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SOURCES OF OUTPUT GROWTH IN INDIAN IRON AND STEEL INDUSTRY

by

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ABSTRACT

The present study makes an attempt to assess, in quantitative terms, the contributions made by various factors to the observed rate of growth of Indian iron & steel industry during the post-war period. The analysis is conducted within the broad framework provided by the well-known neo-classical model. The analysis is based on the time series data covering the period 1946-70, obtained from the annual reports of CMI and ASI.

The main conclusions of the study are that the growth of Indian iron & steel industry during the post-war period has been due largely to the growth of factor inputs; and the behaviour of the residual factor does not seem to have played any positive role in bringing about the acceleration in the growth of iron & steel industry observed during the sixties. The major policy implication of these findings is that more attention needs to be paid to the research and development programmes specifically designed to improve the technological base of the Indian iron & steel industry and promote the growth of total factor productivity in the industry during the years to come.

SOURCES OF OUTPUT GROWTH IN INDIAN IRON AND STEEL INDUSTRY

Bakul H. Dholakia*

I

Rapid development of the iron and steel industry has formed an integral part of India's industrial planning since the beginning of the Second Plan. Consequently, the last two decades have witnessed a remarkable growth of the iron and steel industry in terms of output as well as the factors of production employed in the industry. Moreover, there seems to have been a marked decline in the extent of regional concentration of the industry over the last two decades. This is evident from the fact that the industry, which was concentrated largely in Bihar until 1950, has now developed in a few other states also. In view of the phenomenal expansion of the industry in recent years along with significant changes observed in its regional growth patterns, it would be of obvious interest to examine the relative importance of various factors contributing to the growth of output in the Indian iron & steel industry during the post-war period. The present study, therefore, makes an attempt to estimate the relative contributions of factor inputs and thereby estimate the contribution of the residual factor to the growth of output in

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Indian iron & steel (basic metals) industry during the period 1946 to 1970. By attempting inter-temporal as well as inter-regional comparisons of the contributions of various factors, it also tries to examine whether there existed significant differences in the pattern of relative importance of different factors in the growth of the industry during different periods of time or among different regions. The basic data required for this purpose have been obtained from the various annual reports of the Census of Indian Manufactures (CMI) and the Annual Survey Industries.(ASI).*[1] For the purpose of making broad inter-tempo comparison,, the entire period, i.e. 1946 to 1970, is divided in two major sub-periods, viz., 1946 to 1958 and 1958 to 1970, representing the first and the second half, respectively, of the entire period under consideration.*[2] Similarly, for the purpos of broad inter-regional comparison, the country is divided into two main parts, viz., Bihar and the Rest of India.*[3]

The study is divided into five sections. After a brief introductory first section, the next section discusses the basic theoretical framework and the main assumptions underlying the present study. The third section then examines the growth patt in the iron & steel industry in terms of the estimated rates of growth of output and factor inputs during the period under consideration. The estimates of the absolute and relative contributions made by various factors to the growth rate of val

added in the iron & steel industry have been presented in the fourth section. Finally, the main findings of the study have been summarized in the fifth section.

II

The basic theoretical framework that we have used in the present study for analysing the growth of Indian iron & steel industry is the one provided by the well-known neo-classical theory. According to this framework, if Y represents output, and K and L represent capital and labour inputs measured in real or physical units respectively, then the production function, specifying the relationship between Y on the one hand and K & L on the other, at any given point of time, can be written as:

$$Y = F(K,L) \qquad \ldots\ldots\ldots (1)$$

Given a functional relationship among Y, K & L such as the one indicated above, if we make the following assumptions, viz.,

(i) the production function exhibits constant returns to scale and unit elasticity of substitution between capital and labour;*4

(ii) the production function remains unchanged over time and does not undergo any kind of shift with the passage of time;*5

(iii) the earnings of labour and capital are proportional to the respective values of their marginal products;*[6]

and

(iv) there are no errors of measurement in any of the variables involved;*[7]

then it follows that, under the conditions of equilibrium, the average rate of growth of Y per annum over a specified period of time (G_Y) would be determined by the corresponding average rates of growth of labour and capital (G_L and G_K respectively), and the relative distribution of total product between the two factors during the period of time under consideration.*[8] This relationship can be expressed in the form of the following equation:

$$G_Y = W.G_L + (1-W)G_K \qquad \ldots\ldots\ldots (2)$$

Where, W represents the average value of relative share of labour in total product while (1-W) represents the corresponding average value of the share of capital.

