by the ability of these economies to allocate resources in a nearly optimal fashion. To the extent that these tentative results are confirmed by more detailed studies at fairly disaggregative levels, then it clashes sharply with the conventional conclusion that the gains associated with a movement towards optimal resource allocation are small. We are anxious then to ascertain whether these results from aggregative analysis would be forthcoming for the Philippine manufacturing sector taken by itself.

Starting with expression {4},

{4} $$Q_{it} = A_{it} L_{it}^{\alpha_i} K_{it}^{\beta_i}$$

we can write the percentage rate of increase in value added in industry i, where the "dots" refer to changes, as

$$\frac{\dot{Q}_i}{Q_i} = \frac{\dot{A}_i}{A_i} + \beta_i \frac{\dot{K}_i}{K_i} + (1-\beta_i) \frac{\dot{L}_i}{L_i} .$$

Next, define

$$\gamma^{L_i} = \frac{L_i}{L} , \quad \gamma^{K_i} = \frac{K_i}{K} .$$

Then we have

$$\frac{\dot{L}_i}{L_i} = \frac{\dot{L}}{L} + \frac{\dot{\gamma}L_i}{\gamma L_i}$$

$$\frac{\dot{K}_i}{K_i} = \frac{\dot{K}}{K} + \frac{\dot{\gamma}K_i}{\gamma K_i}.$$

Since the aggregate percentage rate of growth in manufacturing value added can be expressed as

$$\frac{\dot{Q}}{Q} = \frac{\Sigma \dot{Q}_i}{Q} = \Sigma \left[\left(\frac{\dot{Q}_i}{Q_i} \right) \left(\frac{Q_i}{Q} \right) \right],$$

we can utilize the above definitions and write

$$\frac{\dot{Q}}{Q} = \Sigma \left(\frac{Q_i}{Q} \right) \left[\frac{\dot{A}_i}{A_i} + \beta_i \left(\frac{\dot{K}}{K} + \frac{\dot{\gamma}K_i}{\gamma K_i} \right) + (1-\beta_i) \left(\frac{\dot{L}}{L} + \frac{\dot{\gamma}L_i}{\gamma L_i} \right) \right].$$

Finally, we note that

$$\Sigma \beta_i \left(\frac{Q_i}{Q} \right) = \beta$$

$$\Sigma (1-\beta_i) \left(\frac{Q_i}{Q} \right) = (1 - \beta).$$

Thus technical change in Philippine manufacturing can be estimated as[18]

$$\{5\} \quad \frac{\dot{A}}{A} = \Sigma\left(\frac{Q_i}{Q}\right)\left(\frac{\dot{A}_i}{A_i}\right) + \Sigma\left(\frac{Q_i}{Q}\right)\left[\beta_i\left(\frac{\dot{\gamma K_i}}{\gamma K_i}\right) + (1-\beta_i)\left(\frac{\dot{\gamma L_i}}{\gamma L_i}\right)\right].$$

Verbally, technical change in Philippine manufacturing can be decomposed into two component parts. The first is a weighted average of rates of technical change in individual industry groups -- e.g., intra-industry technical change. The second results from an inter-industry shift in capital and labor -- e.g., inter-industry technical change. Although Massell finds the second component to be large and positive in the American

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[18] This follows since

$$\frac{\dot{A}}{A} = \frac{\dot{Q}}{Q} - \beta\left(\frac{\dot{K}}{K}\right) - (1-\beta)\frac{\dot{L}}{L}$$

and we have already seen that

$$\frac{\dot{Q}}{Q} = \Sigma\left(\frac{Q_i}{Q}\right)\left(\frac{\dot{A}_i}{A_i}\right) + \Sigma\left(\frac{Q_i}{Q}\right)\beta_i\left(\frac{\dot{K}}{K}\right) + \Sigma\left(\frac{Q_i}{Q}\right)(1-\beta_i)\left(\frac{\dot{L}}{L}\right)$$

$$+ \Sigma\left(\frac{Q_i}{Q}\right)\left[\beta_i\left(\frac{\dot{\gamma K_i}}{\gamma K_i}\right) + (1-\beta_i)\left(\frac{\dot{\gamma L_i}}{\gamma L_i}\right)\right]$$

