INTER-INDUSTRY RESOURCE ALLOCATION AND TECHNOLOGICAL CHANGE: THE SITUATION IN INDIAN MANUFACTURING

IL SAKONG

GORTI V. L. NARASIMHAM

I

INCREASES IN total factor productivity (or technological change) estimated by using aggregate production function approaches may reflect the improvement of efficiency within industries or a better allocation of resources among industries. Recently, various studies for more developed countries, for example, Massell for the United States and Denison for some European countries, reported that inter-industry resource shifts were important sources of productivity growth [5] [2].

The growth potential from this source in most less developed countries must also be substantial. Conversely, if resources were allocated among industries inefficiently, the loss in a nation's output would be substantial.

Recently, Williamson and Sicat analyzed the magnitude and nature of total factor productivity changes and resource allocation in the Philippine manufacturing sector for the period 1957–65 [8]. One of their findings indicated that the observed rate of the total factor productivity for the Philippine manufacturing sector as a whole was reduced due to negative inter-industry technological changes.[1] In other words, the Philippine economy somehow misallocated resources among various manufacutring subsectors and it caused a reduced rate of technological change for the manufacturing sector as a whole.

In the present study, we examine Indian manufacturing sector using the same methodology adopted by Williamson-Sicat to analyze the magnitude and nature of technological change in Indian industries over the period 1949–58. In doing so, we expect to find out whether or not resources were allocated efficiently for the Indian economy.

The present paper consists of five sections. In the following section, we briefly summarize findings of Williamson-Sicat study. We describe the industrial policy of India and the data used in the present study in the third section. In the fourth

The authors would like to thank Messrs. C. H. Chung and J. B. Sastry for their excellent research assistance.

[1] Intra-industry technical change is defined as productivity improvement within specific industries, while inter-industry technological change is explained as productivity increase resulting from industry to industry interaction. The latter originates from the reallocation of resources among industries.

section, some empirical results are provided. Finally, in the last section, some preliminary conclusions are made.

II

Williamson and Sicat divided the Philippine manufacturing sector into six groups within each of which there was a considerable homogeneity in experiences with respect to factor prices. They then applied Johansen model [3] to these industrial groups and found a positive growth rate of total factor productivity for the manufacturing sector as a whole. After finding this, they utilized Massell's model [5] by which total factor productivities for various manufacturing sectors were disaggregated into their component parts. They summarize their findings from this analysis as follows:

> Intra-industry technical change exceeds by far the total rate of technical change for industry as a whole. . . . Thus there was a very large loss associated with shifts of capital and labor among alternative industry uses over this period. Capital and labor were shifting to less productive employment. [8, p. 42]

They attribute this to "erroneous" economic policies which distort the market, especially the factor market in the Philippines.[2]

III

We use data for the period 1949–58 in analyzing the magnitude and nature of productivity changes in relation to resource allocation in Indian industries. The period was chosen considering the availability of consistent data for Indian industries.[3] Data collected for the period cover all factories which were registered under the Factories Act of 1948. The act was applicable to the industrial units with power employing ten or more workers on one day and to those industrial units without power employing twenty or more workers on one day. Twenty-eight industries were covered in collecting the data.

India after having gained independence in 1947 adopted a new industrial policy by two resolutions, one in 1948 and the other in 1956. The Industrial Policy Resolution of 1948 emphasized clearly the responsibility of the Indian government in the areas of promoting, assisting, and regulating industries for the national interest. Since the adoption of the resolution of 1948, the goals and direction of development had been clearly appreciated and planning had been proceeded on an organized basis. It was felt to strengthen and accelerate this trend in the following years. The 1956 resolution was adopted in the light of these considerations.

[2] Williamson and Sicat did not suggest that resources within industries are utilized inefficiently even if they are misallocated. However, we are inclined to think otherwise. When resources are misallocated among industries, they are going to be utilized inefficiently. In other words, if a sector is more protected or treated more favorably causing misallocation of resources, intra-industry technological change for these sectors would be lower than otherwise. Consequently, misallocation of resources would not only cause negative inter-industry technological change, but cause lower intra-industry technological change.

[3] Data for this period were collected by a census while a sample survey has been used for gathering data since 1958.

The Second Five-Year Plan which was also initiated in 1956 put a high priority in industrialization, especially in developing basic and heavy industries. A large expansion of public enterprise in the sphere of industrial and mineral development was envisaged to strengthen the programs of development of these industries. At the same time, various import and exchange controls were imposed in implementing the plan.