This equation implies that under the conditions specified above, the rate of growth of output is fully accounted for by the growth of factor inputs, with $W.G_L$ representing the partial contribution of the growth of labour input while (1-W). G_K representing the partial contribution of capital input to the observed growth rate of output.*[9] However, it is obvious that in any

actual growth experience, one or more of the above conditions may not be satisfied; and consequently, the separate contributions of factor inputs may not add up to the actual growth rate of output that is recorded over the period under consideration. The observed difference between the actual growth rate of output and the total contribution of factor inputs indicates what is generally referred to as the 'Residual Factor'. In the light of this, we may rewrite the equation 2 given above as:

$$G_Y = W.G_L + (1-W)\, G_K + R \qquad \ldots\ldots (3)$$

Where R is the residual factor. It may be noted that in practice, R can be computed as :

$$R = G_Y - W.G_L - (1-W)\, G_K \qquad \ldots\ldots (3a)$$

The residual factor represents the net effect of actual deviations from the basic conditions specified above. However, for the sake of simplicitly, if we accept the hypothesis that the first, second and fourth of the abovementioned conditions (or assumptions) hold good, we can interpret the residual factor as a a direct indicator of the so-called 'rate of technical progress'. Putting it slightly differently, we may say that to the extent to which the conditions other than the third are also not fulfilled, the residual factor loses its accuracy and precision as an estimate of the rate of technical change in the production process over the time period under consideration. But, inasmuch

as the factors such as non-constant returns to scale and changing quality of factors of production also affect the overall productivity of factor inputs taken together, the residual factor, which captures the net influence of all such factors, can definitely be regarded as a broad indicator of the changing efficiency of the entire production process over a given period of time. In view of this, for the purpose of the present study, we shall assume that in the case of Indian iron & steel industry, the residual factor, computed by using equation 3a given above, can be used as an indicator of the rate of change in total factor productivity, or, what may be alternatively called, the rate of change in the overall efficiency of total resource use in the industry over the period under consideration.

III

It is fairly clear from the basic analytical framework discussed above that the crucial variables involved in the present analysis are the growth rates of value added, labour input and capital input, along with the relative shares of labour and capital in value added. As already indicated above, the basic data required for estimating the value of each of these variables have been obtained from the annual reports of CMI (for the period 1946 to 1958) and ASI (for the period 1959 to 1970). As the first step in the estimation procedure, we have derived the time series

of value added at constant 1960-61 prices, total man-hours worked, gross stock of capital valued at constant 1960-61 prices, and relative shares of labour and capital in value added (at current prices).

The estimates of value added at constant prices have been derived by using the method of double deflation of total output and total input with the help of appropriate price deflators, which, in turn, have been derived from the more detailed data on the quantity and value of various items constituting total output and total input available from the same sources (i.e. CMI and ASI). The estimates of gross stock of capital at 1960-61 prices have been derived by using the well-known Perpetual Inventory Method.*[10] The variant of this method that we have used here requires (a) the estimates of gross capital stock by type of assets valued at the given base period prices for a specified bench-mark year; and (b) the estimates of gross annual additions to the stock of different types of assets valued at the given base period prices. The former have been obtained for the bench-mark year 1960-61 by using the information available from the CMI and ASI (pertaining to the depreciated book value of fixed assets and value of inventories at current prices) along with the information on the gross-net ratios for the iron & steel industry available from the detailed data on the balance sheets of selected firms (covered by ASI) collected by the Reserve Bank of India;*[11] while the latter have

been obtained by deflating the corresponding figures at current prices with the help of appropriate price deflators.*[12] The basic time series of value added at 1960-61 prices, total man-hours worked and gross capital stock at 1960-61 prices, so derived for All-India, Bihar and the Rest of India covering the entire period under consideration have been presented in Appendix Table 1.

Having derived the required time series of value added, labour input and capital input, the next step is to obtain the estimates of the underlying average annual rates of growth of various aggregates. It may be noted in this connection that the actual rate of growth over a specified period of time, computed directly by considering only the two end-points of the given period, is likely to be highly sensitive to the choice of the end-points, inasmuch as the two end-points may differ from each other in several respects including the intensity of resource utilisation. We have, therefore, obtained the required estimates of average growth rates by estimating the exponential trend term for each of the various time series mentioned above. In other words, we have estimated the following equation for each (a) region, (b) time-period and (c) variable under consideration:

$$X_{ij} = A.e^{bt} \qquad \ldots\ldots (4)$$

where X_{ij} is i^{th} variable for j^{th} region; t denotes the variable 'Time' normalised to take the value 1 in 1946 and going upto 25

in 1970; A is the constant term indicating the value of X_{ij} at $t = 0$; and b is the estimated trend rate of growth per annum. It can be readily seen that the above equation can be rewritten in its logarithmic form as:

$$\text{Log } X_{ij} = \text{Log } A + bt \qquad \ldots\ldots (4a)$$

The estimates of equation 4a obtained for each of the variables, regions and time periods, by using the standard regression technique, are presented in Table 1, 2 and 3.

The following observations can be made from these three tables:

1. Out of 27 equations that we have estimated, as many as 24 show a statistically significant exponential time trend, the coefficient of the exponential trend term being positive and statistically significant at 1% level in the case of 23 equations and at 10% level in the case of one equation. Most of the equations also show a fairly satisfactory explanatory power.

2. The three equations for which the estimated rate of growth turns out to be statistically insignificant are all confined to the case of Bihar and relate to the time period 1946-58. In other words, the growth rates of all the three variables, viz., value added, labour input and capital input, turn out to be statistically insignificant during the period 1946-58 in the case of Bihar, implying thereby that the iron &

steel industry did not experience any significant growth at all during the post-war and pre-Second Plan period in Bihar, the only state which, in fact, dominated the industry at the national level precisely during this period. As a direct consequence, we find that the period 1946-58 turned out to be a period of relative stagnation for the iron & steel industry at the national level, despite a remarkable rate of growth experienced by the industry in states other than Bihar during the same period.