$$= \left\{\Sigma\left(\frac{Q_i}{Q}\right)\left(\frac{\dot{A}_i}{A_i}\right)\right\} + \beta\left(\frac{\dot{K}}{K}\right) + (1-\beta)\left(\frac{\dot{L}}{L}\right) +$$

$$\left\{\Sigma\left(\frac{Q_i}{Q}\right)\left[\beta_i\left(\frac{\dot{\gamma K_i}}{\gamma K_i}\right) + (1-\beta_i)\left(\frac{\dot{\gamma L_i}}{\gamma L_i}\right)\right]\right\}$$

case, most economists familiar with Philippine experience prior to 1960 or 1962 have a strong intuitive feeling that resources were shifted away from their more productive use. We, too, suspect that inter-industry technical change was negative over this period which terminates with the year of decontrol, but that the size of this drag on productivity improvement in manufacturing diminishes sharply in the more recent period since decontrol, perhaps disappearing entirely.

Table 2.9 confirms our expectations. Intra-industry technical change exceeds by far the total rate of technical change for industry as a whole whether we use the 1957 or 1962 value added weights. 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.

Before we turn to a detailed discussion of the implications of these tentative results, it should prove profitable to examine the regression results more closely. In particular, we would like to ascertain whether the residuals from the regression

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(footnote 18 cont')

$$= \left\{ \begin{matrix} \text{INTRA-industry} \\ \text{technical change} \end{matrix} \right\} + \beta \left(\frac{\dot{K}}{K} \right) + (1-\beta) \left(\frac{\dot{L}}{L} \right)$$

$$+ \left\{ \begin{matrix} \text{INTER-industry} \\ \text{technical change} \end{matrix} \right\} .$$

Table 2.9

INTRAINDUSTRY AND INTERINDUSTRY TECHNICAL CHANGE IN PHILIPPINE MANUFACTURING: 1957-1962

Industry Group	Rate of Technical Change $\left(\frac{A_{i62}}{A_{i57}}\right)$	$\left(\frac{Q_{i57}}{Q_{57}}\right)$	$\left(\frac{Q_{i62}}{Q_{62}}\right)$	Intra-industry Rate of Technical Change $\left(\frac{A_{i62}}{A_{i57}}\right)\left(\frac{Q_{i57}}{Q_{57}}\right)$ (1957 weights)	Intra-industry Rate of Technical Change $\left(\frac{A_{i62}}{A_{i57}}\right)\left(\frac{Q_{i62}}{Q_{62}}\right)$ (1962 weights)
A. Six Industry Group					
I	4.19	.507	.482	2.124	2.019
II	2.14	.104	.103	.222	.220
III	1.35	.067	.057	.090	.077
IV	.74	.134	.143	.099	.106
V	1.53	.063	.086	.096	.132
VI	1.67	.125	.129	.209	.215
ALL	1.77	1.000	1.000	2.840	2.769
B. Four Industry Group					
I	4.19	.507	.482	2.124	2.019
II	2.14	.104	.103	.222	.220
III & IV	1.38	.201	.200	.277	.276
V & VI	1.53	.188	.215	.288	.329
ALL	1.77	1.000	1.000	2.911	2.844

Sources: The estimates of technical change in the second column come from Table 2.8. The value added weights come from the Annual Survey of Manufactures, 1957 and 1962.

equations can be related to other economic factors such as size of establishment or changes in labor quality. The hypotheses to be explored are the following: those industries within each industry group which attained higher than predicted rates of labor productivity growth should be either (a) of large size and/or (b) improving the quality of their labor force over the period. The first hypothesis permits us to explore more fully the existence of scale economies. It also allows us to investigate the potential impact of large scale research and development expenditures, normally associated with large scale establishments, upon the growth rate of labor productivity. Thus we expected a positive association between average size of establishment and the residuals from our regression equations. In fact no such relationship exists for Philippine manufacturing and thus large size does not insure any advantage in rates of labor productivity growth. The second hypothesis is straightforward enough although the measurement problems are ticklish. What we require is a crude index of labor quality whether by age, sex, duration of employment (on-the-job training), or formal education. Such information is, unfortunately, not available. Although the amount of variation in real average earnings growth between industries is very small during this period, it seemed a useful proxy for changes in labor quality. Thus those industries undergoing more rapid improvements in average real earnings are assumed to be those adopting a higher level of skilled labor. Rates of labor productivity growth exceeding predicted levels should be associated with relatively large increases in average wages paid. In fact, no such relationship prevailed in the Philippines over this time period.

