

Impact of Policy Shift On Elasticity of Substitution In Indian Non-Metallic Mineral Industry

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INTRODUCTION

India, with diverse and significant mineral resources, is the leading producer of some of the minerals. Of the 89 minerals produced in India, 52 are non-metallic, 11 metallic, 4 fuel minerals and 22 minor minerals. The share of the mineral sector in the gross domestic product (GDP) of the country is around 3.5 per cent while accounting for 10 percent share in the index of industrial production. Though 80 per cent of the mines are in the private sector, yet 91 percent of the production in terms of size comes from the government owned mining ventures. Mining employs over 8 lakh persons. India is the largest producer of mica blocks and mica splitting; ranks third in the production of barites and chromites; 4th in production of iron ore, 6th in production of Metallic bauxite and manganese ore, and 10th in aluminum and 11th in crude steel. Iron- ore, copper-ore, chromites, zinc concentrates, gold, manganese ore, bauxite, lead concentrates and silver account for the entire metallic production. Limestone, magnesite, dolomite, barites, kaolin, gypsum, apatite and phosphorite, stealite and fluorite account for 92 per cent of non-metallic minerals.

The present paper attempts to analyse the elasticity of substitution in Indian non-metallic mineral industry during pre and post liberalization periods.

NEED FOR THE STUDY

From the point of view of modernization, technology upgradation is very low in order to compete with developed nations. In a wide range of manufactured goods, consumer durables to capital goods, a number of studies have examined the nature and scope of elasticity of substitution, but the studies covering a fairly recent time period are limited. Thus, in this study, an attempt is made to examine the elasticity of substitution in Indian non-metallic mineral industry during pre and post liberalisation period.

STATEMENT OF THE PROBLEM

Productivity improvement, cost reduction and effective cost control are the hall mark of efficiency. Proper input mix and factor substitution is the key to achieve optimization. Economic rationality underlines that cheaper factor would replace costlier input so that manufacturing cost is controlled. Labour is relatively a cheaper input vis-à-vis capital in the Indian context and therefore, rational entrepreneurs are expected to substitute capital by labour.

The policy changes of 1990s have affected different industries in different ways; more over, there was no clear cut evidence to prove that economic liberalization has favoured every industry. Much of the conventional arguments relating to the static and dynamic gains from liberalization were based on fragile theoretical backgrounds. The arguments favouring trade liberalization are not supported by existing research which generally fails to capture the complex and ambiguous effects of liberalization and openness. Hence, a comprehensive analysis of the existing scenario in terms of elasticity of substitution in Indian non-metallic mineral industry during pre and post liberalization period has to be embarked upon.

OBJECTIVES OF THE STUDY

1. To trace the theoretical frame work related to elasticity of substitution.
2. To analyze elasticity of substitution during pre and post liberalisation periods.
3. To compare the results during pre and post liberalisation periods.
4. To draw conclusions, suggestions and policy recommendations.

HYPOTHESIS FORMULATED

- H_1 'e' is expected to be less than one ($e < 1$) in a liberalized environment.

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METHODOLOGY

SCOPE

This research paper covers two distinct periods: pre-liberalisation (1980-1991) and post-liberalisation (1992-2005). There were seven product groups as per three digit (NIC Code 87 (1989 - 98)) and four digit (NIC code 98 (1998 onwards)) classification of NIC code and the data pertaining to all these product groups have been collected.

DATA COLLECTION

The paper is based on the secondary data collected from the various issues of Annual Survey of Industries (ASI) published by Central Statistical Organization (CSO), Government of India. The product groups considered in the analysis are:

Table-1 : Selected Product Groups

S.No.	NIC Code 87(NIC 98)	Name of the Product Groups
1	320(2692+2693)	Manufacture of Refractory Products and Structural Clay Products.
2	321(2610)	Manufacture of Glass and Glass Products.
3	322+323(2691)	Manufacture of Earthen and Plaster Products + Manufacture of Non-Structural Ceramic-Ware.
4	324(2694)	Manufacture of Cement Lime and Plaster.
5	325+329(2699)	Manufacture of Mica Products+ Manufacture of Miscellaneous Non-Metallic Mineral Products N.E.C.
6	326(2696)	Stone Dressing and Crushing Manufacture of Structural Stone Goods and Stone Ware.
7	327(2695)	Manufacture of Asbestos Cement and Other Cement Products.