3. The period 1958-70 witnessed a significant acceleration in the pace of development of the iron & steel industry especially in relation to the preceeding twelve - year - period. Moreover, notwithstanding the differences that existed in the intensity of acceleration among regions and also among different aggregates, the phenomenon of acceleration can certainly be regarded as all-round and fairly wide spread in its influence. This is evident from the fact that the rates of growth of value added as well as factor inputs show a significant increase between the two sub-periods; and this increase is noticeable in the case of both Bihar and the Rest of India.

4. Over the period as a whole, Capital input has, on an average, grown at a faster rate than labour input, implying thereby that the iron & steel industry has become

increasingly more capital intensive during the period 1946-70. However, the temporal pattern of change in capital intensity has not been uniform in different regions. Thus, we find that capital intensity shows a tendency to increase during 1946-58 and remain more or less steady during 1958-1970 (taken as a whole) in the case of Bihar; while it shows a fairly clear tendency to decline during the first-half and increase significantly during the second-half of the period under consideration in the case of the Rest of India.

5. For the country as a whole, capital input on an average seems to have grown at a faster rate as compared to value added over the entire period under consideration. Consequently, at the national level, the capital-output-ratio shows a marked tendency to increase over the period as a whole. This overall tendency, however, seems to be far more pronounced in the case of Bihar and virtually absent in the case of the Rest of India so far as the period as a whole is concerned. In fact, in the Rest of India, the capital-output ratio shows a mild tendency to decline over the period as a whole. The temporal pattern of the underlying trend in capital-output ratio is also quite interesting. Thus, for instance, we find that the capital-output ratio shows a tendency to increase during the period 1946-58 and a tendency to decrease during the period 1946-58 but again reveals an

exactly opposite tendency during the subsequent period in the case of the Rest of India.

6. Finally, value added has by and large grown at a much faster rate than labour input; and this has been the case irrespective of the region or the time period under consideration. As a result, the average productivity of labour in the iron & steel industry has registered a considerable increase over the period as a whole, though it may be noted in this connection that the overall gains in the labour productivity have generally been more impressive in the case of the Rest of India than in the case of Bihar.

Having examined the broad trends in the growth of output and factor inputs in India iron & steel industry, we may now examine the implications of the same for the relative importance of different factors in the growth of the industry among different regions and over different time periods. As already indicated above, we require for this purpose the weights given by average values of the relative shares of labour and capital over the corresponding time periods covered (vide Equation 3 above); and the same are presented in Table 4.

It can be seen from the table that, on an average, the total earnings of labour account for about one-half to three-fifths of the value added (at current prices) in Indian iron & steel industry

during the period 1946-70. There are, however, significant variation in the relative share of labour between the two regions and the two sub-periods under consideration. Thus, we find that the share of labour is considerably lower in Bihar in relation to the Rest of India on the one hand, during the first-half of the period as compared to the second-half, on the other. Moreover, the tendency of the relative share of labour to increase over time is far more pronounced in the case of Bihar than in the case of Bihar than in the case of the Rest of India. As a result, the difference between the relative shares of labour in Bihar and the Rest of India has considerably narrowed down during the second-half of the period in relation to the one observed during the first-half of the period under consideration.

The estimates of absolute as well as relative contributions of factor inputs and the residual factor to the growth of Indian iron & steel industry, derived by using Equation 3 given above, are presented in Table 5.

It is evident from the figures given in this table that there are considerable differences in the contributions of various factors to the growth of iron & steel industry, both among different regions and among different periods that we may consider. However, notwithstanding these differences, we may observe that the growth of Indian iron & steel industry during

the period 1946-70, appears, on the whole, to have been due largely to the rapid growth of factor inputs in the industry. Thus, for instance, we find that the growth of factor inputs accounts for about 96% of the growth of value added at the national level, more than the recorded growth rate of value added in the case of Bihar, and about 72% of the growth of value added in the case of the Rest of India, over the entire period under consideration. Moreover, while capital seems to have contributed to a greater extent to the growth of value added as compared to labour over the period as a whole, the difference between their relative contributions had shown a clear tendency to narrow down during the second-half of the period.

The contribution of the residual factor shows remarkable variation over time as well as among regions. As a result, the average value of the residual factor, observed at the national level for the period as a whole, conceals more than what it reveals. Thus, behind the All-India average value of 0.34 percentage points observed for the period as a whole, lie a significantly high value of 4.43 percentage points and a negative value of 0.42 percentage points, observed in the Rest of India and Bihar respectively; and, similarly, a relatively significant average value of 0.81 percentage points and on insignificant trifling value of 0.03 percentage points, during the first-half and the second-half of the period respectively. This clearly implies that the overall

efficiency of resource use or the total factor productivity, as it may be alternatively called, has not increased at a significant rate at the national level; and, it has actually declined in the case of Bihar over the period 1946-70. Fortunately, the overall decline in total factor productivity observed in the case of Bihar appears to have been confined primarily to the earlier part of the period; the second-half of the period, in fact, shows a remarkable improvement in the situation by bringing about a sharp increase of 1.51 percentage points in the growth-rate of total factor productivity in relation to the one recorded during the first-half of the period.

