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TRENDS IN THE ECONOMIC EFFICIENCY
OF
INDIAN RAILWAYS

by
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ABSTRACT

This paper aims at examining the performance of Indian railways based on the criterion of total factor productivity. The paper makes an attempt to analyse the available data on output and factor inputs to estimate the rate at which the overall economic efficiency of Indian railways has changed during the period 1950-51 to 1977-78. An attempt is also made to analyse the sources of output growth in the railways by estimating the contribution made by factor inputs and total factor productivity of the observed growth rate of net product.

The main conclusion that emerges from the study is that there has been a considerable increase in the overall economic efficiency of resource utilisation in Indian railways during the period under consideration. Moreover, there has been a significant acceleration in the rate of growth of total factor productivity in the railways during the period following 1970-71 as compared to the earlier period.

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I. Introduction

Indian Railways represent the largest public sector organisation operating in the country. Their growth in the post-independence period has also been remarkable. Since the railway system occupies a key position in the strategy of building up basic infrastructure required for a developing economy, a substantial amount of nation's productive resources are almost continuously directed towards supporting and sustaining the growth of railways. The latest information available for the year 1977-78 indicates that the net domestic product originating in Indian railways is more than Rs. 1000 crores while the annual gross capital formation in railways is more than Rs. 470 crores. Similarly, the total employment provided by the railways exceeds 1.5 million. Moreover, each of these aggregates has shown a significant upward trend during

the last three decades. From the past trends, it is evident that an increasing amount of scarce productive resources will continue to be allocated to the expanding railway system during the years to come. It is interesting, therefore, to examine at this stage the trends in the productivity of factor inputs employed in the railways and estimate the rate at which the overall economic efficiency of railways has changed since the inception of planning in our economy. An attempt has been made in this paper to analyse the available data on output and factor inputs to measure the growth of overall efficiency of resource utilisation in Indian Railways during the period 1950-51 to 1977-78.

II. The Methodology

The growth in the overall efficiency of resource utilisation can be measured with the help of the index of total factor productivity. The index of total factor productivity, also referred to as the index of output per unit of total factor input, represents a comprehensive index of economic efficiency because it takes into account the total benefit to the economy as a whole that accrues from any production process. This index is derived as a ratio of the index of net output to the index of total factor input. The former

indicates the actual growth of net value added at constant base period prices, while the latter indicates the extent of growth that would have occurred had the overall productivity of all factors of production remained constant during the period under consideration. Thus, if we find that the index of total factor input for, say, the terminal year of the period under consideration is less than the index of net output, it implies that the observed growth of output exceeds the amount of growth that would have resulted under conditions of constant productivity of factor inputs. Since the actual growth exceeds the growth resulting from the estimated growth under the assumption of unchanging efficiency of factor inputs, it follows that the overall efficiency of all factor inputs taken together has increased during the period. The index of total factor productivity measures in precise quantitative terms the extent of increase in the overall efficiency of factor inputs employed in the given organisation or the industry.

The attempt to measure the growth of economic efficiency involves estimation of the contributions made by factor inputs to the observed growth of real net product over a given period of time. The various types of factor inputs entering into the process

of production can be classified broadly under the two conventional categories of factors of production, viz., labour input and capital input. We have, therefore, estimated the contributions made by the growth of labour input, capital input and total factor productivity to the growth rate of net product originating in railways during the period 1950-51 to 1977-78. The methodology that we have adopted for this purpose is based primarily on the celebrated factor share approach which has been widely used in economic literature especially in the field of quantitative analysis of economic growth.*1

The factor share approach follows directly from the marginal productivity analysis. It provides a fairly satisfactory set of estimates of the contributions made by various factors to the measured growth rate under the conditions where the average earnings of various factors of production are proportional to the value of their respective marginal products. In particular, under the special case of competitive equilibrium with constant returns to scale,

*1 For details, see Bakul H. Dholakia, The Sources of Economic Growth in India, Good Companions, 1974.

this method simply involves the direct use of the relative share of a given factor of production in net product to represent the elasticity of output with respect to that factor. Thus, the contribution made by the growth of, say, capital input to the observed growth of output can be measured by (a) estimating the average growth rate of capital input, and (b) multiplying it by the estimated average relative share of capital in net product, during the period under consideration.