DATA ANALYSIS

The collected data were classified product group wise over different years for the purpose of analysis. In order to examine the various objectives of the study, all conventional mathematical and statistical tools have been used. Except the labour input, which is measured by the total number of persons engaged in an average establishment, ASI reports gross fixed capital formation and gross value added data in value terms. Nominal values of gross value added were deflated by the wholesale price index. Gross fixed capital formation was deflated by the price index of machinery and machine tools manufacturing industry. Both of these variables are measured at 1980-81 prices at all-India level.

REVIEW OF EARLIER STUDIES

Dhanamani (1995) studied technical efficiency in small- scale basic metals and alloys industry. The objective of the study was to study technical progress and to examine the nature of technology used in the manufacturing process. The data for the study was collected from the records of DIC, Coimbatore. The study concluded that the growth of employment was low as compared to the growth of other monetary variables. The incremental capital labour ratio had increased. There was negative capital output relationship in 8 product groups. The technology co-efficient was not significant in most of the product groups. Labour productivity was low when compared to capital productivity.

Tarlok Singh (1996) examined Total Factor Productivity in the Manufacturing Industries in India for the period 1973-74 to 1993-94. The total factor productivity was computed in levels using the Solow's residual for different industries in the manufacturing sector in India. He concluded that the TFP in the food product industry recorded trend growth rate of 2.68 per cent during the overall period 1973-94. TFP recorded improvement in all the sample industries, except for the basic metals industries. The highest growth in TFP was observed in the case of the food product industry.

Ganesan (1999) made an attempt to study factor substitution in small scale electrical machinery industry during the period (1980-1996) with reference to DIC data. The main objectives of the study were (1) to examine the marginal product of capital (MP_K) & labour (MP_L), (2) To estimate marginal rate of substitution (MRS_{LK}) between labour & capital, (3) To analyse Inter-product and Intra-product capital & labour productivities and capital intensities, and (4) To measure elasticity of substitution. The result showed that capital intensity was much higher in parts & accessories of electrical machinery (3608), storage batteries (3621) and appliances conductors (3634). The substitution parameter (P) was positive in 6 product groups and negative in 8 product groups. The Elasticity of substitution 's' was found to be low in 13 out of 17 product groups.

Saurabh Bandyopadhyay (2000) provided an explanation for inter-temporal changes in the level of TFP growth in India during 1973-74 and 1995-96, based on ASI data. The empirical estimations have been done on the basis of two

regression models, where TFP indices of Solow, Translog and Kendrick were taken as the dependent variables and value added, capital-labour ratio, skill composition factor, import substitution, export intensity and industrial concentration were used as independent variables. The study found that different industries showed a common pattern, which is very much in line with the standard H-O-S model, where relative factor abundance played a crucial role in determining gains from trade and productivity growth. A strong positive relationship was found between total factor productivity growth and output growth. Import substitution variables were found to have a significant positive effect on TFP growth in a number of industries.

Sangho Kim and Han (2001) applied a stochastic frontier production model to Korean manufacturing industries to decompose the sources of total factor productivity (TFP) growth into technical progress, changes in technical efficiency changes in allocative efficiency and scale effects. Empirical results based on data from 1980–1994 show that productivity growth was driven mainly by technical progress that changes in technical efficiency had a significant positive effect, and that allocative efficiency had a negative effect. This study suggested that specific guidelines are required to promote productivity in each industry, and provides additional insight into understanding the recent debate on TFP growth in Korean manufacturing.

Gomathi (2001) analysed Technology, Technical progress and factor substitution in small scale machinery and machine tools manufacturing industry during 1980-2000. She concluded that some enterprises underrecord the number of employees so as to evade the Labour legislations and inspection by the officials. Marginal product of labour (MP_L) was higher than MP_K , capital intensity has increased, but with a positive contribution to output. There was a visible attempt to replace labour, higher K/L ratio had contributed positively to output, and measures have to be taken to improve labour productivity.

