ELASTICITY OF SUBSTITUTION BETWEEN LABOUR AND CAPITAL ACROSS TWENTY SIX MAJOR INDUSTRIES IN INDIA DURING 2004-05

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Abstract.

The magnitude of the elasticity of substitution between labour and capital across twenty six major Industries [Factory Sector]   in India has been estimated in the present paper by fitting a Constant Elasticity of Substitution Production Function for the year 2004-05.The empirical results emerged out of the cross section data demonstrate that the estimate of the elasticity of substitution between labour and capital across the major Indian Industries is significantly more than unity implying that substitution possibilities are rather more in favour of labour in the Indian major Industries

JEL Codes: C51, O5, O53

Keywords: Industry, Production Function, India, Elasticity of Substitution, Economic Development

1. Need for Empirical Study

The empirical value of the estimate of elasticity of substitution between the capital and labour[1] in the major Indian industries is very important to comprehend the extent of substitution possibilities between labour and capital.There are good number of empirical studies[2] on the elasticity of substitution between labour and capital (Asif Banarji [1975], Goldar [186], Gujarati [1966] ,Isher Judge Ahulwalia [1981] ,Sinha and Sawhney [1970], Upender [1996],Diwan and Gujarati [1968], Mehta [1980], Swamy [1984], Shankar[1970], Umar Kazi [1980] Vijay Basin and Vijay Seth1977], Sanjib Pohit,Rajesh Chadha, Bina and Sangeeta [1996],and Inderpal Kaur [1997]) in India on the elasticity of substitution between inputs based on cross section and time series data so far as the Indian

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[1] Elasticity of substitution between capital and labour will all the time be unity in Cobb Douglas Production Function

[2] Infra references

Industries are concerned. The empirical information on elasticity of substitution between labour and capital across the major industries at a point of time [for latest year] is required to understand the extent of substitution possibilities. Keeping this in view, an attempt has been made to provide empirical content on the estimate of elasticity of substitution between labour and capital in the present paper by using latest cross section data available for the year 2004-05

2. Empirical Methodology

Cross Section Data

The required cross section data on net value added [Rs.Lakhs] , total persons engaged and total emoluments[3] [Rs.Lakhs] for the twenty six major Indian Industry group for the year 2004-2005 [latest year for which cross section data is available] has been collected from Annual Survey of Industries [Factory Sector] 2004-05[4]. The Whole sale price index for manufactured products and consumer price index for industrial workers for 2004-05 have been collected from Economic Survey-2006-07.The net value added and total emoluments have been deflated by whole sale price index for manufactured products and consumer price index for industrial workers respectively to convert the series into real terms

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[3] see appendix for basic data used

[4] The Annual Survey of Industries (ASI) is the principal source of industrial statistics in India. It provides statistical information to assess and evaluate, objectively and realistically, the changes in the growth, composition and structure of organised manufacturing sector comprising activities related to manufacturing processes, repair services, gas and water supply and cold storage. Industrial sector occupies an important position in the Indian economy and has a pivotal role to play in the rapid and balanced economic development. Viewed in this context the collection and dissemination of ASI data, on a regular basis, are of vital importance. The Survey is conducted annually under the statutory provisions of the Collection of Statistics Act 1953, and the Rules framed there-under in 1959, except in the State of Jammu & Kashmir where it is conducted under the State Collection of Statistics Act, 1961 and the rules framed there-under in 1964.

Variables used

[i] Net Value Added [P] is considered as surrogate for Production[5].

[ii] Total Emoluments [W] are considered as proxy for wages[6].

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[5] It is arrived by deducting total input [Total value of fuels and materials consumed as well as expenditures such as cost of contract and commission work done by others on materials supplied by the factory, cost of materials consumed for repair and maintenance of factory's fixed assets including cost of repairs and maintenance work done by others to the factory's fixed assets, inward freight and transport charges, rates and taxes (excluding income tax), postage, telephone and telex expenses, insurance charges, banking charges, cost of printing and stationery and purchase value of goods sold in the same condition as purchased .] and depreciation [Consumption of fixed capital due to wear & tear and obsolescence during the accounting year and is taken as provided by the factory owner or is estimated on the basis of cost of installation and working life of the fixed assets] from total output. [Total ex-factory value of products and by-products manufactured as well as other receipts such as receipts from non-industrial services rendered to others, work done for others on material supplied by them, value of electricity produced and sold, sale value of goods sold in the same condition as purchased, addition in stock of semi- finished goods and own construction .]