Our primary objective of the present study is to examine whether or not resources were allocated efficiently among industries during the period under consideration. In the following section, we report our empirical findings.

IV

Johansen model [3] was applied to the Indian data for two periods 1949–55 and 1955–58. The breaking of periods is based on the fact that 1955 was the year when a major technological change was found in an earlier study [6]. The year 1956 was the beginning of the Second Five-Year Plan when major shifts in government policy took place. Johansen model, which relates the rate of growth of labor productivity over a period to the property income share in value-added, yields an estimate of the rate of technological change and a measure of the movements of labor cost relative to capital cost. Thus, the model permits an indirect estimate of relative factor price movements which can be compared with observed changes in factor combinations in Indian industries.[4]

The regression equation estimated is the following:

$$\log\left(\frac{a_i t_1}{a_i t_o}\right) = \alpha_i (\log w) + \log\left(\frac{A_i t_1}{A_i t_o}\right),$$

where $a_i t_1$ and $a_i t_o$ are labor productivities for industry i in two periods t_1 and t_o respectively; and $A_i t_1$ and $A_i t_o$ are the indices of total factor productivities for industry i in periods t_1 and t_o respectively. The elasticity of output with respect to capital for industry i is denoted by α_i, and w is defined as the change in cost of labor relative to cost of capital. If $w_i < 1$, relative wages decreased and vice versa. The above model was estimated for India for twenty-eight industries which were divided into four broad groups. Grouping of industries was based largely on homogeneity of industries with respect to their efficiencies based on an earlier study by one of the authors. Grouping was done also to satisfy the Johansen assumption that relative increases in wages is broadly the same within these groups. The grouping is described in Table I.

Table II presents the estimates of parameters of the function, while weighted averages of rates of technological changes are provided in Table III. The decomposition of total technological change into intra- and inter-industry change was done by using Massell method [4] [5].

From the preceding tables, it seems that technological change of the industry as a whole during 1949–55 was higher than the following period 1955–58.[5] It can also be seen that the intra-industry technological change based on both 1949 and

[4] Johansen model requires somewhat restrictive assumptions. See [3] for the details.

[5] The coefficient of determination is rather low and statistical tests were not significant enough to warrant a firm conclusion.

TABLE I

INDUSTRY GROUPS AND DESCRIPTIONS FOR INDIAN MANUFACTURES

Industry Group	Industry Description
Group I	1. Wheat flour
(N = 8)	2. Rice milling
(Food and related industries)	3. Biscuit making
	4. Fruit and vegetable processing
	5. Sugar
	6. Distilleries and breweries
	7. Starch
	8. Vegetable oils
Group II	9. Paints and varnishes
(N = 6)	10. Soap
(Chemicals)	11. Tanning
	16. Paper and paperboard
	17. Matches
	21. Chemicals
Group III	22. Aluminum, copper, and brass
(N = 7)	23. Iron and steel
(Metals and engineering)	24. Bicycles
	25. Sewing machines
	26. Electric lamps
	27. Electric fans
	28. General engineering
Group IV	12. Cement
(N = 7)	13. Glass and glassware
(Textiles, ceramics, glass, and wood)	14. Ceramics
	15. Plywood and tea chests
	18. Cotton textiles
	19. Woolen textiles
	20. Jute textiles

TABLE II

EMPIRICAL RESULTS FOR JOHANSEN MODEL

Period: 1949–55

Industry Group	No.	$\log\left(\frac{A_{1955}}{A_{1949}}\right)$	$\log w$	$\frac{A_{1955}}{A_{1949}}$	w	R^2
Group I	8	−0.2503	0.9028	0.779	2.466	0.230
Group II	6	0.0865	0.0969	1.090	1.102	0.010
Group III	7	0.5125	−0.0858	1.669	0.918	0.002
Group IV	7	0.2027	0.2972	1.225	1.346	0.100
All	28	0.1948	0.2622	1.215	1.300	0.053

TABLE II (Continued)
Period: 1955–58

Industry Group	No.	$\log\left(\frac{A_{1958}}{A_{1955}}\right)$	$\log w$	$\frac{A_{1958}}{A_{1955}}$	w	R^2
Group I	8	0.0020	0.3605	1.002	1.434	0.036
Group II	6	−0.3136	0.1461	0.731	1.159	0.023
Group III	7	−1.4666	2.0538	0.231	7.797	0.923
Group IV	7	0.5648	−0.6241	1.759	0.536	0.097
All	28	−0.2999	0.5875	0.741	1.800	0.113