Bee-Yan Aw (2002) examined the link between firm size, growth and productivity. It showed that firms grow because they are more productive and not because they are larger in size. Indeed, the statistical analysis shows that while employment growth among Taiwanese firms was positively related to initial levels of total factor productivity, it was negatively related to initial size. The study also showed that the productivity-size relationship has a virtuous cycle built in. More productive firms get larger and, in the process, obtain access to resources and information which enables them to become more productive. One implication of these results was that public policies should target productivity rather than size and should support reforms that make it possible for market mechanisms to weed out low productivity firms while facilitating the entry or growth of high productivity firms. Taiwan's ability to keep entry and exit costs low is one reason why productivity gains there have been high.

Kasi (2003) analyzed the study of factor substitution and technical change in small scale basic metal and metal products manufacturing industry during the period 1980-2003. He concluded that since MP_L is higher than MP_K , it would be advantageous if more labour is inducted. In all product groups, technical change is non-neutral. In 14 out of 17 product groups, technical change is capital saving and only in 3 product groups, it was labour saving.

Thus it is evident that the number of studies analyzed the productivity trends, elasticity of substitution in various manufacturing industries. But the studies related to elasticity of substitution in Indian non-metallic mineral products industry is very few and scanty. So this paper makes an attempt to overcome this short coming by focusing on elasticity of substitution in Indian non-metallic mineral products industry during the pre and post liberalization period.

THEORETICAL FRAMEWORK

CONCEPTUAL FRAMEWORK

ELASTICITY OF SUBSTITUTION

Production structure should be flexible enough so that it is easy to substitute labour for capital. The technical change could be in a direction so that it encourages labour intensive rather than capital intensive techniques. In this context, the structure, magnitude of elasticity of substitution becomes much more relevant and can shed light not only upon these issues but also helps to understand the relevant pattern of resources used in the productive organization of the economic system.

Elasticity of substitution measures the ease with which factors can be substituted for another. The concept has got an important economic relevance, because various factors of production have alternative substitution possibilities. Mathematically, it can be shown as,

$$\sigma = \frac{\Delta (K/L) / K/L}{\Delta MRS / MRS}$$

where, σ is the elasticity of factor substitution, 19 'K' and 'L' respectively the capital and labour and MRS is the ratio between the marginal productivity of labour and capital respectively.

MEASUREMENT OF ELASTICITY OF SUBSTITUTION

The elasticity of substitution can be divided into three categories. viz.,

1. The marginal productivity of the factors of production.
2. The marginal rate of substitution and elasticity of substitution.
3. Factor intensity.

THE MARGINAL PRODUCTIVITY OF THE FACTORS OF PRODUCTION

Mathematically, the marginal product of each factor is the partial derivatives of the production function with respect to this factor.

Thus $MP_L = (\Delta O / \Delta L)$ and $MP_K = (\Delta O / \Delta K)$

In principle, the marginal product of a factor may assume any value- positive, zero or negative. However, basic production theory concentrates only on the efficient part of the production function that is on the range of output over which the marginal products of the factors are positive.

MARGINAL PRODUCTIVITY OF CAPITAL: MP_K

Marginal productivity of capital may be defined as the relationship between change in output in a given economy or industry in a time period for a given change in gross block of that economy or industry, for a similar period. We have derived MP_K from the following Cobb-Douglas function:

$$O = b_o \cdot K^{b_1} \cdot L^{b_2}$$

Marginal productivity of capital is indicated as;

$$\begin{aligned} MP_K &= \partial O / \partial K \\ &= b_1 \cdot b_o \cdot K^{b_1-1} \cdot L^{b_2} \\ &= b_1 (b_o \cdot K^{b_1} \cdot L^{b_2}) K^{-1} \\ &= b_1 \cdot (O/K) \\ &= b_1 \cdot (AP_K) \end{aligned}$$

Where AP_K = Average productivity of capital.