It is evident that the use of the above method of analysing growth of output requires time series data on (a) net product at constant prices, (b) net stock of capital at constant prices; (c) total employment; (d) relative shares of labour and capital in net product. We have obtained the required time series data relating to Indian railways from various official and other sources of information. The data on net domestic product originating in railways measured at constant 1970-71 prices have been obtained from various issues of National Accounts Statistics. The time series of capital stock in railways measured at 1970-71 prices is derived from the time series of capital formation in railways at 1970-71 prices and the estimator of total capital stock

in railways for the benchmark year 1970-71. The information on capital formation is obtained from various issues of National Accounts Statistics, while the estimate of capital stock in railways for the year 1970-71 is obtained from a recent study by Uma Roy Choudhury.*² The time series of total employment in Indian railways is derived from the information available from various issues of Indian Labour Statistics and Pocket Book of Labour Statistics. Finally, the time series of relative shares of labour and capital in net domestic product originating in railways is derived from the information given in various issues of Estimates of National Product and National Accounts Statistics.

III. Growth of Output and Factor Inputs

The time series of output, capital input, labour input and relative labour share are presented in Table 1. It is evident from this table that the Railways have registered significant growth during the period 1950-51 and 1977-78. Net domestic product originating in railways measured at 1970-71 prices, has increased from Rs. 207 crores in 1950-51 to Rs. 714 crores in 1977-78 indicating an average compound rate of growth of 4.69 per cent

*² Cf. Uma Datta Roy Choudhury: "Industrial Breakdown of Capital Stock in India, The Journal of Income and Wealth, Vol.I, No.2, April 1977.

per annum. The growth of output has been fairly smooth and significant during the entire period under consideration. However, the rate of growth of output observed during the sixties (4.23 percent) is found to be somewhat lower than the growth rates observed during the fifties and the seventies.

There has been a considerable growth of factor inputs flowing to the railways system. Total capital stock (measured at 1970-71 prices) employed in railways has increased from Rs. 2636 crores in 1950-51 to Rs. 5396 crores in 1977-78, which implies a growth rate of 4.8 percent per annum. While the growth of capital stock has been smooth and continuous during the period under consideration, the rate of growth of capital stock seems to be declining. This is evident from the growth rate of 6.52 percent per annum observed during the fifties, of 5.02 percent per annum observed during the sixties, and of 2.1 percent per annum observed during the period from 1970-71 to 1977-78. Thus, although the flow of capital into the railway system is increasing over time, it is found to be increasing at a declining rate.

A similar phenomenon is also found in the case of the flow of labour input in railways. Total employment in railways shows an

increase from 923 thousands in 1950-51 to 1517 thousands in 1977-78 indicating a growth rate of 1.86 percent per annum. However, the growth rates observed for the periods 1950-51 to 1960-61, 1960-61 to 1970-71 and 1970-71 to 1977-78 are 2.34 percent per annum, 1.72 percent per annum and 1.37 percent per annum respectively. Thus, the relative pace of capital formation as well as employment generation in railways seems to have slackened especially during the seventies. It may be noted, however, that the deceleration in the pace of growth is significant in the case of capital input, whereas it is mild and less significant in the case of labour input.

IV. Trends in Labour Productivity and Capital Intensity

From the estimates of output and factor inputs given in table 1, we can derive time series of important ratios such as labour productivity, capital-labour ratio and capital-output ratio indicating economic characteristics of the enterprise and its operations. Trends in these ratios observed in the case of railways during the period 1950-51 to 1977-78 are brought out by the estimates given in Table 2.

It can be seen from table 2 that the average labour productivity in Indian railways measured in terms of net domestic product per person employed at 1970-71 prices has registered a significant increase during the period under consideration. Average growth rate of labour productivity observed during the period as a whole turns out to be 2.8 percent per annum. In recent years, however, the growth of labour productivity seems to have accelerated, the growth rate observed during the period 1970-71 to 1977-78 being 3.2 percent as against the growth rate of 2.5 percent per annum observed during 1960-61 to 1970-71.

There has also been a marked increase in the degree of capital intensity in Indian railways especially during the first two decades of planning. Over the twenty seven year period as a whole, the amount of capital employed per worker has increased at the rate of about 3 percent per annum. If we examine the temporal pattern of growth, we find that there has been a steady decline in the growth rate of capital intensity. The growth rates of capital employed per worker have declined from 412 percent observed during the fifties to 0.7 percent per annum observed during the period 1970-71—1977-78. The deceleration in the growth of capital intensity of Indian railways appears to be mainly the result of slower growth

of capital coupled with efforts to maintain relatively high growth rate of employment.

