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CAPITAL-LABOR RATIOS, CAPITAL-OUTPUT RATIOS, AND RATES OF PROFIT IN INDIAN INDUSTRY

Preliminary Analysis of Published Data

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PREFACE

An increased rate of growth in agricultural production achieved through yield-increasing technological change has major implications to the potentials for growth in employment and optimal allocation of capital resources among industries. The Cornell University-USAID research project on the effect of rapid technological change in agriculture on employment and income distribution is concerned with these issues. Occasional papers No. 42 and No. 43 in this series deal with the theoretical issues, a model of growth and the broad policy issues of these changes This paper by Grace Horowitz provides data on capital-labor; capital-output and capital-profit ratios which will later be expanded and used for study of potentials for increasing both the short term and long term employment component of economic growth.

These papers are part of a series which includes papers from a previous AID research contract concerned with the role and function of agricultural prices in economic development. Many of those papers, particularly those concerned with intersectoral resource transfers, have relevance to the current research on employment and income distribution

Because economic planning models have in the past given so little integrated, explicit attention to employment, the data for employment and the capacity to relate this to capital requirements has received little attention and are generally poorly developed. As a result the effort required in pushing economic analysis in this direction is still substantial. It is planned to publish a series of papers on this subject

John W. Mellor

Ithaca, New York
February 15, 1971.

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1. Introduction

This paper is an attempt to fill certain lacunae in the data on Indian investment and further to point out those areas in which primary data collection could usefully take place.

The paper presents capital-labor ratios, capital-output ratios, and rates of profits, using four categories of capital; fixed capital, plant and machinery, fixed and working capital, and replacement value of capital. Fixed capital, working capital, plant and machinery, value added, and profits data from 1950-51 to 1963-64 for joint stock companies (corporations) with paid-up capital of Rs. 500,000 (about $67,000) or more are available in the Reserve Bank of India's series on "Finances of Indian Joint Stock Companies" (referred to as RBI). Fixed capital employment, and value added figures from 1946 to 1958 are given in the Census of Manufacturing Industries (referred to as CMI) for all factories in 28 industries employing twenty or more workers and using mechanical power; and subsequent to 1958 in the Annual Survey or Industry (referred to as ASI) for factories in all industries employing fifty or more workers and using mechanical power or a hundred or more workers and using hand power.

2. Replacement Value of Capital

Since there are no price indices for land and buildings valid for India as a whole, we have calculated replacement value for only the plant and machinery component of fixed capital. Replacement value of plant and machinery (P + M) in 1963-64 prices was obtained by deflating

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I am grateful to Dr. Roger A. Selley for assistance in computation.

annual gross investment[1] in $P + M = (P + M)_t - (P + M)_{t-1}$ by the price index for machinery and transport equipment (weights = 1952-53) and adding the deflated figures back onto the 1950-51 P + M, thus giving the value of P + M for each year in 1950-51 prices. It should be noted that although 1950-51 is the base year, the weights are from 1952-53. Replacement value of P + M in 1963-64 prices was obtained by multiplying P + M in 1950-51 prices by the price index number of 1963-64.

Replacement value of fixed capital in 1958 for the CMI was obtained in a similar manner by deflating annual fixed investment[2] by a price index obtained by joining the price index for manufactured goods for 1946 to 1951 (base 1939 = 100) to the price index for machinery and transport equipment (base 1952-53 = 100) for 1951 to 1958.

Both the RBI series for replacement value of plant and machinery and the CMI series of replacement value of fixed capital explained above obviously leave much to be desired. In order to obtain accurate figures for replacement value of fixed assets, one should know the age

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1/ Since the RBI series from 1950-51 to 1963-64 includes three series, 1950-5, 1955-60, and 1960-5 with varying percentages of coverages in terms of paid-up capital, it was necessary to divide the plant and machinery data for each industry by the percentage of book value of all joint stock companies of Rs. 500,000 or over in the industry covered in the sample (on the assumption that investment in plant and machinery bears the same relationship to paid-up capital for each firm) in order to blow up each sample to 100 percent, thus making the three series comparable.