O = Output

K = Capital

MARGINAL PRODUCTIVITY OF LABOUR: MP_L

Marginal productivity of labour may be defined as the relationship between the change in employment in a given economy or industry for given time period, and the change in output of that economy or industry for a similar period.

We have derived MP_K from the following Cobb-Douglas function:

$$O = b_o \cdot K^{b_1} \cdot L^{b_2}$$

Marginal productivity of labour is indicated as;

$$\begin{aligned} MP_L &= \partial O / \partial L \\ &= b_2 \cdot b_o \cdot K^{b_1} \cdot L^{b_2-1} \\ &= b_2 (b_o \cdot K^{b_1} \cdot L^{b_2}) L^{-1} \\ &= b_2 \cdot (O/L) \\ &= b_2 \cdot (AP_L) \end{aligned}$$

where AP_L = Average productivity of labour.

O = Output

L = Labour

MARGINAL RATE OF SUBSTITUTION

The marginal product of a factor is defined as the change in output resulting from a very small change of this factor, keeping all other factors constant. Marginal product of each factor is the partial derivative of the production function with respect to this factor.

$$MP_L = \frac{\partial O}{\partial L} \text{ and } MP_K = \frac{\partial O}{\partial K}$$

It can be proved that the MRS is equal to the ratio of the marginal products of the factors.

$$MRS_{LK} = (\partial O / \partial L) / (\partial O / \partial K) = MP_L / MP_K$$

ELASTICITY OF FACTOR SUBSTITUTION

The elasticity of substitution is defined as the percentage change in the capital labour ratio, divided by the percentage change in the rate of technical substitution. The marginal productivity theory treats that in a competitive economy, the marginal products of labour and capital would be equal to the wage rate and per unit rental charges respectively. It can be expressed as follows:

$$e = \frac{\text{Percentage change in } K/L}{\text{Percentage change in MRS.}}$$

$$e = \frac{\Delta(K/L) / (K/L)}{\Delta(MRS) / MRS}$$

Where, 'e' is the measure for factor substitution.

'K' and 'L' are respectively capital and labour and MRS is the ratio between MP_L and MP_K are respectively marginal productivities of capital and labour.

FACTOR INTENSITY

The factor intensity of any process is measured by the slope of the line through the origin representing the particular process. Thus, the factor intensity is the capital – labour ratio.

COMPARATIVE ANALYSIS OF INTER-PRODUCT GROUP SUBSTITUTION PARAMETERS DURING PRE-LIBERALIZATION PERIOD

Table-2 presents the comparative analysis of inter-product factor and elasticity of substitution parameters during pre-liberalisation period. The MRS_{LK} ratios were positive, which implies that the additional capital and additional labour inputs have contributed positively to output.

As regards elasticity of substitution, the theoretical postulate is that, "the labour abundant low wage countries would tend to hold comparative advantage in industries which have relative lower elasticities of substitution, between labour and capital."

Table-2 : Comparative Analysis of Inter-Product Group Substitution Parameters During Pre-Liberalization Period

S.No.	NIC Code	Product Groups	MRS_{LK}	Capital Intensity	Elasticity of Substitution
1.	320	Manufacturing of Refractory Products and Structural Clay Products.	Positive	Fluctuates	<1
2.	321	Manufacturing of Glass and Glass Products.	Positive	Fluctuates	<1
3.	322+323	Manufacturing of Non-Structural Ceramic-Ware + Manufacture of Earthen and Plaster Products.	Positive	Fluctuates	=1
4.	324	Manufacturing of Cement Lime and Plaster.	Positive	Fluctuates	>1
5.	325+329	Manufacturing of Mica Products + Manufacturing of Miscellaneous Non-Metalic Mineral Product N.E.C.	Positive	Fluctuates	<1
6.	326	Stone Dressing and Crushing Manufacture of Structural Stone Goods and Stone Ware	Positive	Fluctuates	<1
7.	327	Manufacturing of Asbestos Cement and Other Cement Products.	Positive	Fluctuates	>1

Empirically, elasticity of substitution was greater than one in 2 product groups and less than one in 4 product groups and equal to one in 1 product group.