[6] It is the sum of wages and salaries [All remuneration in monetary terms and also payable more or less regularly in each pay period to workers as compensation for work done during the accounting year . It includes (a) direct wages and salary (i.e., basic wages/salaries, payment of overtime, dearness, compensatory allowance, house rent and other allowances), (b) remuneration for the period not worked (i.e., basic wages, salaries and allowances payable for leave period, paid holiday, lay-off payments and compensation for unemployment, if not paid from sources other than employers), (c) bonuses and ex-gratia payment paid both at regular and less frequent intervals (i.e., incentive bonuses, good attendance bonuses, productive bonuses, profit sharing bonuses, festival or year-end bonuses, etc.). It excludes lay off payments which are made from trust or other special funds set up exclusively for this purpose i.e., payments not made by the employer. It also excludes imputed value of benefits in kind, employer's contribution to old age benefits and other social security charges, direct expenditure on maternity benefits and crèches and other group benefits. Travelling and other expenditure incurred for business purposes and

[iii] Total Persons Engaged [L] are considered as labour[7] in the present study.

 [iv] Labour Productivity [P/L] is real net value added per unit of labour

[v] Wage Rate [W/L] is real wage per unit of labour

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reimbursed by the employer are excluded. The wages are expressed in terms of gross value i.e., before deduction for fines, damages, taxes, provident fund, employee's state insurance contribution, etc.], employers' contribution as provident fund and other funds [Old age benefits like provident fund, pension, gratuity, etc. and employers contribution towards other social security charges such as employees state insurance, compensation for work injuries and occupational diseases, provident fund-linked insurance, retrenchment and lay- off benefits]. and workmen and staff welfare expenses [Group benefits like direct expenditure on maternity, crèches, canteen facilities, educational, cultural and recreational facilities; and grants to trade unions, co- operative stores, etc. meant for employees.]

[7] It include the employees [all workers [All persons employed directly or through any agency whether for wages or not and engaged in any manufacturing process or in cleaning any part of the machinery or premises used for manufacturing process or in any other kind of work incidental to or connected with the manufacturing process or the subject of the manufacturing process . Labour engaged in the repair & maintenance, or production of fixed assets for factory's own use, or employed for generating electricity, or producing coal, gas etc. are included.] and persons receiving wages and holding clerical or supervisory or managerial positions engaged in administrative office, store keeping section and welfare section, sales department as also those engaged in purchase of raw materials etc. or purchase of fixed assets for the factory as well as watch and ward staff.] as defined above and all working proprietors and their family members who are actively engaged in the work of the factory even without any pay, and the unpaid members of the co-operative societies who worked in or for the factory in any direct and productive capacity. The number of workers or employees is an average number obtained by dividing man days worked by the number of days the factory had worked during the reference year.

Empirical Model for estimation of Elasticity of Substitution

The following constant elasticity of substitution production function has been considered in the present paper to know the extent of substitution possibilities between labour and capital across the major Indian Industries for year 2004-05. The specification of the constant elasticity of substitution production function is

$$P = A [\delta K^{-\rho} + (1-\delta) L^{-\rho}]^{-1/\rho} \qquad \text{(Equation-1)}$$

Where
P = Production
K and L = Capital and Labour inputs respectively.
A = Efficiency parameter
ρ = Extent of substitution between labour and capital related to $\sigma = 1/1+\rho$
δ = Distribution parameter

The above equation has been estimated empirically by Ordinary Least Squares method under the marginal productivity conditions. [marginal productivity of labour = wage rate]. The marginal productivity of labour is obtained from the above function [equation -1] as follows:

$$\partial P / \partial L = A[\delta K^{-\rho} + (1-\delta)L^{-\rho}]^{-1/\rho} [\delta K^{-\rho} (1-\delta)L^{-\rho}]^{-1} (1-\delta) L^{-(1+\rho)}$$

$$= [P * P^{\rho}] / A^{\rho} [1-\delta] . 1/L^{1+\rho}$$

$$= 1 - \delta / A^{\rho} * P^{1+\rho} * 1/L^{1+\rho}$$

Equilibrium condition between $\partial P/\partial L$ (Marginal Product of labour [MPL] and W/L [Real Wage Rate]) is

$$\partial P/\partial L = W/L$$
$$[1-\delta / A^{\rho}] [P/L]^{1+\rho} = W/L$$

Solving for [P / L]

$$[P/L]^{1+\rho} = [A^{\rho} / (1-\delta) * W/L]$$

$[P/L] = [A^{\rho}/(1-\delta) * W/L]^{1/1+\rho}$

Taking logarithms both sides

$\ln [P/L] = 1/1+\rho \ln[A^{\rho}/1-\delta] + 1/1+\rho \ln[W/L]$

$1/1+\rho \ln [A^{p}/1 - \delta] = $ Constant

$1/1+\rho = \sigma = $ Elasticity of Substitution or Elasticity of labour productivity with respect to wage rate.