As against this, the situation seems to have deteriorated considerably in the Rest of India, where the growth rate of total factor productivity shows a steep decline from nearly eight percent to less than one-half percent over the two sub-periods. This steep declined observed in the case of the Rest of India, together with an increasingly greater allocation of resources for the expansion of the industry in the Rest of India (especially after the year 1956), where the capital output ratio is on the whole much higher as compared to Bihar, may be regarded as the main factors responsible for bringing about a sharp decline in the growth of total factor productivity at the national level.

It is interesting to assess in this connection the relative importance of various factors contributing to the acceleration in the growth of iron & steel industry observed during the period 1958-70 in relation to the earlier period 1946-70. This has been attempted in Table 6. It can be noticed from this table that the accelerated growth of capital has turned out to be the major source of the accelerated growth of value added in the Indian iron & steel industry observed during the sixties. The contribution of capital to the acceleration of growth is particularly striking in the case of the Rest of India, which in turn has accounted for no less than 82% of the observed growth of iron & steel industry during the period 1958-70. This obviously implies that the accelerated growth of the iron & steel industry observed during the sixties is due largely to the sustained flow of heavy investments in the industry since 1958. It is rather unfortunate to find that a variety of other possible sources of acceleration have remained relatively dormant as far as their net influence is concerned. One may simply wonder how rapid the growth of the industry would have been, had some of the other sources of acceleration been also operative along with the massive investments undertaken during the period 1958-70. A simple exercise may illustrate this point more effectively. If we assume that the positive contribution of the residual factor to the accelerated growth of value added observed in the case Bihar,

had also been operative in the case of the Rest of India, then, all other things remaining the same, we find that the average rate of growth of the iron & steel industry at the national level would have turned out to be as high as 22.67% per annum during the period 1958-70. This, in turn, implies that, given the situation in the initial year (1958), the output of iron & steel industry would have been 107.7% higher in 1970 than what has actually been achieved.

V

The main findings of the present study may now be summarized in the form of the following broad conclusions emerging from the above analysis:

1. While the Indian iron & steel industry has experienced rapid growth in recent years, there exist significant differences in the broad inter-temporal as well as inter-regional patterns of growth.

2. The elasticity of output with respect to labour*[13] seems to have a tendency to increase as the industry expands; and its average value seems to be lower in Bihar as compared to the Rest of India.

3. The rapid growth of Indian iron & steel industry, observed during the post-war period, appears to have been due largely to the rapid and sustained growth of factor inputs. The overall efficiency

of resource use in the industry does not appear to have increased at a satisfactory rate at the national level; and, in fact, it seems to have declined marginally in the case of Bihar over the period 1946-70.

4. The growth rate of total factor productivity shows a marked tendency to decline at the national level; and the tendency seems to be more pronounced in the case of all states other than Bihar taken together. In the case of Bihar, it shows a fairly clear tendency to increase.

5. Accelerated growth of capital appears to have been the major source of acceleration in the growth of Indian iron & steel industry observed during the sixties. On the whole, the behaviour of the residual factor has been a retarding factor, rather than a helping factor, in the process of acceleration especially in the case of all states other than Bihar taken together.

The policy implications of these findings are obvious. Comprehensive research in the direction of identifying the main factors responsible for retarding the growth of total factor productivity, and simultaneously exploring the factors favourable to efficiency growth, needs to be given more attention in the specific case of the iron & steel industry than has hitherto been paid. Special emphasis needs to be given to the research and development programmes specifically designed to improve the

technological base of the Indian iron & steel industry. In view of the huge amount of investments being made in the industry, it would not be inappropriate to make a relatively higher allocation for Research and Development at least in the public sector enterprises, and, at the same time, provide sufficient encouragement to the private enterprises for undertaking more research and development oriented programmes. Such steps, however, would take a fairly long time to produce the desired results. In the meanwhile, considering the strategic importance of the industry in our economic planning and industrial development programmes, there is an urgent need, therefore, to take all possible steps to improve the degree of capacity utilisation in the industry, and, in any case, to sustain the flow of large-scale investments in the industry at least in the short-run to ensure a further rapid expansion of the iron & steel industry during the years to come.