TABLE III
INTRA-INDUSTRY TECHNICAL CHANGES IN INDIAN MANUFACTURING
Period: 1949–55

	Rate of Technical Change (A_{i55}/A_{i49})	Q_{i49}/Q_{49}	Q_{i55}/Q_{55}	Intra-Industry Technical Change $\left(\frac{A_{i55}}{A_{i49}}\right)\left(\frac{Q_{i49}}{Q_{49}}\right)$	$\left(\frac{A_{i55}}{A_{i49}}\right)\left(\frac{Q_{i55}}{Q_{55}}\right)$
Group I	0.779	0.1139	0.1160	0.0887	0.0904
Group II	1.090	0.0848	0.1089	0.0924	0.1187
Group III	1.669	0.1974	0.2434	0.3295	0.4062
Group IV	1.225	0.6038	0.5317	0.7396	0.6513
All	1.215	1.0000	1.0000	1.2502	1.2666

Period: 1955–58

	Rate of Technical Change (A_{i58}/A_{i55})	Q_{i55}/Q_{55}	Q_{i58}/Q_{58}	Intra-Industry Technical Change $\left(\frac{A_{i58}}{A_{i55}}\right)\left(\frac{Q_{i55}}{Q_{55}}\right)$	$\left(\frac{A_{i58}}{A_{i55}}\right)\left(\frac{Q_{i58}}{Q_{58}}\right)$
Group I	1.002	0.1160	0.0918	0.1162	0.0920
Group II	0.731	0.1089	0.3013	0.0796	0.2202
Group III	0.231	0.2434	0.1788	0.0562	0.0413
Group IV	1.759	0.5317	0.4281	0.9353	0.7530
All	0.741	1.0000	1.0000	1.1873	1.1065

1955 output weights was about the same as total technological change for the period 1949–55 indicating that resources (capital and labor) might not have been as much misallocated as to reduce the total technical change very much. On the other hand, for the period 1955–58 intra-industry technological change was found to be much higher than total change suggesting there was some misallocation of resources among industries. These phenomena may be attributed to a deliberate government industrial policy during the second plan emphasizing heavy industries which fall under Group III compared to the period 1949–58 when it was relatively high.[6] What this might suggest is that resources are not only misallocated in these sectors

[6] It should be pointed out that, the technological changes defined here may be affected by economies of scale and changes in the quality of inputs. Those factors are not taken into consideration here.

TABLE IV

CAPITAL-LABOR RATIO IN INDIAN MANUFACTURING 1949–55 AND 1955–58

(In thousand rupees)

Industry Group	(K/L) 1949	(K/L) 1955	(K/L) 1958	$\frac{(K/L)\ 1955}{(K/L)\ 1949}$	$\frac{(K/L)\ 1958}{(K/L)\ 1955}$
Group I	4.064	6.189	6.995	1.523	1.130
Group II	5.280	9.979	4.858	1.890	0.847
Group III	4.025	6.453	10.668	1.603	1.653
Group IV	2.380	3.471	5.162	1.458	1.487
All	3.024	4.807	6.496	1.590	1.351

TABLE

TECHNOLOGICAL CHANGE IN INDIAN MANUFACT

Industry	$\dot{K}_i/K$	
	1949–55	1955–56
1. Wheat flour	0.0830	0.1096
2. Rice milling	0.1107	0.0049
3. Biscuit making	0.1094	0.0189
4. Fruit and vegetable processing	0.0445	0.0787
5. Sugar	0.1770	0.0822
6. Distilleries and breweries	0.0504	0.5711
7. Starch	0.2351	0.4388
8. Vegetable oils	−0.0346	0.0009
9. Paints and varnishes	0.0303	1.0133
10. Soap	0.0209	−0.2520
11. Tanning	0.0757	0.4335
12. Cement	0.2713	−0.1950
13. Glass and glassware	0.1154	2.5724
14. Ceramics	0.1706	−0.0035
15. Plywood and tea chests	0.1446	0.1460
16. Paper and paperboard	0.1925	0.3170
17. Matches	0.0742	0.0378
18. Cotton textiles	0.0666	0.0916
19. Woolen textiles	0.1498	0.2043
20. Jute textiles	0.0117	0.2349
21. Chemicals	0.4412	0.1095
22. Aluminum, copper, and brass	0.0909	0.3496
23. Iron and steel	0.1391	4.5554
24. Bicycles	0.5798	−0.1928
25. Sewing machines	0.1897	0.9126
26. Electric lamps	0.1579	0.2009
27. Electric fans	0.0277	0.1651
28. General engineering	0.1290	0.1542
All	0.0755	0.1288

but utilized inefficiently within these sectors during later periods. Considering w which measures per unit labor cost relative to capital, it is found that between the periods 1949–55 and 1955–58 labor costs appear to have risen relative to capital costs for all industries.[7] Under these conditions it can be expected that capital would have been substituted more and more for labor. A comparison with the actual figures on capital/labor ratios for the two periods revealed that capital intensity has actually increased over those periods (see Table IV).