2/ Since each year varying percentages of factories in each industry required to turn in questionnaires may do so, it was necessary to blow up investment data for each industry to 100 percent by dividing the figures by the percentage of factories reporting on the assumption that the percentage of factories reporting is equal to the percentage of capital for that industry.

and composition of fixed assets in each industry and then deflate by the price index for that asset. Unfortunately, there are no separate price indices for different assets. The closest price index available was machinery and transport equipment starting in 1950-51 and the price index for manufactured goods from 1939 to 1951. Since there was no information as to age of assets, we have had to assume that the RBI plant and machinery for 1950-51 and CMI fixed capital for 1946 were new those years and therefore purchased at those base year prices. This, of course, is not true. Much of the capital stock in Indian industry in the early post World War II before the Five Year Plan period dated from before the war. Since the Five Year Plans, however, there has been such rapid growth of industrial investment that the base year capital stock in the CMI and RBI series is a small percentage of the capital stock of the final year of each series used thus minimizing the error involved in the above procedure. We have used our figures on replacement value of capital to construct capital-labor ratios, capital-output ratios, and rates of profit shown in column 4 of Tables 1, 2, and 3 and columns 2 and 4 of Table 4. In light of the limitations in the primary data, these figures on replacement value of capital are a contribution to the literature. More useful for predictive purposes, however, even than figures on replacement value of capital actually reflecting age and composition of assets and based on deflation by separate price indices for each asset, would be estimates of <u>future</u> costs of capital per unit of employment, output, and expected profit. Such estimates which we do not have, would take into account changes in technology, omitted in our own estimates.

3. Capital-Labor Ratios (RBI)

The Reserve Bank of India (RBI) series provides detailed balance sheets and income statements, but gives no information on employment in the sample of firms covered in each industry. The best source for that employment data is the Annual Survey of Industry (ASI). Unfortunately, not only do the RBI and ASI cover different samples of units[3/] but they each use different industrial classifications. Where the corresponding ASI classification was uncertain, it was necessary to eliminate that RBI industry. In order to obtain employment in the RBI samples, we must assume that the average wage or salary (including fringe benefits) (=W) is the same as wage or salary for the firms in the same industry included in the ASI. Let L = average daily employment, and total wages = TW.

Then $W = \frac{TW}{L}$

Since by assumption $W_{RBI} = W_{CMI}$,

$$\frac{TW_{RBI}}{L_{RBI}} = \frac{TW_{CMI}}{L_{CMI}} \quad \text{for corresponding industries}$$

then $$TW_{RBI} \frac{TW_{CMI}}{L_{CMI}} = TW_{RBI} \frac{TW_{RBI}}{L_{RBI}} = L_{RBI},$$

thus giving us employment data for RBI industries. This procedure, despite its obvious shortcomings is preferable to simply assuming that the RBI capital for each industry was equal to the ASI labor force for

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3/ The ASI covers all factories employing fifty or more workers and using mechanical power or 100 or more using hand power. The RBI series covers a sample of joint stock companies (corporations) whose paid-up capital is about 80 percent of the total for companies whose paid-up capital is Rs. 500,000 (about $67,000) or more.

Table 1. Capital-Labor Ratios, India, 1963-4

Industry	Fixed Capital per Employee	Plant and Machinery per Employee	Fixed and Working Capital of per Employee	Replacement Value Plant & Machinery per Employee in 1963-4 Prices
1. Matches	Rs. 5349	Rs. 2773	Rs. 12352	Rs. 3640
2. Tobacco	6223	3104	24626	3995
3. Pottery, china, earthenware & structural clay products	5990	3730	10393	4732
4. Electrical machinery, apparatus, appliances, etc.	7188	4469	20341	5253
5. Woolen textiles	6634	4552	15524	---
6. Jute Textiles	6003	4352	11126	5630
7. Medicines and pharmaceutical preparations	11753	6172	26536	7297
8. Cotton textiles	7840	6171	13501	7766
9. Grains and pulses	12319	6233	25140	8499
10. Edible vegetable & Hydrogenated oils	12626	8017	30671	10884
11. Sugar	14722	9589	27437	12431
12. Non-ferrous metals	17563	12310	45990	14848
13. Rubber and rubber manufactures	18834	13189	43539	15782
14. Aluminum	25697	19046	39338	22246
15. Cement	27036	18186	41664	22772
16. Paper and paper products	24953	19929	35761	23671
17. Silk and rayon textiles	26287	21169	41414	---
18. Basic industrial chemicals	35416	25455	55018	29238
19. Iron and steel	31065	26143	42020	32831
20. Electricity generation & supply	50686	29316	61445	37423

Sources: Capital -- Reserve Bank of India, Bulletin, Vol. 21^2, pp. 1589-1604, Vol. 16^2, pp. 1163-1176, Vol. 11^2, pp. 883-897.