Table 1

ESTIMATED RATES OF GROWTH OF VALUE ADDED IN IRON AND STEEL INDUSTRY

Region/Period	Regression Coefficients		Coefficient of Determination (R^2)	F- Ratio
	Constant Term (Log A)	Compound Rate of Growth per annum (b in percent)		
(1)	(2)	(3)	(4)	(5)
ALL INDIA:				
1946 to 1970	3.2253* (32.2344)	8.7586* (13.0130)	0.8804	169.3330
1946 to 1958	3.6185* (69.9663)	2.5898* (3.9747)	0.5895	15.7950
1958 to 1970	2.3114* (7.6845)	13.5361* (8.7148)	0.8735	75.9504
BIHAR:				
1946 to 1970	3.2951* (54.4432)	2.6954* (6.6207)	0.6559	43.8331
1946 to 1958	3.4893* (55.3804)	-0.3894 (0.4905)	0.0215	0.2421
1958 to 1970	2.8084* (13.6205)	5.2123* (4.8952)	0.6854	23.9687
REST OF INDIA:				
1946 to 1970	1.3934* (11.4466)	15.8970* (19.4133)	0.9425	376.8800
1946 to 1958	1.6777* (12.3414)	11.2920* (6.5931)	0.7980	43.4687
1958 to 1970	0.7721 (1.6618)	19.1346* (7.9749)	0.8525	63.6000

* Statistically significant at 1% level of significance (Figures in brackets indicate the t-ratios computed for the correspond regression coefficients).

Source: Appendix Table 1

Table 2

ESTIMATED RATES OF GROWTH OF LABOUR INPUT IN IRON AND STEEL INDUSTRY

Region/Period	Regression Coefficients		Coefficient of Determination (R^2)	F - Ratio
	Constant Term (Log. A)	Compound Rate of Growth per annum (b in percent)		
(1)	(2)	(3)	(4)	(5)
ALL INDIA:				
1946 to 1970	2.6047* (28.4346)	6.3259* (10.2662)	0.8209	105.3960
1946 to 1958	2.9067* (134.0790)	2.1238* (7.7756)	0.8460	60.4495
1958 to 1970	1.4871* (6.7754)	12.0609* (10.6408)	0.9115	113.2250
BIHAR:				
1946 to 1970	2.2389* (39.9561)	1.3402* (3.5556)	0.3547	12.6450
1946 to 1958	2.3539* (152.0350)	-0.0377 (0.1933)	0.0020	0.0220
1958 to 1970	1.5824* (8.6220)	4.6555* (4.9122)	0.6869	24.1281
REST OF INDIA:				
1946 to 1970	1.7191* (15.0248)	9.1552* (11.8955)	0.8602	141.5040
1946 to 1958	2.0694* (48.4326)	4.2294* (7.8567)	0.8487	61.7267
1958 to 1970	0.4808 (1.4235)	15.5244* (8.9016)	0.8741	79.2377

* Statistically significant at 1% level of significance
(Figures in brackets indicate the t-ratios computed for the corresponding regression coefficients)

Source: Appendix Table 1

Table 3

ESTIMATED RATES OF GROWTH OF CAPITAL INPUT IN IRON AND STEEL INDUSTRY

Region/Period	Regression Coefficients		Coefficient of Determination (R^2)	F - Ratio
	Constant Term (Log A)	Compound Rate of Growth per annum (b in percent)		
(1)	(2)	(3)	(4)	(5)
ALL INDIA:				
1945 to 1970	4.6797* (33.1906)	10.7260* (11.3092)	0.8476	127.8980
1946 to 1958	5.2610* (90.1369)	1.4685*** (1.9970)	0.2657	3.9808
1958 to 1970	3.8185* (10.7991)	15.4630* (8.4685)	0.8670	71.7132
BIHAR:				
1946 to 1970	4.5937* (64.3475)	4.8575* (10.1153)	0.8165	102.3350
1946 to 1958	4.8205* (56.2825)	0.9696 (0.8985)	0.0683	0.8065
1958 to 1970	4.7081* (30.6650)	4.5339* (5.7186)	0.7482	32.6906
REST OF INDIA:				
1946 to 1970	3.4242* (15.9994)	14.8643* (10.3250)	0.8225	106.6050
1946 to 1958	4.2329* (90.4110)	2.1995* (7.8532)	0.8485	61.6214
1958 to 1970	1.8142** (2.6774)	23.4316* (6.6963)	0.8030	44.8406

* Statistically significant at 1% level of significance
** Statistically significant at 5% level of significance
*** Statistically significant at 10% level of significance
(Figures in brackets indicate the t-ratios computed for the corresponding regression coefficients)

Source: Appendix Table 1

Table 4

RELATIVE SHARES OF LABOUR AND CAPITAL IN VALUE ADDED IN IRON AND STEEL INDUSTRY

PERIOD	ALL INDIA		BIHAR		REST OF INDIA	
	Share of Labour	Share of Capital	Share of Labour	Share of Capital	Share of Labour	Share of Capital
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1946-70	0.5250	0.4750	0.4946	0.5054	0.5933	0.4067
1946-58	0.4806	0.5194	0.4488	0.5512	0.5881	0.4119
1958-70	0.5732	0.4268	0.5442	0.4558	0.5988	0.4012

Source: Annual Reports of CMI (1946 to 1958) and ASI (1959 to 1970), Central Statistical Organization, Government of India.