One final point remains. Salter (1960) **and others**[19] have found that rates of growth of labor productivity and large increases in value added are positively correlated. We would like to see how well this generalization holds for the Philippines after having controlled for the conditions of the Johansen model. Table 2.10 summarizes the rank correlation results where R_i is the difference between actual rates of labor productivity improvement and the predicted rates of labor productivity improvement from the regression equation. With the peculiar exception of industry group II, there appears to be some confirmation of this hypothesis.

Kaldor (1957, 1962) and Arrow (1962), however, offer alternative suggestions. Arrow sees the integral of past gross investment (or output) as the proper index of productivity. Thus, changes in the gross-stock of capital are the proper

[19] See also Johansen (1961), pp. 780-1, and, for a summary, F. Hahn and R.C.O. Matthews (1964), pp. 836-50.

Table 2.10

SPEARMAN'S RANK CORRELATION COEFFICIENT BETWEEN R_i AND SOME EXPLANATORY VARIABLES SUGGESTED BY CURRENT MODELS OF EMBODIMENT

Independent Variable	Spearman's ρ I	II	III	IV	V	VI
$\frac{\Delta Q}{Q}$	.50*	-.06	.89*	.53*	.69*	.69*
$\frac{\Delta K}{K}$	.32	-.27	.72	-.32	.35	.44
$\frac{\Delta I}{I}$	.24	-.31	.89*	-.38	.73*	.04
Number of Items Ranked (N)	17	10	6	10	11	11

*Significantly different from zero at 95 per cent level.

independent variables[20] in accounting for technical change through learning by doing. Kaldor's views have changed sharply over the past decade, but the "technical progress function (1957)" has the rate of growth of investment explaining the rate of average productivity growth. (Both of these models assume, of course, that the independent variables are deflated by the labor force.) In any case, Table 2.10 shows the results of our crude test of these competing hypotheses. It would appear that the Arrow formulation performs better than Kaldor's, but we reserve judgment until more detailed inquiry is possible. For the time being, we can certainly suggest that those 3-digit and 4-digit industries exhibiting rates of labor productivity growth in excess of their predicted levels are precisely those which enjoyed very rapid rates of value added, investment, and capital stock growth. The implication may be simply -- but critically--that it is far easier to introduce new cost-reducing technique within a flexible environment of rapid growth than in one of stagnation. This is certainly the message of the more realistic production functions which introduce the vintage of

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[20] Not quite proper. A more accurate variable is the integral of all past investments, whether the equipment is still in operation or not.

capital equipment explicitly into the analysis. Again, it appears also to be the case for the Philippines.[21]

2.2 Implications of the Johansen Model: 1957-62. Thus far we have shown that the overall rate of technical progress in Philippine manufacturing prior to 1962 was rapid in spite of relatively sluggish growth in industry value added. We have also found abundant quantitative confirmation of the hypothesis that the manufacturing sector increasingly misallocated capital and labor by industrial use: a wide discrepancy was discovered between the overall performance of the manufacturing sector with technical change and the intra-industry performance. Inter-industry technical change was highly negative during the period and this result must be explained by increasingly poor resource allocation among sectors. Thus, discussions of the impact of government policy on the misallocation of resources is hardly an academic exercise.[22] The

[21] Our model, of course, is not of the factor-augmenting or vintage type, but rather the "manna-from-heaven" type. At a latter date, Williamson intends to pursue these alternative hypotheses in greater detail on Philippine data. Our focus at present is on the impact of commercial and exchange rate policy on overall productivity movements.