Labor -- India, Central Statistical Organization, Annual Survey of Industries, 1964, Vol. 1.

For details and method of calculation see text, Sections 2 and 3.

Table 2. Capital-Output Ratios, India, 1963-64

Industries	Fixed Capital	Plant & Machinery	Fixed & Working Capital	Replacement Value of Plant & Machinery
	Value-Added	Value-Added	Value-Added	Value-Added
1. Matches	.4	.2	.9	.3
2. Tobacco	.2	.1	.9	.2
3. Pottery, china, earthenware & structural clay products	3.0	1.9	5.2	2.4
4. Electrical machinery, apparatus, appliances, etc.	1.6	1.0	4.4	1.1
5. Woolen textiles	1.6	1.1	3.8	---
6. Jute textiles	2.6	1.9	4.8	2.4
7. Medicines & pharmaceutical preparations	1.9	1.0	4.3	1.2
8. Cotton textiles	2.0	.6	3.5	2.0
9. Grains and pulses	4.3	2.2	8.8	2.9
10. Edible vegetable & hydrogenated oils	1.1	.7	2.6	.9
11. Sugar	1.9	1.2	3.5	1.6
12. Non-ferrous metals	3.6	2.5	9.5	3.1
13. Rubber & rubber manufactures	1.0	.7	2.2	.8
14. Aluminum	5.3	2.9	8.1	4.6
15. Cement	2.9	2.0	4.5	2.5
16. Paper and paper products	3.8	3.1	5.5	3.6
17. Silk and rayon textiles	.4	.3	.6	---
18. Basic industrial chemicals	6.1	4.4	9.5	5.0
19. Iron and steel	4.6	3.8	6.2	4.8
20. Electricity generation & supply	17.9	10.3	22.0	13.2

Sources: Capital -- Reserve Bank of India, Bulletin, Vol. 21[2], pp. 1589-1604, Vol. 16[2], pp. 1163-1167, Vol. 11[2], pp. 883-897.
Output -- Reserve Bank of India, Bulletin, Vol. 21[2], pp. 1566-1581.

For details and method of calculation see text.

Table 3. Ratio of Gross Profit to Capital, India, 1963-4

	Industries	Gross Profit / Fixed Capital	Gross Profit / Plant & Machinery	Gross Profit / Fixed & Working Capital	Gross Profit / Replacement Value of Plant & Machinery
1.	Matches	.27	.53	.12	.40
2.	Tobacco	.39	.78	.10	.61
3.	Pottery, china, earthenware & structural clay products	.13	.21	.08	.17
4.	Electrical machinery, apparatus, appliances, etc.	.38	.62	.14	.53
5.	Woolen textiles	.32	.46	.13	---
6.	Jute textiles	.15	.20	.08	.16
7.	Medicines & pharmaceutical preparations	.30	.58	.14	.49
8.	Cotton textiles	.11	.14	.06	.11
9.	Grains and pulses	.18	.36	.09	.27
10.	Edible vegetable and hydrogenated oils	.13	.21	.05	.15
11.	Sugar	.15	.23	.08	.18
12.	Non-ferrous metals	.33	.47	.12	.39
13.	Rubber & rubber manufactures	.19	.27	.08	.23
14.	Aluminum	.18	.24	.12	.21
15	Cement	.11	.17	.07	.13
16.	Paper and paper products	.09	.11	.06	.09
17.	Silk and rayon textiles	.12	.15	.08	---
18.	Basic industrial chemicals	.13	.19	.09	.16
19.	Iron and steel	.11	.13	.08	.11
20.	Electricity generation & supply	.09	.16	.08	.13

Sources: Profits -- Reserve Bank of India, Bulletin, Vol. 21^2, pp. 1566-1581.