Table 5

CONTRIBUTION OF VARIOUS FACTORS TO THE GROWTH OF VALUE ADDED IN IRON AND STEEL INDUSTRY

Region/Period	Absolute Contribution (in percentage points)				Growth Rate of Value Added	Relative Contribution (in per cent)				Growth Rate of Value Added
	Labour	Capital	Total of Factor Inputs	The Residual Factor		Labour	Capital	Total of Factor Inputs	The Residual Factor	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
ALL INDIA:										
1946 to 1970	3.32	5.10	8.42	0.34	8.76	37.90	58.22	96.12	3.88	100.00
1946 to 1958	1.02	0.76	1.78	0.81	2.59	39.38	29.34	68.72	31.28	100.00
1958 to 1970	6.91	6.60	13.51	0.03	13.54	51.03	48.74	99.77	0.23	100.00
BIHAR:										
1946 to 1970	0.66	2.46	3.12	-0.42	2.70	24.44	91.11	115.55	-15.55	100.00
1946 to 1958	-0.02	0.53	0.51	-0.90	-0.39	- 5.13	135.90	130.77	-230.77	-100.00
1958 to 1970	2.54	2.06	4.60	0.61	5.21	48.75	39.54	88.29	11.71	100.00
REST OF INDIA:										
1946 to 1970	5.43	6.04	11.47	4.43	15.90	34.15	37.99	72.14	27.86	100.00
1946 to 1958	2.49	0.91	3.40	7.89	11.29	22.05	8.06	30.11	69.89	100.00

Table 6

SOURCES OF THE NET INCREASE IN THE GROWTH RATE OF VALUE ADDED IN INDIAN IRON & STEEL INDUSTRY*

(Figures in percentage points)

	Source	All-India	Bihar	Rest of India
1.	Accelerated Growth of Labour Input	4.78	2.11	6.64
2.	Change in the Relative Share of Labour	1.11	0.45	0.16
	SUB-TOTAL: CONTRIBUTION OF LABOUR	5.89	2.56	6.80
3.	Accelerated Growth of Capital Input	7.27	1.97	8.74
4.	Change in the Relative Share of Capital	- 1.43	- 0.44	- 0.25
	SUB-TOTAL: CONTRIBUTION OF CAPITAL	5.84	1.53	8.49
5.	Contribution of the Residual Factor	- 0.78	1.51	- 7.45
	TOTAL: NET INCREASE IN THE GROWTH RATE OF VALUE ADDED	10.95	5.60	7.84

* refers to the increase in the average annual rate of growth of value added recorded during the period 1958-70 in relation to the corresponding rate of growth observed during the period 1946-58.

NOTES AND REFERENCES

1. The annual reports of CMI issued by Central Statistical Organisation (CSO), Government of India cover the period 1946-58, while the reports of annual survey of industries (Census Sector) issued by CSO cover the period 1959-70. It may be noted in this connection that the specific industry under consideration, viz., Iron & Steel (Basic Metals), is reported as industry No. 23 under CMI and industry No. 341.1 under ASI.

2. The main reason behind selecting the year 1958 for the prupose of dividing the period 1946-70 into two sub-periods (viz., 1946-58 and 1958-70) is two-fold. In the first place, the year 1958 happens to be a turning point in the broad trends observed in all the major variables involved, since it represents the year which marked the beginning of the period of substantial expansion of the industry. The second reason behind the choice of the year 1958 is of course that, besides representing the mid-point of the entire period under consideration, it also happens to be the year in which the basic source of data underwent a change, CMI being replaced by ASI after 1958.

3. The reason why we have divided the country into only two main parts, viz., Bihar and the Rest of India, for making inter-regional comparison is that among different states

of the country, Bihar alone dominated the scene during the first half of the period under consideration so far as the iron & steel industry is concerned. This is evident from the fact that Bihar accounted for no less than about four-fifths of the value added and about two thirds of the total capital employed (depreciated book value) in the Indian iron & steel industry. No other State came closer to Bihar especially during the earlier part of the period under consideration. Moreover, since the importance of Bihar declined very steeply over the period 1946-70, it is obvious that the average rates of growth of output and factor inputs would be considerably different between Bihar on the one hand and the Rest of India on the other.

4. It may be noted that the only production function which simultaneously fulfills both the conditions of constant returns to scale and unit elasticity of substitution between labour and capital is the well-known Cobb-Douglas production function.

For details, see R.G.D. Allen: Macro-Economic Theory - A Mathematical Treatment (London : Macmillan, 1968); Ch.3

5. It may be noted that this is mainly the assumption of the basic technology remaining unchanged over a period of time, i.e., the assumption of no technological change of any kind.

It also implies, however, that any other factor, besides technological change, which might lead to a shift in the production function, also remains unchanged over time.

6. The sufficient conditions for this assumption to hold good are the existence of perfect competition in product as well as factor markets and also of the tendency on the part of the economic units to minimise costs.

7. The errors in the measurement of factor inputs arise primarily on account of the changing quality or composition of the factor inputs and also the fluctuations in the degree of capacity utilisation over a period of time. In addition to this the errors of measurement may arise in the case of output or capital input also on account of the errors in the choice of appropriate price deflators, for obtaining the value of the respective aggregates at some constant base period prices. For a detailed discussion of the errors of measurement that arise in the derivation of the indices of output factor inputs and factor productivities, see D.W. Jorgenson and Z. Griliches: "The Explanation of productivity change," Review of Economic Studies, Vol. 34, 1967; pp. 249-83.