[22] These results contradict quite strikingly those discovered in advanced nations and the current view in the theoretical literature. See for example H.G. Johnson (1966); A. Fishlow and P. David (1966); A.C. Harberger (1959, 1962). On the other hand, our results confirm Bruton's suggestive hypotheses developed on the basis of Latin American experience. H. Bruton (1967).

magnitude of the losses associated with labor and capital shifts into less productive use at the margin were enormous up to 1962. A very large share of the unimpressive overall Philippine growth performance, in spite of very rapid rates of capital formation and high rates of technical change within industry can be explained (a) by the character and pace of growth in the industrial sector and its impact on resource allocation as estimated in Williamson's research and (b) the increasingly poor use of resources within the industrial sector as seen in this present paper. Both of these effects, of course, may be explained by the same factors: a misguided government industrial policy, especially biased towards import dependent import substituting industries.

The second issue with which this section attempts to contend is the use of resources within industrial subsectors. Is it also true that resources were increasingly poorly utilized within industrial groups? Again, the Johansen model should take us a long way towards answering that fundamental question in resource allocation since it generates an estimate of relative factor cost changes (ω).

Vital to policy is the evidence that the relative costs of capital rose considerably over the period. Part of this behavior may be explained by the rising costs of foreign exchange before 1962, by decontrol in 1962 and partly by other forces contributing to the decline of real wages over the period. The forces which determined the price of capital goods, in view of foreign exchange controls and tax-exemption to new and necessary industries, had lost their weight gradually as the country's balance of payment position worsened, especially after 1957. If we take 1957 as a base of 100, then Table 2.8 argues that the relative cost of a unit of labor compared to a unit of capital (ω) was, on the average, .41 in 1962. This represents an enormous decline in per unit labor costs (relative to capital) over the period. Nevertheless, there appears to be an exceedingly large variation around that average. Relative per unit capital costs rose dramatically in industry groups I and II, at about average rates in industry groups V and VI, very little in industry group III, and declined in industry group IV. These estimates of relative factor price changes (ω) are very close to the relative factor price (not cost) data we estimated in earlier pages. (See Tables 2.2, 2.3, and 2.4.)

Since we now have indirect estimates of relative factor cost movements over this period and by industry, it would be extremely interesting to compare them with changing capital-labor ratios in manufacturing. Table 2.11 presents some data which estimates the shift in capital-labor ratios, by various industry groupings, over this five year period. As we argued earlier, these capital stock figures should be

Table 2.11

CAPITAL-RATIOS IN PHILIPPINE MANUFACTURING (BASED ON BOOK VALUES), 1957 TO 1962

Industry Group	$(K/L)_{1965}$ (₱1,000)	$(K/L)_{1962}$ (₱1,000)	$(K/L)_{1960}$ (₱1,000)	$(K/L)_{1957}$ (₱1,000)	$(K/L)_{1965}/(K/L)_{1962}$		$(K/L)_{1965}/(K/L)_{1960}$		$(K/L)_{1962}/(K/L)_{1957}$	
20	11.208	6.648	6.178	5.567	1.686	(117.9)*	1.814	(112.3)*	1.194	(83.0)*
21	7.193	5.530	5.412	5.222	1.301	(91.0)	1.329	(82.3)	1.058	(73.5)
22	3.921	2.716	2.707	1.982	1.443	(100.9)	1.448	(89.6)	1.370	(95.2)
23	14.151	10.669	6.987	4.939	1.326	(92.8)	2.025	(125.4)	2.160	(150.1)
24	2.126	1.929	1.567	1.376	1.102	(77.1)	1.357	(84.0)	1.401	(97.4)
25	5.227	4.748	4.767	3.139	1.101	(77.0)	1.096	(67.9)	1.512	(105.1)
26	5.534	4.843	2.020	1.321	1.143	(80.0)	2.740	(169.6)	3.666	(254.8)
27	20.269	14.640	14.115	6.036	1.384	(96.8)	1.436	(88.9)	2.425	(168.5)
28	6.319	4.929	3.602	3.324	1.282	(89.7)	1.754	(108.6)	1.485	(103.2)
29	4.640	4.049	4.031	2.662	1.146	(80.2)	1.151	(71.3)	1.521	(105.7)
30	10.330	6.571	9.359	12.296	1.572	(110.0)	1.104	(68.3)	.534	(37.1)
31	11.509	8.464	8.569	9.827	1.360	(95.2)	1.343	(83.1)	.861	(59.8)
33	20.230	13.643	11.849	10.547	1.483	(103.8)	1.707	(105.7)	1.293	(89.9)
34	13.246	8.954	9.233	4.472	1.479	(103.5)	1.435	(88.8)	2.002	(139.1)
35	6.234	6.475	8.878	4.033	.963	(67.4)	.702	(43.5)	1.605	(111.5)
36	6.119	4.993	4.942	3.666	1.225	(85.7)	1.238	(76.6)	1.361	(94.6)
37	6.590	4.826	4.172	4.077	1.365	(95.5)	1.579	(97.8)	1.183	(82.2)
38	6.772	6.650	6.502	6.487	1.018	(71.2)	1.041	(64.4)	1.025	(71.2)
39	6.211	5,568	13.947	15.665	1.115	(78.0)	.445	(27.6)	.355	(24.7)
I	9.107	5.669	5.451	5.127	1.606	(112.4)	1.671	(103.5)	1.105	(76.8)
II	11.138	7.934	4.952	2.717	1.404	(98.2)	2.249	(139.2)	2.920	(202.9)
III	5.399	4.587	3.755	2.613	1.177	(82.4)	1.438	(89.0)	1.755	(122.0)
IV	10.861	7.588	7.514	10.618	1.431	(100.1)	1.445	(89.5)	.714	(49.6)
V	8.509	6.641	5.940	3.895	1.281	(89.6)	1.432	(88.7)	1.705	(118.5)
VI	15.053	9.992	8.858	6.153	1.506	(105.4)	1.699	(105.2)	1.623	(112.3)
All	10.044	7.027	6.218	4.883	1.429	(100.0)	1.615	(100.0)	1.439	(100.0)