Capital -- Reserve Bank of India, Bulletin, Vol. 21^2, pp. 1589-1604, Vol. 16^2, pp. 1163-1176, Vol. 11^2, pp. 883-897.

For details and method of calculation see text.

Table 4. Capital-Labor Ratios and Capital-Output Ratios in India, 1958.

	Industries	Fixed Capital per Employee (in rupees)	Replacement Value of Fixed Capital per Employee (in rupees)	Fixed Capital / Value Added	Replacement Value of Fixed Capital / Value Added (in 1958 prices)
1.	Matches	2202	2719	.6	.8
2.	Rice milling	2366	2839	2.6	3.7
3.	Tanning	2046	3174	1.2	1.9
4.	Glass & glassware	2239	3220	1.7	2.5
5.	Jute textiles	2480	3394	1.4	1.9
6.	Cotton textiles	2878	3630	1.4	1.8
7.	Ceramincs	3449	4018	1.6	1.8
8.	Gen. & elec. engineering	3832	4732	1.3	1.5
9.	Woolen textiles	3400	5195	1.1	1.7
10.	Electric fans	3286	5555	1.1	1.9
11.	Sewing machines	4888	5635	.9	1.0
12.	Paints and varnishes	4603	6123	.6	.8
13.	Plywood and teachests	4802	6209	1.9	2.4
14.	Fruit and vegetable	4091	6318	1.8	2.7
15.	Bicycles	6066	6393	1.4	1.5
16.	Sugar	5220	6514	1.8	2.1
17.	Electric lamps	5636	7576	1.8	2.4
18.	Biscuit making	6797	8750	1.6	2.1
19.	Wheat flour	6933	8932	1.6	2.0
20.	Aluminum, copper & brass	6521	9039	1.3	1.8
21.	Vegetable oils	7127	10111	2.7	3.9
22.	Paper & paperboard	12144	12397	2.8	2.8
23.	Starch	11500	13385	2.5	2.9
24.	Distilleries & brewies	8127	14873	2.1	3.9
25.	Chemicals	13615	15625	2.2	2.5
26.	Soap	10137	16301	.8	1.3
27.	Iron & steel	18846	21540	3.6	4.1
28.	Cement	21594	24528	5.1	5.8

Source: Census of Manufacturing Industries, 1946-1958.
For details and method of calculation see text.

4. Capital-Output Ratios (RBI)

Table 2. uses the same four types of capital as Table 1. with output defined as value added, or the sum of sal. ·s, wages, and fringe benefits; excise duty and cess; and half of a category called "other" which includes an unknown percentage of employee expenses; and gross profits.[4/]

5. Rates of Profit (RBI)

Table 3. uses the same four types of capital as Tables 1. and 2. Gross profits is defined as profits before income taxes, and includes interest and managing agents commission. It was felt that gross profits as defined above were the best indicator of return to investment.

6. Capital - Labor and Capital - Output Ratios (CMI)

In Table 4. capital-labor and capital-output ratios are constructed using data from the Census of Manufacturing Industries (CMI) which includes a larger number of industries than the RBI. Fixed capital, employees, value-added, and replacement value are defined as in Tables 1., 2. and 3. Since gross fixed assets are not given in the CMI, an approximation can be figured by adding to net fixed capital the depreciation allowances for previous years.[5/] Thus, gross fixed capital for 1958 is equal

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[4/] Since the percentage of "other" which includes employee expenses, is not given, rather than include all or none of this category, I have felt that it would be more accurate to include half of the category "other" in value added.

[5/] Depreciation figures have been blown up in a manner similar to investment figures. See footnote 2.

to net fixed capital for 1958 plus the total depreciation allowances for the years 1946, the year of the first CMI, to 1958. We are merely adding depreciation back into net fixed assets in order to get gross fixed assets.

According to the procedure just outlined, the fixed capital stock for 1958 is therefore equal to net fixed assets for 1946 plus gross investment for the years 1947-58. Of course, we have only net fixed assets for 1946. As explained in Section 2, however, investment in CMI industries in the years following 1946 was so heavy as to reduce any 1946 net fixed assets retained to a small percentage of the 1958 fixed capital, thereby minimizing any error involved in using this procedure. We are in effect assuming that all increments to fixed capital stock since 1946 were still in place by 1958 and kept in adequate repair, an assumption which is probably correct for India.