8. It may be noted that if the economic units seek to minimise costs and are also free to select the combination of resources that best achieves this purpose, then it follows

that under the conditions of competitive equilibrium with constant returns to scale, the factor price would be equal to the corresponding marginal productivity for each factor; and this, in turn, would imply that the relative share of a given factor of production would be equal to the elasticity of output with respect to that factor at the point of equilibrium. For details, see J.E. Meade:. A Neo-classical Theory of Economic Growth (London: George Allen & Unwin Ltd., Revised Second Edition, 1962); Ch. 2. See also, R.G.D. Allen, op. cit.

9. In practice, the partial contributions of labour and capital inputs may not exactly add up to the total contribution of factor inputs inasmuch as there might exist an interaction term. However, if the observed growth rates of factor inputs are not very high, the interaction term would be quantitatively insignificant and can therefore be conveniently ignored.

10. For a detailed discussion of the perpetual inventory method, see Goldsmith: "A Perpetual Inventory of National Wealth", Studies in Income and Wealth, Volume 14 (New York, National Bureau of Economic Research, 1951).
See also, B.H. Dholakia: The Sources of Economic Growth in India (Baroda: Good Companions; 1974); pp. 141-42.

11. The gross-net ratios computed from the balance sheet data relating to about 1000 firms (covered by ASI for the year 1960) collected by the Reserve Bank of India have been reproduced in S.R. Hashim and M.M. Dadi: Capital Output Relations in Indian Manufacturing, the M.S.University economic series No. 2, Baroda, 1973; pp. 14-15.

It may be noted here that the gross-net ratios (relating to the fixed capital stock valued at purchase prices), derived for the iron & steel industry, turn out to be 1.3297 for buildings and construction, 1.5777 for plant and machinery and 1.5778 for other fixed assets.

12. The price indices for buildings & construction and machinery and equipment are obtained from B.H. Dholakia, op. cit., p. 196. The price index for inventories is derived by computing the weighted average of the separate price indices for output and materials consumed (derived from the detailed data obtained from CMI and ASI), the weights representing the respective shares of the stocks of finished and semi-finished products on the one hand, and the raw-materials on the other, in the total value of the stock of inventories in the year 1960.

13. As already indicated above, the elasticity of output with respect to labour is assumed to be approximately indicated by the average value of the relative share of labour in value added measured at current prices.

Appendix Table I (a)

TIME SERIES OF OUTPUT AND FACTOR INPUTS IN IRON & STEEL INDUSTRY — ALL INDIA

Year	OUTPUT			CAPITAL INPUT			LABOUR INPUT
	Gross Output	Total Input	Value added	Gross Stock of Fixed Capital	Inventories	Gross Capital stock	Total man-hours worked
(1)	(2)	(3)	(4)=(2)-(3)	(5)	(6)	(7)=(5)+(6)	(8)
1946	93.88	56.53	37.35	173.68	33.38	207.06	1791
1947	102.62	63.05	39.57	169.77	37.82	207.59	1905
1948	93.24	58.55	34.69	166.07	38.63	204.70	1993
1949	112.09	67.89	44.20	161.83	42.71	204.54	2059
1950	117.56	71.47	46.09	160.95	48.84	207.79	2053
1951	123.44	80.01	43.43	153.90	57.86	211.76	2178
1952	129.09	84.05	45.04	147.18	54.59	201.77	2090
1953	125.71	78.37	47.34	145.90	63.03	208.21	1989
1954	123.87	75.48	48.39	149.79	50.62	200.41	2226
1955	127.26	81.16	46.10	151.68	50.25	201.93	2323
1956	134.28	79.18	55.10	162.61	40.49	203.10	2367
1957	128.47	74.01	54.46	193.59	38.72	232.31	2353
1958	123.52	79.72	43.80	252.61	49.63	302.24	2373
1959	167.68	91.15	76.53	302.50	58.52	361.02	2120
1960	174.12	116.17	57.95	309.90	57.38	367.28	2378
1961	194.24	114.35	79.89	320.50	58.70	379.20	2437
1962	307.96	180.37	127.59	837.60	123.48	961.08	4547
1963	359.80	217.52	142.28	897.13	139.99	1037.12	4335
1964	369.42	205.12	164.30	947.62	152.23	1099.85	4731
1965	396.62	193.07	203.55	953.26	139.02	1092.28	4712
1966	398.75	227.22	171.53	1042.76	201.93	1244.69	4852
1967	509.95	320.12	189.83	1258.70	228.19	1486.89	7367
1968	563.40	351.78	211.62	1341.25	211.31	1552.56	7569
1969	609.31	375.84	233.47	1390.55	205.26	1595.81	7824
1970	644.23	399.15	245.08	1469.71	206.19	1675.90	7956

Note: All values are in Rs. crores at 1960-61 prices, while Man-hours are in lakhs