To check the results obtained from the Johansen model, we utilized the Denison-Solow model [1] [7] and found that overall results were consistent wiht the results obtained earlier. Table V presents average annual rates of technological change for each of twenty-eight industries for the two periods 1949–55 and 1955–58. The

V

URING 1949–58 USING DENISON-SOLOW MODEL

Per Annum Rate of Change					
$\dot{L}_i/L$		$\dot{V}_i/V$		$\dot{A}_i/A$	
1949–55	1955–58	1949–55	1955–58	1949–55	1955–58
0.0350	0.0180	0.1136	0.1276	0.0177	0.005
0.0233	0.0321	0.2498	−0.1101	0.1242	−0.110
0.0085	−0.0001	0.0225	0.1740	−0.0087	0.169
0.1132	0.0505	0.1084	0.0009	0.0178	−0.235
0.0115	−0.1493	0.1072	−0.0089	−0.0756	−0.099
−0.0206	0.5686	0.0882	0.3333	0.0637	−0.2369
−0.0258	0.6732	0.6396	0.5781	0.4950	0.0380
−0.0339	−0.0423	−0.0400	0.0150	−0.0053	0.0093
0.0260	0.4760	0.0123	0.7674	−0.0164	−0.0470
−0.0095	−0.2398	0.0573	−0.2932	0.0421	−0.0395
0.0137	−0.0768	−0.0172	1.5985	−0.1202	1.0090
0.0327	−0.2102	0.2921	−0.2753	0.0661	−0.0074
0.0306	0.3217	0.1060	1.5280	0.0264	−0.1671
0.0154	−0.0675	0.0762	−0.0389	−0.0374	−0.0119
0.1452	0.1968	0.1890	0.2818	−0.0001	0.0776
0.0450	0.1712	0.2250	0.2131	0.0762	−0.0605
0.0474	−0.2387	0.0121	0.4204	−0.0452	0.5573
0.0087	−0.1293	0.0486	−0.0325	−0.0162	−0.1181
0.0124	0.1364	0.0036	0.5867	−0.0495	0.4303
−0.0227	0.2960	0.0219	−0.2232	0.0319	−0.5011
0.1018	1.5202	0.2622	0.7169	−0.0132	−0.0816
−0.0541	0.3015	0.1854	0.4582	0.1308	−0.3976
0.0224	0.0227	0.1070	−0.2593	0.0689	−1.3929
0.3460	−0.1390	0.5827	−0.1887	−0.2231	0.0973
0.1605	0.3033	0.3127	0.5682	0.1252	−0.2984
0.7996	0.3752	0.1019	0.8300	−0.0330	0.5777
0.0171	0.1585	0.6931	0.2100	0.0426	0.0458
0.0316	0.0730	0.1235	1.4266	0.0302	1.2599
0.0078	0.0869	0.0981	0.1423	0.7159	0.4605

[7] The analysis of covariance run for each group of industries has revealed that there was significant differences in relative factor prices between the two periods 1949–55 and 1955–58 for Groups I, II, and III, but not for Group IV.

overall change for 1949–55 was 0.7159 compared to 0.4605 for 1955–58, suggesting again the rate of change in the first period was higher than in the second.

Using the Denison-Solow model for two periods 1949–55 and 1955–58, it is further possible to estimate relative contributions of capital and labor shifts to inter-industry technical change. Table VI presents the estimates of inter-industry technical changes in the two periods 1949–55 and 1955–58. Since the capital used here were not adjusted for different utilization rates, the estimates on technical changes may not be very reliable. Nevertheless, the estimates obtained here broadly agree with the findings obtained earlier with the Johansen model.