It would be desirable to have a figure for capital stock for a year later than 1958 but unfortunately it was not possible to construct a continuous series for the years covered by the CMI (1946-58) and the ASI after 1958 because different industrial classifications are used in the CMI and ASI, and because of the change in lower size limit of factories covered (see Section 1). Fixed capital stock for 1964 (the latest ASI available to the author) would thus consist of net fixed capital for 1960, the year of the first reliable ASI plus gross value of investment for 1961-64. Thus the 1960 net figure would represent a fairly high percentage of fixed capital for 1964. In the absence of publication of data on gross fixed assets or, preferably, reliable depreciation data, it will not be possible to use data on fixed capital in the ASI before the ASI for about 1970.

Table 5. Linear Correlations Among Various Measures of Capital/Labor, Capital/Output and Gross Profit/Capital in India, 1963-64

Ratio	Measure of Capital: Fixed Capital (1)	Plant and Machinery (2)	Fixed and Working Capital (3)	Replacement Value of Plant & Machinery (4)
			Correlation Matrix	
Capital/Labor				
(1)	1.000	.9702	.9081	.9752
(2)		1.0000	.8823	.9971
(3)			1.0000	.8774
(4)				1.0000
Capital/Output				
(1)	1.0000	.9824	.9689	.9904
(2)		1.0000	.9515	.9929
(3)			1.0000	.9542
(4)				1.0000
Gross Profit/ Capital				
(1)	1.0000	.9669	.7946	.9782
(2)		1.0000	.7475	.9955
(3)			1.0000	.7869
(4)				1.0000

Sources: Calculation of Pearson product-moment correlation based on data in Tables 1, 2 and 3 omitting woolen textiles and silk and rayon textiles.

7. Conclusions

There were high correlations between any pair of the four types of RBI capital-labor ratios in Table 1 with correlation coefficients ranging from .8220 to .9971 (Table 5). The correlation coefficients for any pair of the four types of RBI capital-output ratios in Table 2 range from .9203 to .9929; while the coefficients for any pair of the four types of RBI rates of profit in Table 3 range from .7010 to .9955. All of the above correlation coefficients were regarded as highly significant.

For the data given in Tables 1, 2, 3 and 4 we have included no information on capacity. If there were less than full capacity utilization, then the capital-output ratios and probably the capital-labor ratios given are too low. Furthermore it is not possible to compare employment and output generated by a given amount of capital invested in different industries or even in the same industry if capacity utilization varies from industry to industry and from year to year. Unfortunately it is difficult to obtain data on capacity utilization for similarly defined industries and for a comparable sample of firms in each industry. Furthermore, when output declines by the same amount different firms will lay off different numbers of workers, frequently depending upon the strength of unionization in the industry. Thus the effect of less than full capacity utilization on the capital-labor ratio is uncertain. We do know, however, that capacity utilization varies widely from industry to industry and from year to year.

It would have been most useful to have included data on a fifth concept of capital, total capital, including all capital, direct and indirect, needed in supplying industries to produce the output of a given

industry. Unfortunately, however, all the available input-output tables for India use only depreciated book value of capital as the capital input, since that is the only data on capital provided by the CMI and ASI which contains the other data needed by the input-output table.

We believe that the data presented will be useful to students of Indian economic development. We should note, however, that certain important lacunae in the data still remain. Easiest to remedy would be the inclusion of original book value of capital in the ASI and inclusion of employment data in the RBI. Availability of these data would eliminate the difficulties and inaccuracies involved in taking capital from one source and labor from the other. It would be useful if the RBI, ASI, and the Monthly Statistics of Production which contains data on capacity and output, would use the same industrial classification, or, at least, provide a conversion guide. In order to obtain accurate data on net assets, it is essential that accurate depreciation data for each asset be gathered. In order to obtain accurate data on replacement value of capital for each industry, we must know the weight of each asset in the stock of capital for that industry. Then we must have an accurate price index for each asset in order to deflate annual investment. For predictive purposes, however, far better than replacement value of capital for use with present employment, output, and profits data, would be estimates of future investment needs, employment, and profits for given increases in output for each industry.

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