Source: See the text (Section III, pp. 6 - 8)

Appendix Table I (b)

TIME SERIES OF OUTPUT AND FACTOR INPUTS IN IRON & STEEL INDUSTRY — BIHAR

Year	OUTPUT			CAPITAL INPUT			LABOUR INPUT
	Gross Output	Total Input	Value added	Gross Stock of Fixed Capital	Inventories	Gross Capital Stock	Total man-hours worked
(1)	(2)	(3)	(4)=(2)-(3)	(5)	(6)	(7)=(5)+(6)	(8)
1946	69.69	36.35	33.34	113.50	21.22	134.72	1033
1947	69.87	36.16	33.71	110.92	22.22	133.14	1008
1948	59.41	32.62	26.79	108.08	23.66	131.74	1061
1949	67.04	35.19	31.85	104.55	24.52	129.07	1056
1950	71.63	36.78	34.85	100.07	29.76	129.83	1080
1951	71.32	39.71	31.61	95.55	39.26	134.81	1088
1952	74.49	43.00	31.49	90.77	36.43	127.20	1066
1953	78.52	41.03	37.49	87.88	40.90	128.78	1054
1954	65.29	34.55	30.74	87.07	26.77	113.84	1044
1955	66.56	36.44	30.12	90.90	25.44	116.34	1056
1956	66.70	31.74	34.96	98.34	20.49	118.83	1023
1957	64.49	30.85	33.64	122.03	18.71	140.74	1078
1958	56.84	30.94	25.90	179.81	25.22	205.03	1006
1959	83.08	37.12	45.96	203.74	26.17	229.91	1028
1960	82.77	51.41	31.36	203.63	29.38	233.01	1028
1961	87.11	45.23	41.88	206.63	31.28	237.91	1021
1962	91.87	45.30	37.57	206.24	30.75	236.99	1021
1963	92.17	50.27	41.90	205.59	32.47	238.06	1050
1964	93.56	49.28	44.28	204.05	31.57	235.62	1031
1965	103.56	47.69	55.87	201.26	28.07	229.33	1039
1966	101.19	48.07	53.12	205.95	32.54	238.49	1028
1967	119.17	67.77	51.40	276.29	40.23	316.52	1424
1968	126.73	73.64	53.09	307.05	43.66	350.71	1642
1969	121.69	71.09	50.60	303.11	37.84	340.95	1586
1970	151.81	89.11	62.70	355.39	31.79	387.18	1782

Note : All values are in Rs. crores at 1960-61 prices, while Man-hours are in

Source: See the text (Section III, pp. 6 - 8)

Appendix Table I (c)

TIME SERIES OF OUTPUT AND FACTOR INPUTS IN IRON & STEEL INDUSTRY — REST OF INDIA

Year	OUTPUT			CAPITAL INPUT			LABOUR INPUT
	Gross Output	Total Input	Value added	Gross Stock of Fixed Capital	Inventories	Gross Capital stock	Total man-hours worked
(1)	(2)	(3)	(4)=(2)-(3)	(5)	(6)	(7)=(5)+(6)	(8)
1946	24.19	20.18	4.01	60.18	12.16	72.34	758
1947	32.75	26.89	5.86	58.85	15.60	74.45	897
1948	33.83	25.93	7.90	57.99	14.97	72.96	932
1949	45.05	32.70	12.35	57.28	18.19	75.47	1003
1950	45.93	34.69	11.24	60.88	17.08	77.96	973
1951	52.12	40.30	11.82	58.35	18.60	76.95	1090
1952	54.60	41.05	13.55	56.41	18.16	74.57	1024
1953	47.19	37.34	9.85	58.02	21.41	79.43	935
1954	58.58	40.93	17.65	62.72	23.85	86.57	1182
1955	60.70	44.72	15.98	60.78	24.81	85.59	1267
1956	67.58	47.44	20.14	64.27	20.00	84.27	1344
1957	63.98	43.16	20.82	71.56	20.01	91.57	1275
1958	66.68	48.78	17.90	72.80	24.41	97.21	1367
1959	84.60	54.03	30.57	98.76	32.35	131.11	1092
1960	91.35	64.76	26.59	106.27	28.00	134.27	1350
1961	107.13	69.12	38.01	113.87	27.42	141.29	1416
1962	216.09	126.07	90.02	631.36	92.73	724.09	3526
1963	267.63	167.25	100.38	691.54	107.52	799.06	3285
1964	275.86	155.84	120.02	743.57	120.66	864.23	3700
1965	293.06	145.38	147.68	752.00	110.95	862.95	3673
1966	297.56	179.15	118.41	836.81	169.39	1006.20	3824
1967	390.78	252.35	138.43	982.41	187.96	1170.37	5943
1968	436.67	278.14	158.53	1034.20	167.65	1201.85	5927
1969	487.62	304.75	182.87	1087.44	167.42	1254.86	6238
1970	492.42	310.04	182.38	1114.32	174.40	1288.72	6174

Note : All values are in Rs. crores at 1960-61 prices, while Man-hours are in lakhs.

Source : See the text (Section III, pp. 6 - 8)