	0.82	12	Accept (4.04)
17.	381	Metal Products	0.854 (3.094)*	-0.077 (-0.508)	0.32	16	Accept (1.42)
18.	382	Non-electrical Machinery	0.653 (2.865)*	-0.011 (-0.077)	0.32	16	Reject (8.8)
19.	383	Electrical Machinery	0.522 (3.068)*	0.478 (4.332)*	0.61	16	Accept (6.16)
20.	384	Transport Equipment	0.746 (2.150)*	0.285 (1.782)*	0.45	16	Accept (6.16)
21.	38A	Miscellaneous Manufacturing	0.793 (3.217)*	0.272 (1.449)*	0.37	16	Accept (1.24)
22.	4	Electricity, Gas & Water Supply	0.729 (2.135)*	0.231 (1.104)	0.38	12	Accept (5.87)
23.	7	Transport, Storage & Communi-cation	0.550 (0.801)	0.260 (1.125)	0.00	16	Accept (3.48)

* Denotes Significance at 10% level based on t-test.
+ Indicates the value of Chi-Square Statistics.
\# Denotes Elasticities of Substitution for VES Production Function.
++ Denotes t-value at 10% level of significance.
Source of Data *: ASI, 1989-90.*

Table 6 : Summary of Results

Sl. No.	Sector Code	Sector Name	Year 1988-89		Year 1989-90	
			CES	VES	CES	VES
1.	310	Food, Beverages and Tobacco				
2.	321	Textiles	0.580 (0.12)*			
3.	322	Wearing Apparel	1.022 (0.740)			
4.	323	Leather Products	1.076 (0.140)			
5.	324	Footwear		-0.308 (0.220)		
6.	331	Wood Products	0.797 (0.360)	0.835 (0.480)	0.621 (0.260)	0.517 (0.550)
7.	332	Furniture and Fixtures				
8.	341	Paper and Paper Products	0.911 (0.720)		1.233 (0.300)	
9.	342	Printing & Publishing			0.953 (0.550)	0.806 (0.690)
10.	35A	Chemicals			1.409 (0.340)	
11.	35B	Petroleum & Related Products	1.620 (0.210)		2.269 (0.480)	
12.	355	Rubber Products	1.200 (0.370)	0.657 (0.730)		
13.	36A	Non-metallic Mineral Products	0.906 (0.370)	0.515 (0.760)	1.095 (0.450)	0.613 (0.860)
14.	362	Glass & Glass Products	0.658 (0.340)		0.931 (0.530)	

(Continued)

Table 6 – *(Contd.)*

Sl. No.	*Sector Code*	*Sector Name*	*Year 1988-89*		*Year 1989-90*	
			CES	*VES*	*CES*	*VES*
15.	371	Iron & Steel	0.566 (0.140)			
16.	372	Non-ferrous Metals	0.960 (0.340)		1.504 (0.450)	0.689 (0.820)
17.	381	Metal Products	0.627 (0.150)	1.100 (0.210)	0.796 (0.340)	
18.	382	Non-electrical Machinery	0.896 (0.440)		0.645 (0.350)	
19.	383	Electrical Machinery			0.569 (0.200)	0.522 (0.610)
20.	384	Transport Equipment		1.629 (0.068)	1.081 (0.380)	0.746 (0.450)
21.	38A	Miscellaneous Manufacturing	0.590 (0.390)	0.641 (0.600)	0.801 (0.330)	0.793 (0.370)
22.	4	Electricity, Gas & Water Supply			0.913 (0.370)	
23.	7	Transport, Storage & Communication	0.881 (0.500)			

* The figuress in parenthesis indicates Adjusted R-Square of the fitted equation.