An alternative measure of capital intensity is provided by capital-output ratio which indicates the amount of capital employed per unit of output. The capital-output ratio is found to be very high in the case of railways especially in relation to its counterpart in other sectors of the economy. During the period under consideration, the capital-output ratio is found to vary from 12.7 to 17.3, whereas the capital-output ratio for the economy as a whole is estimated to be around 2.1 to 2.9.*³ This comparison clearly brings out the high degree of capital intensity of Indian railways.

It is, however, interesting to observe that the capital output ratio has shown a marked tendency to decline in recent years especially after 1973-74. During the period from 1950-51 to 1973-74, the capital-output ratio in Railways shows a tendency to rise. But this upward trend observed during the earlier period arrested and reversed during the subsequent period with the capital-output ratio declining sharply from 17.3 in 1973-74 to 13.1 in 1977-78.

*³ Cf. Uma Datta Roy Choudhury, "Industrial Breakdown of Capital Stock in India", op.cit.

On the whole, therefore, it appears that, though Indian railways continue to be highly capital intensive, the growth of capital intensity has decelerated and, during the years to come, the amount of capital employed per unit of output is likely to have a tendency to decline. It may be noted in this connection that a decline in the capital-output ratio coupled with continued growth of output is an indicator of improved efficiency of production and better utilisation of the existing production capacity.

V. Index of Total Factor Productivity

To measure the rate of growth of economic efficiency of the railways, we have derived the indexes of total factor input and total factor productivity from the time series given in table 1. The index of total factor input is derived as a weighted average of the indexes labour input and capital input, the weights being the corresponding relative shares of labour and capital in net product. The index of total factor productivity is then derived by dividing the index of net output with the index of total factor input. The indexes of net output, total factor input and total factor productivity derived for Indian railways are presented in Table 3.

It can be seen from table 3 that, while the index of total factor input shows a smooth and continuous upward trend throughout the period under consideration, the index of total factor productivity is marked by noticeable fluctuations around an upward trends. This indicates that, although there has been a steadily increasing flow of factor inputs in Indian railways, the overall economic efficiency of resource utilisation has increased in some years and decreased or remained constant in other years. If we examine the temporal behaviour of total factor productivity in railways, we observe the following broad pattern: The period 1950-51 to 1958-59 is marked by a declining trend in total factor productivity. The next four years from 1959-60 to 1962-63 show a significant improvement in total factor productivity. The following period from 1962-63 to 1967-68 is characterised by relative constancy or stability in the index of total factor productivity. Crucial breakthrough on the total factor productivity front seems to have been made in the subsequent period resulting in a significant increase in the index of total factor productivity during the period 1967-68 to 1977-78. Thus, after an initial period of decline with some fluctuations in the upward direction, the total factor productivity in railways seems to be increasing attaining a certain

plateau and then making a further breakthrough resulting a continuation of the upward trend.

VI. Sources of Output Growth

From the information given in tables 1 and 3, we can estimate the contribution made by labour input, capital input and total factor productivity to the observed growth rate of net product originating in railways during the period 1950-51 to 1977-78. Our estimates of the absolute as well as relative contributions made by these factors to the growth of Indian railways are given in Table 4. To examine the trends in the contribution made by different factors over a period of time and the likely changes that might have occurred in the quantitative importance of different sources of growth, we have estimated the contribution not only for entire twenty seven year period as a whole, but also for three sub-periods, viz., 1950-51 to 1960-61, 1960-61 to 1970-71, and 1970-71 to 1977-78.

It can be seen from table 4 that considering the period as a whole, the growth of total factor productivity contributed 1.75 percentage points to the observed growth rate of net product

originating in railways, whereas the contribution of the growth of total factor input is found to be 2.94 percentage points. Between the two factor inputs, the contribution made by capital input is more than that of labour input. In relative terms, the labour input and capital input account for 28.6 percent and 34.1 percent of the measured growth rate of net product whereas total factor productivity accounts for 37.3 percent.