Source: Basic data from <u>Annual Survey of Manufactures</u> 1957, 1960, 1962 and 1965 Bureau of the Census worksheets. L refers to total employment.

treated with caution since, among other imperfections, they are not deflated and prices of capital equipment, construction materials, and construction labor inputs increased dramatically throughout the period as Tables 2.2, 2.3, and 2.4 attest. Thus the measured overall industry increases in the deflated capital stock utilized per man hour. What is more, normally we assume each industry to use a different capital mix in the production process thus making it difficult to assume that the relative changes in capital-labor ratios accurately measure the relative increases in capital intensity by industry group. Given the similar secular movements in capital goods prices, however, it appears that a comparison between industry groups should be far more meaningful than the evidence presented for manufacturing as a whole. Thus, the discussion which follows only considers relative changes in factor mix, not absolute variations in capital-labor ratios.[23]

Having made these apologies for our unadjusted estimates of capital-labor ratios, it would appear that there was a very high rate[24] of substitution of capital for labor through-

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[23]To accept the absolute variations in capital-labor ratios without criticism would suggest that firms almost doubled capital per worker when the relative price of capital almost doubled! Strange behavior indeed even if we assume an intricate set of lags in factor mix to factor price.

[24]Not necessarily elasticity. Estimates of the elasticity of substitution will be discussed below.

out this period in Philippine manufacturing. The largest rates of capital-labor substitution appear in the 2-digit industries 23 (textiles), 25 (wood and cork products), 26 (furniture and fixtures), 27 (paper and paper products), 28 (printed materials), 29 (leather products), 34 (basic metals), and 35 (metal products). Three industry groups substituted labor for capital: 30 (rubber products), 31 (chemicals), and 39 (miscellaneous manufactures).

The obvious question to pursue at this point is whether these measured rates of substitution of capital for labor are attributable to changes in relative factor costs (and/or product mix) or to changes in capacity utilization. Up to this point, we have assumed full employment of resources within firms and industrial groups. Chart 3 illustrates that there was considerable variation in the degree of capacity utilization in 1961, but more importantly that there was little evidence of a negative correlation between increases in capital-labor ratios (1957-62) and degree of capacity utilization in 1961. Thus, these measured increases in capital intensity cannot be explained by excess capacity conditions. The only exception to this rule appears in our industry groups IV (30, 31) and V (34, 35, 36, 37, 38). Within these groups, there is a high inverse relation between these two variables. To the extent that industry IV moved to a high level of capacity utilization by 1961-62, it would exhibit low rates of measured--