It seems from the total inter-industry technical changes in the Table VI that capital was allocated even worse relative to labor during those two periods.[8] In

TABLE

INTER-INDUSTRY TECHNICAL CHANGE IN INDIAN

Industry	ΔK_i Industry Share of Total Capital			ΔL_i Industry Share of Total Labor		
	1949	1955	1958	1949	1955	1958
1. Wheat flour	0.0068	0.0064	0.0063	0.0034	0.0040	0.0041
2. Rice milling	0.0213	0.0226	0.0165	0.0313	0.0345	0.0369
3. Biscuit making	0.0042	0.0044	0.0033	0.0030	0.0030	0.0029
4. Fruit and vegetable processing	0.0018	0.0014	0.0013	0.0005	0.0009	0.0010
5. Sugar	0.0795	0.1062	0.0096	0.0667	0.0684	0.0037
6. Distilleries and breweries	0.0057	0.0046	0.0907	0.0033	0.0027	0.0702
7. Starch	0.0013	0.0020	0.0034	0.0012	0.0009	0.0028
8. Vegetable oils	0.0776	0.0351	0.0254	0.0382	0.0276	0.0235
9. Paints and varnishes	0.0078	0.0056	0.0164	0.0030	0.0033	0.0078
10. Soap	0.0149	0.0102	0.0018	0.0038	0.0034	0.0009
11. Tanning	0.0057	0.0052	0.0087	0.0055	0.0057	0.0043
12. Cement	0.0234	0.0404	0.0121	0.0098	0.0114	0.0041
13. Glass and glassware	0.0078	0.0084	0.0530	0.0128	0.0147	0.0282
14. Ceramics	0.0062	0.0082	0.0058	0.0108	0.0114	0.0088
15. Plywood and tea chests	0.0028	0.0034	0.0035	0.0021	0.0040	0.0061
16. Paper and paperboard	0.0195	0.0273	0.0384	0.0122	0.0152	0.0224
17. Matches	0.0052	0.0047	0.0004	0.0082	0.0103	0.0028
18. Cotton textiles	0.3323	0.2906	0.2672	0.4144	0.4169	0.3905
19. Woolen textiles	0.0103	0.0126	0.0146	0.0099	0.0086	0.0117
20. Jute textiles	0.1297	0.0837	0.0010	0.1914	0.1526	0.0003
21. Chemicals	0.0359	0.0876	0.0839	0.0184	0.0298	0.1618
22. Alminum, copper, and brass	0.0247	0.0241	0.0616	0.0147	0.0134	0.0248
23. Iron and steel	0.0774	0.0912	0.1557	0.0458	0.0502	0.0523
24. Bicycles	0.0023	0.0069	0.0021	0.0014	0.0046	0.0026
25. Sewing machines	0.0017	0.0024	0.0066	0.0011	0.0023	0.0043
26. Electric lamps	0.0019	0.0024	0.0028	0.0009	0.0013	0.0028
27. Electric fans	0.0052	0.0037	0.0040	0.0034	0.0028	0.0041
28. General engineering	0.0868	0.0985	0.1039	0.0830	0.0961	0.1142

[8] Similar conclusions were drawn by Williamson and Sicat for the Philippines.

1949–55, inter-industry technical change was found to be −0.0125 with the components, −0.0141 due to *K*-shifts and 0.0016 due to *L*-shifts. In 1955–58, inter-industry technical change was −0.0608 with the components −0.0762 and 0.0154 due to *K*-shifts and *L*-shifts respectively.

V

Throughout this study we have used the aggregate production function approach to suggest that "technological change" is affected by the allocation of resources. The results reported here are along the same line with the findings made by Williamson and Sicat for the Philippines.