$\ln [P/L] = $ Constant $+ \sigma \ln [W/L]$ (Equation-2)

        The coefficient on ln W/L in the above regression of ln P/L on lnW/L is the   estimate of constant elasticity of substitution between labour ands capital , σ.
Specification of constant elasticity of substitution Production function with real variables is

$\ln[P/L*1/WPI] = $ Constant $+ \sigma \ln [W/L*1/CPI]$ (Equation-3)

Where

P/ L*1/WPI = Real labour productivity

W/L*1/CPI=Real wage rate

P = Net value added

L= Total Persons Engaged

W =Total empluments

WPI=Whole sale price index for manufactured product during 2004-05

CPI= Consumer price index for industrial workers during 2004-05

The above equation - 3 has been   estimated by Ordinary Least Squares method under the equilibrium [marginal product of labour

= real wage rate] conditions with one way causation between labour productivity and wage rate.

3: Cross Section Estimate of Elasticity of Substitution across the Indian Industries

The regression results of the Constant Elasticity of Substitution Production Function fitted to the cross section data belonging to twenty six major Indian Industries [factory sector] for the year 2004-05 have been set out in table -1.

Table–1: CES Productuon Function: Elasticity of
Substitution across the Indian Industries for 2004-05

$$\ln(P/L*1/WPI] = 4.148056* + 1.283339 \ln[W/L*1/CPI]*$$
$$t = [4.105504] \qquad [8.349573]$$

$$R^2 = 0.743905 \qquad \text{Durbin-Watson statistic} = 1.661094$$

Note:* Significant at one percent level

The regression results of the constant elasticity of substitution production function illustrate that the coefficient of real wage rate [labour cost],known as the elasticity of labour productivity with respect to wage rate, is notably positive and more than unity confirming the choice of constant elasticity of substitution production function and evincing the fact that the substitution possibilities are more in favour of labour in the major Indian industries [factory sector].The estimate of the elasticity of substitution implies that a one percent increase in real wage rate will lead to increase the labour productivity across the major industries in India

4. Conclusion

The present paper is carried out to examine the extent of substitution possibilities between labour and capital across twenty six major industries in India during 2004-05. The numerical value of elasticity of substitution obtained from constant elasticity of substitution production

function based on cross section data is more than unity evincing the fact that the substitution possibilities are relatively more in favour of labour across the major Indian industries.

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APPENDIX -I
Basic Data Used To Generate The Variables
For Estimation Of Ces Production Function [2004-05]

Major Industry Group	Net Value Added [Rs.Lakhs]	Total Emoluments [Rs. Lakhs]	Total Persons Employed
Basic Metals	4925070.	714827.0	577301.0
Chemicals And Chemical Products	4273582.	892720.0	784907.0
Coke, Petroleum Products And Nuclear Fu	3020073.	153803.0	79470.00
Food Products And Beverages	1805955.	644307.0	1342925.
Motor Vehicles, Trailers And Semi-Trailer	1678997.	439153.0	336820.0
Textiles Products	1448674.	714951.0	1264427.
Machinery And Equipment N.E.C.	1352361.	495211.0	438048.0
Non-Metallic Mineral Products	1191251.	288889.0	524429.0
Other Transport	790683.0	206809.0	185021.0

Equipments			
Electrical Machinery And Apparatus, N.E.	783993.0	256553.0	237190.0
Rubber And Plastic Products	699398.0	219518.0	304476.0
Fabricated Metal Products	603333.0	238529.0	319626.0
Tobacco & Related Products	498661.0	102904.0	473351.0
Other Industries	477094.0	100582.0	152541.0
Wearing Apparel, Dressing & Dyeing Of Fur	446989.0	222732.0	450175.0
Furniture & Other Manufacturing N.E.C.	381707.0	133775.0	176214.0
Radio, Television And Communication Equi	372405.0	138798.0	102013.0
Paper And Paper Products	338770.0	133920.0	178110.0
Publishing, Printing And Related Activities	297231.0	122125.0	115445.0
Medical, Precision And Optical Instrumen	241966.0	71945.00	61985.00
Leather & Related Products	135011.0	68763.00	149878.0
Office, Accounting And Computing Machin	109089.0	38185.00	25850.00
Agriculture & Related Activities	68454.00	17622.00	108080.0
Wood And Wood Products	39015.00	18910.00	50618.00
Other Mining And Quarrying	7169.000	3896.000	12509.00
Recycling	3756.000	1165.000	2215.000

Source: Annual Survey Of Industries -2004-05