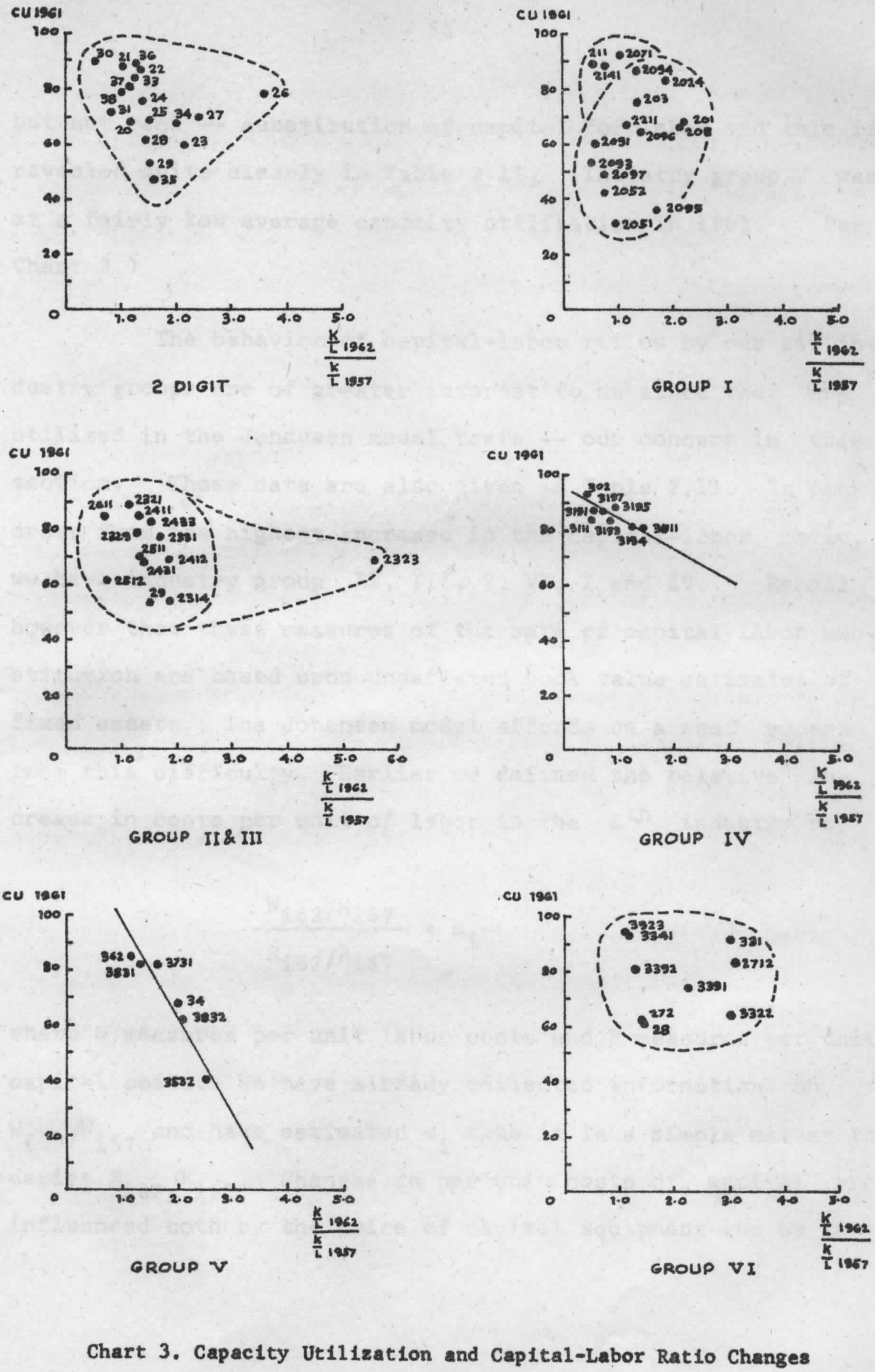

Chart 3. Capacity Utilization and Capital-Labor Ratio Changes

but not real -- substitution of capital for labor and this is revealed quite clearly in Table 2.11. (Industry group V was at a fairly low average capacity utilization in 1961. See Chart 3.)