It is interesting to observe that the contributions made by both labour input as well as capital input have shown a clear tendency to decline with the passage of time, the contribution for each succeeding sub-period being less than the previous period. As against this, the contribution made by total factor productivity has increased sharply during the period following 1970-71, as compared to the fifties and the sixties. The increase in the contribution of total factor productivity is remarkable in absolute as well as relative terms. In absolute terms, the contribution of total factor productivity to the growth of output is 1.41 percentage points during the fifties, 1.21 percentage points during the sixties, and 3.01 percentage points during the seventies, the

corresponding figures for the relative contribution being 26.9 percent, 18.6 percent and 65.7 percent, respectively.

An important implication of such a temporal pattern of growth of factor inputs is that the overall rate of growth of net product originating in railways would have declined considerably if the growth of total factor productivity would not have accelerated especially in the recent years. For instance, had the growth of total factor productivity remained the same during the seventies as observed during the sixties, the measured growth rate of net product originating in railways would have been only 2.78 percent per annum as against the growth rate of 4.58 percent actually observed during the period 1970-71 to 1977-78. Thus, the accelerated growth of total factor productivity has played a crucial role in sustaining high rate of growth of net product in Indian railways especially during the last few years.

The obvious implication of the above findings is that the economic efficiency of resource utilisation in Indian railways is increasing with the passage of time at a significant rate. Moreover, the growth of efficiency has accelerated during the seventies as compared to the earlier decades. Two broad sets of factors seem

to have been instrumental in bringing about a significant acceleration in the growth of total factor productivity during the seventies. The first set of factors include improvement in the quality of factor inputs, better organization of the production process and the phenomenon of technical progress on a comparatively greater scale during the more recent years in relation to the earlier years. The second set of factors would include improvement in the capacity utilisation rates and a significant reduction in the lag between investment and the flow of output achieved through a relatively faster completion of projects under construction.

A significant increase in the growth of economic efficiency of the railways can thus be attributed to either the phenomenon of rapid technical progress or a better utilisation of the existing productive capacity or both. It may be mentioned in this connection that in the Fourth Five Year Plan, the main focus so far as the railway plan is concerned, was on modernisation of the railway system to improve the overall efficiency of operation.*4

*4 Cf. The Draft Five Year Plan, 1978-83, Planning Commission, Government of India; p.207.

Similarly, in the Fifth Plan, the main emphasis was on better utilisation of the existing track and the rolling stock capacity and achieving higher operational efficiency through maximization of movements in block rakes and reducing turn-round time.^{*5} To achieve this objective additional investment in the Fifth Plan was directed more towards improvement in the utilisation of the existing capacity rather than mere extension of the railway system as such. It seems, therefore, that these efforts and policy measures have contributed to the accelerated growth of total factor productivity observed during recent years.

VII. Conclusion

The main conclusion that emerges from the above analysis is that there has been a considerable increase in the overall economic efficiency of resource utilisation in Indian railways during the period 1950-51 to 1977-78. A welcome feature of the improving efficiency of the railway system is the significant acceleration in the growth rate of economic efficiency observed during the period following 1970-71 as compared to the earlier period.

^{*5} Ibid.

It is interesting to note that, if the tempo of accelerated growth of efficiency continues and if the flow of factor inputs into the railway system starts growing again at the same rate as that attained during the sixties, the overall growth rate of net product from railways will be around seven percent per annum during the next decade. Such a high rate of growth implicit in the projection based on recent trends, if achieved, will ensure fulfilment of the targets for freight traffic and suburban and non-suburban passenger traffic set up in the Sixth Plan for the five year period ending 1982-83. Thus, if the trends in total factor productivity observed in recent past were to provide any indication regarding the future, the overall growth prospects of Indian railways appear to be very bright during the years to come.