VI
MANUFACTURES 1949–55 AND 1955–58

Percentage Industry Share in Total				Effect due to Shifts (1949 Weights)		Effects due to Shifts (1949 Weights)	
1949–55		1955–58					
Capital	Labor	Capital	Labor	In Capital 1949–55	In Labor 1949–55	In Capital 1955–58	In Labor 1955–58
−0.0570	0.1805	−0.0360	0.0272	−0.0004	−0.0002	−0.0003	−0.0001
0.0587	0.1031	−0.2680	0.0686	0.0006	−0.0002	−0.0050	−0.0002
0.0532	0.0050	−0.2377	−0.0269	0.0001	0.0001	−0.0002	−0.0001
−0.2176	0.6972	−0.1084	0.1522	−0.0001	0.0004	−0.0001	0.0001
0.3356	0.0250	−0.9101	−0.9462	0.0213	−0.0001	−0.0660	0.0023
−0.1931	−0.1888	18.5687	25.3791	−0.0005	−0.0001	−0.0048	0.0376
0.5772	−0.2233	0.6713	1.9436	0.0002	−0.0001	0.0007	0.0016
−0.5480	−0.2773	−0.2768	−0.1491	−0.0176	0.0009	−0.0042	0.0002
−0.2768	0.1212	1.9137	1.3665	−0.0018	0.0005	0.0089	0.0037
−0.3162	−0.1149	−0.8239	−0.7266	−0.0044	0.0002	−0.0112	0.0012
−0.0875	0.0394	0.6593	−0.2500	−0.0006	−0.0001	0.0027	0.0002
0.7293	0.1654	−0.7008	−0.6399	0.0079	0.0004	−0.0151	−0.0032
0.0785	0.1513	5.2872	0.9150	0.0003	0.0003	0.0211	0.0023
0.30886	0.0501	−0.2807	−0.2228	0.0015	0.0001	−0.0014	−0.0006
0.2001	0.9119	0.0372	0.5501	−0.0001	0.0024	−0.0001	0.0022
0.4002	0.2471	0.4072	0.4752	0.0043	0.0011	0.0074	0.0036
−0.0938	0.2626	−0.9197	−0.7234	−0.0004	0.0021	−0.0026	−0.0035
−0.1255	0.0059	−0.0805	−0.0632	−0.0543	0.0001	−0.0305	−0.0006
0.2221	−0.1337	0.1633	0.3726	0.0008	−0.0012	0.0004	0.0022
−0.3548	−0.2026	−0.9877	−0.9982	−0.0124	−0.0168	−0.0259	−0.0624
1.4384	0.6243	−0.0417	4.4193	0.0211	0.0087	−0.0011	0.01147
−0.0238	−0.0877	1.5596	0.8561	−0.0002	−0.0014	0.0257	0.0213
0.1774	0.0973	0.7070	0.0409	0.0041	0.0006	0.0188	0.0007
2.0170	2.2448	−0.6960	−0.4320	0.0043	0.0037	−0.0049	−0.0023
0.3886	1.0140	1.6963	0.8617	0.0006	0.0001	0.0050	−0.0002
0.2556	0.4789	0.1561	1.0721	0.0003	0.0002	0.0002	0.0006
−0.2879	−0.1656	0.0785	0.4384	−0.0009	−0.0001	0.0002	0.0001
0.1353	0.1579	0.0549	0.1880	0.0122	−0.0003	0.0060	−0.0028
Total inter-industry technical change				−0.0141	0.0016	−0.0762	0.0154

It may be necessary, however, to draw readers' attention on some of limitations of interpreting the results reported here. Indian data available in Census of Manufactures is subject to large errors of measurement. Some evidence is found in the examination of some major ratios like capital/labor and capital/output ratios. Furthermore, capital stock value reported in the census was based on book value for any given year and no adjustments could be made for utilization of capital. Also, labor employed was given to be the number of workers and not hours of work spent in production. However, in spite of these limitations, this study yielded some interesting observations on the effect of resource allocation on total factor productivity in Indian industries. Findings of this nature are important for policy makers in developing countries in their formulation of industrial development policies. Provided reliable data are available similar studies for other developing countries should be undertaken to further generalize these results.

We emphasize here again the fact that this study is preliminary in nature and it calls for similar studies for different countries. At the same time, studies of this kind also underscores the need for improvement of the quality of data in developing countries to make any meaningful analysis.

REFERENCES

1. DENISON, E. F. *The Sources of Economic Growth in the United States and the Alternatives before Us*, Supplementary Paper No. 13 (New York: Committee for Economic Development, 1962).
2. ————. *Why Growth Rates Differ: Post-War Experience in Nine Western Countries* (Washington: Brookings Institution, 1967).
3. JOHANSEN, L. "A Method for Separating the Effects of Capital Accumulation and Shifts in Production Functions upon Growth in Labor Productivity," *Economic Journal*, December 1961.
4. MASSELL, B. F. "Capital Formation and Technological Change in U.S. Manufacturing," *Review of Economics and Statistics*, May 1960.
5. ————. "A Disaggregated View of Technical Change," *Journal of Political Economy*, December 1961.
6. NARASIMHAM, G.V.L., and FABRYCY, M. S. "Relative Efficiencies and Organized Industries in India," presented at the Econometric Society Meetings in Detroit, Michigan, December 1970.
7. SOLOW, R. M. "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics*, August 1957.
8. WILLIAMSON, J. G., and SICAT, G. P. "The Technical Change and Resource Allocation in Philippine Manufacturing: 1957–1965" (Discussion Paper No. 6821, Institute of Economic Development and Research, University of Philippines, 1968).