The behavior of capital-labor ratios by our six industry groups are of greater interest to us since they are utilized in the Johansen model tests -- our concern in this section. Those data are also given in Table 2.11. In rank order from the highest increase in the capital-labor ratio, we have industry group II, III, V, VI, I and IV. Recall however that these measures of the rate of capital-labor substitution are based upon undeflated book value estimates of fixed assets. The Johansen model affords us a neat escape from this difficulty. Earlier we defined the relative increase in costs per unit of labor in the i^{th} industry as

$$\frac{W_{i62}/W_{i57}}{R_{i62}/R_{i57}} = \omega_i$$

where W measures per unit labor costs and R measures per unit capital costs. We have already collected information on W_{i62}/W_{i57} and have estimated ω_i thus it is a simple matter to derive R_{i62}/R_{i57}. Changes in per unit costs of capital are influenced both by the price of capital equipment and by interest rates.[25] It seems highly reasonable to assume that intra-industry variations in R_{i62}/R_{i57} are produced primarily by variations in the prices of capital equipment. In any case, we have assumed as much by using R_{i62}/R_{i57} as deflators of our $\frac{(K/L)_{i62}}{(K/L)_{i57}}$ measures. These adjusted indices of capital-labor shifts (relative to industry as a whole) are plotted on Chart 4 with ω_i (relative to industry as a whole).

What appears there is a confirmation of traditional neoclassical microeconomic theory. (Recall that the Johansen model assumes identical elasticities of substitution in every industry group -- namely, unity.) Those industry groups which faced the largest increase in per unit capital costs (relative to labor) were precisely those which underwent the lowest rates of substitution of capital for labor. We note, however, that despite the relative increase of capital costs, on the average no substitution of labor for capital occurs. Evidently, the combination of output expansion, biased technical change, and/or a changing product mix acted to increase observed capital intensity. Our predictions were based upon a world of no output expansion and with neoclassical factor substitution possibilities, where labor will be substituted for capital if per

[25] As we indicated above, it is not quite simple. The capital costs per annum of a unit of real investment is a functrion of (1) the rate of interest, (2) the price of capital goods, (3) risk, and (4) expectations of longevity. See Salter (1960), pp. 17-21.