Table 1

Trends in Output, Factor Inputs and Labour Share
in Indian Railways

Years	Net Domestic Product Originating in Railways at Constant 1970-71 prices (Rs. Crores)	Capital Stock in Railways at Constant 1970-71 prices (Rs. Crores)	Employment in Railways (in '000)	Share of Labour in Railways (In Percent)
1	2	3	4	5
1950-51	207	2636	923	64.29
1951-52	211	2751	932	59.01
1952-53	205	2835	931	66.44
1953-54	208	2926	965	73.61
1954-55	219	3078	990	70.32
1955-56	249	3318	1031	69.05
1956-57	278	3662	1063	66.67
1957-58	281	4098	1119	69.74
1958-59	268	4469	1155	70.73
1959-60	309	4718	1160	65.78
1960-61	345	4959	1163	63.89
1961-62	369	5271	1180	59.79
1962-63	393	5701	1217	58.79
1963-64	426	6203	1276	54.96
1964-65	430	6699	1324	63.61
1965-66	465	7115	1358	64.00
1966-67	473	7378	1370	65.73
1967-68	475	7594	1368	70.78
1968-69	516	7784	1359	65.23
1969-70	531	7916	1364	67.20
1970-71	522	8092	1379	69.16
1971-72	559	8305	1395	66.03
1972-73	557	8517	1455	70.23
1973-74	502	8679	1436	89.19
1974-75	562	8847	1449	85.78
1975-76	638	9017	1460	82.52
1976-77	699	9151	1490	68.39
1977-78	714	9356	1517	73.79

Table 2Trends in Labour Productivity and Capital Intensity

Years	Labour Productivity (In Rupees)	Capital- labour ratio (In Rupees)	Capital Output Ratio
1	2	3	4
1950-51	2243	28559	12.73
1951-52	2264	29517	13.04
1952-53	2202	30451	13.83
1953-54	2155	30321	14.07
1954-55	2212	31091	14.05
1955-56	2415	32182	13.33
1956-57	2615	34450	13.17
1957-58	2511	36622	14.58
1958-59	2320	38693	16.68
1959-60	2664	40672	15.27
1960-61	2966	42640	14.37
1961-62	3127	44669	14.28
1962-63	3229	46845	14.51
1963-64	3339	48613	14.56
1964-65	3248	50597	15.58
1965-66	3424	52393	15.30
1966-67	3453	53854	15.60
1967-68	3472	55512	15.99
1968-69	3797	57277	15.09
1969-70	3893	58035	14.91
1970-71	3785	58680	15.50
1971-72	4007	59534	14.86
1972-73	3936	60191	15.29
1973-74	3496	60439	17.29
1974-75	3879	61056	15.74
1975-76	4370	61760	14.13
1976-77	4691	61416	13.09
1977-78	4707	61674	13.10

Table 3

Indexes of Output, Total Factor Input and Total
Factor Productivity

Years	Index of Net Product	Index of Total Factor Input	Index of Total Factor Productivity
1	2	3	4
1950-51	100.00	100.00	100.00
1951-52	101.93	102.09	99.84
1952-53	99.03	103.06	96.09
1953-54	100.48	106.67	94.20
1954-55	105.80	110.38	95.85
1955-56	120.29	116.36	103.38
1956-57	134.30	122.71	109.45
1957-58	135.75	131.94	102.89
1958-59	129.47	138.90	93.21
1959-60	149.28	142.09	105.06
1960-61	166.67	145.07	114.89
1961-62	178.26	149.93	118.90
1962-63	189.86	157.66	120.42
1963-64	205.80	167.90	122.57
1964-65	207.73	177.22	117.22
1965-66	224.64	184.57	121.71
1966-67	228.50	187.91	121.60
1967-68	229.47	189.59	121.03
1968-69	249.28	190.38	130.94
1969-70	256.52	191.95	133.64
1970-71	252.17	194.85	129.42
1971-72	270.05	197.81	136.52
1972-73	269.08	201.18	133.75
1973-74	242.51	204.38	118.66
1974-75	271.50	206.76	131.31
1975-76	308.21	208.92	147.53
1976-77	337.68	212.93	158.59
1977-78	344.93	217.02	158.94

Table 4

Sources of Growth of Indian Railways

Sources	1950-51	1960-61	1970-71	1950-51
	to	to	to	to
	1960-61	1970-71	1977-78	1977-78
	(In Percentage Points)			
	<u>Absolute Contribution</u>			
Labour Input	1.62	1.14	1.05	1.34
Capital Input	2.21	1.88	0.52	1.60
Total Factor Input	3.83	3.02	1.57	2.94
Total Factor Productivity	1.41	1.21	3.01	1.75
Net Domestic Product	5.24	4.23	4.58	4.69
	<u>Relative Contribution (In percent)</u>			
Labour Input	30.92	26.95	22.93	28.57
Capital Input	42.17	44.44	11.35	34.12
Total Factor Input	73.09	71.39	34.28	62.69
Total Factor Productivity	26.91	28.61	65.72	37.31
Net Product	100.00	100.00	100.00	100.00