Thus, it is evident that 4 out of 7 product groups did hold comparative advantage in factor substitution during pre-liberalisation period due to lower elasticities of substitution between labour and capital.

COMPARATIVE ANALYSIS OF INTER-PRODUCT GROUP SUBSTITUTION PARAMETERS DURING POST-LIBERALIZATION PERIOD

Table-3 presents the comparative analysis of inter product substitution during post-liberalisation period. The industry's mean MRS_{LK} during post-liberalisation period was less than one which implies that MP_K was greater than MP_L . The K/L ratios have fluctuated in all the product groups. Elasticity of substitution was greater than one in 3 product groups and less than one in 4 product groups. Thus, it is evident that 4 out of 7 product groups did hold comparative advantage in factor substitution during post-liberalisation period due to lower elasticities of substitution between labour and capital.

Table-3 : Comparative Analysis of Inter-Product Group Substitution Parameters During Post-Liberalization Period

S.No.	NICCode	Product Groups	MRS_{LK}	Capital Intensity	Elasticity of Substitution
1.	320	Manufacturing of Refractory Products and Structural Clay Products.	Positive	Fluctuates	>1
2.	321	Manufacturing of Glass and Glass Product.	Positive	Fluctuates	<1
3.	322+323	Manufacturing of Non-Structural Ceramic-Ware +Manufacture of Earthen and Plaster Products.	Positive	Fluctuates	>1
4.	324	Manufacturing of Cement Lime and Plaster.	Positive	Fluctuates	<1
5.	325+329	Manufacturing of Mica Products+Manufacturing of Miscellaneous Non-Metalic Mineral Products.	Positive	Fluctuates	>1
6.	326	Stone Dressing and Crushing Manufacture of Structural Stone Goods and Stone Ware	Positive	Fluctuates	<1
7.	327	Manufacturing of Asbestos Cement and Other Cement Products.	Positive	Fluctuates	<1

POLICY SHIFT AND ITS INPUT OF FACTOR SUBSTITUTION

Table-4 presents the details of substitution parameters during pre and post liberalisation period.

It is evident that MRS_{LK} ratio was positive and less than one during both the periods, which implies that the marginal productivity of capital was greater than the marginal productivity of labour. The mean K/L ratio has increased with a positive contribution to output over the period.

In the protected regime, 5 out of 7 product groups did hold comparative advantage in factor substitution when compared to 4 product groups in the liberalized regime.

Table-4
Comparative Analysis of Substitution Parameters: Pre vs Post Liberalization Period

Parameters	Pre-Liberalization	Post-Liberalization
	Mean	Mean
MRS_{LK}	0.0214	0.0676
K/L ratio	0.0964	0.2271
Elasticity of Substitution	No. of Product Groups	No. of Product Groups
$e < 1$	4	4
$e > 1$	2	3
$e = 1$	1	0

CONCLUSION

It is evident that MRS_{LK} was positive in all product groups and greater than one in most of the product groups. Since marginal productivity of both labour and capital were positive in all product groups, there is ample scope for expansion of output.

The K/L ratio in all products was found to be increasing moderately during the pre liberalisation period.

In majority of the product groups, 'e' is less than one, implying that proportionate change in MRS was higher than proportionate change in K/L and hence capital can substitute labour.

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➤ In a protected environment, 5 out of 7 product groups did not hold comparative advantage and it was 4 out of 7 product groups in the liberalized regime. Therefore ' H_1 ' is not accepted.

SUGGESTIONS AND RECOMMENDATIONS

- ✓ In the protected regimes, 5 out of 7 product groups did hold comparative advantage in factor substitution when compared to 4 product groups in the liberalized regime. It would advantageous so long as 'e' is less than one.
- ✓ Hence, a protected environment is needed for this industry to hold competitive advantage.

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However, they have to be more consistent and aggressive in their approach to build up fruitful relationships with their customers. At the same time, they have to be responsible corporate citizens, whose customers are proud to "own" them. Holistic branding, collaborative approach and total commitment to customer service will equip them to face the challenges in the market place and come out as winners.

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