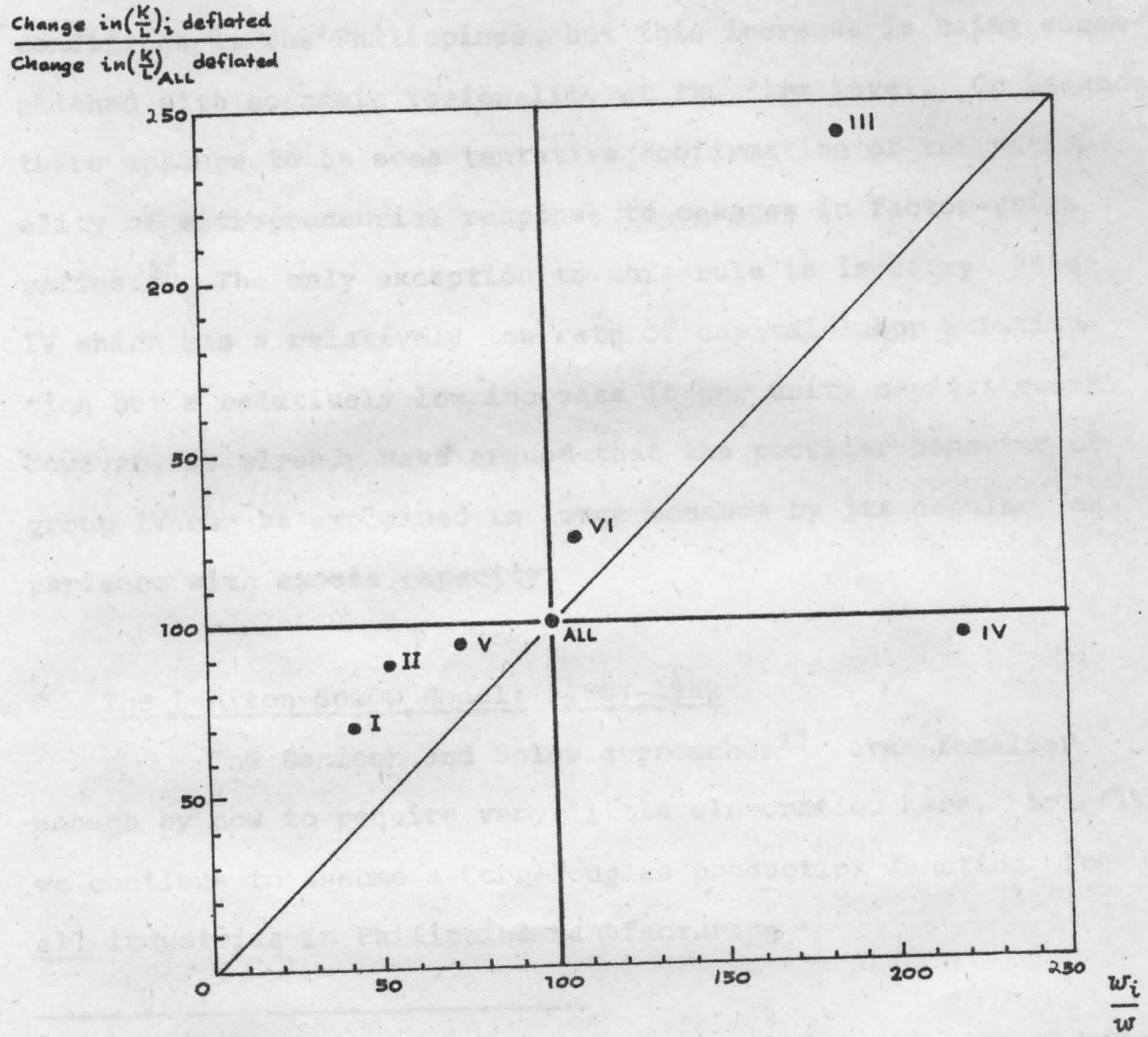

Chart 4. Relative Factor Price Changes and Capital-Labor Shifts by Six Industry Groups: Philippine Manufacturing, 1957-1962 (All Industries = 100)

unit capital cost in terms of labor rises. Our evidence points out that there is an increasing rate of capital-intensity in Philippine manufacturing apparently unrelated to factor cost conditions in the Philippines, but this increase is being accomplished with economic rationality at the firm level. On balance, there appears to be some tentative confirmation of the rationality of entrepreneurial response to changes in factor-price ratios.[26] The only exception to this rule is industry group IV which has a relatively low rate of capital-labor substitution but a relatively low increase in per unity capital costs. However, we already have argued that the peculiar behavior of group IV can be explained in large measure by its secular experience with excess capacity.

3. The Denison-Solow Model: 1957-1962

The Denison and Solow approaches[27] are familiar enough by now to require very little elaboration here. Briefly, we continue to assume a Cobb-Douglas production function for all industries in Philippine manufacturing

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[26] This section assumes, of course, (a) that the elasticity of substitution is the same for all industry groups (namely, unity) and (b) that firms respond instantaneously to changes in relative factor prices. The first assumption is challenged in Section 5.3 while the second is taken to task in J.G. Williamson (1968c).

[27] Robert Solow (1957); Edward F. Denison (1962); Richard R. Nelson (1964). For a review, see L. Lave (1966).

$$\{6\} \qquad Q_{it} = A_{it}\, K_{it}^{\beta_i}\, L_{it}^{(1-\beta_i)},$$

and as in Johansen's model constant returns are assumed to prevail. When we take logarithms, differentiate, while assuming β_i constant (e.g., "neutral technological change"), the rate of growth of output becomes

$$\{7\} \qquad \frac{\dot{Q}_i}{Q_i} = \frac{\dot{A}_i}{A_i} + \beta_i \frac{\dot{K}_i}{K_i} + (1-\beta_i) \frac{\dot{L}_i}{L_i}.$$

All we require to estimate technical change by industry are 1957 and 1962 figures on L_{it}, K_{it}, Q_{it} and the breakdown of value added, Q_{it}, into labor and non-labor income components. We can then utilize the computed property income shares as estimates of β_i as long as we continue to accept the (somewhat dubious) assumption that the price per unit of each employed factor is equal to its marginal value product.

The Johansen and the Denison-Solow (D-S) models are not competitors in terms of economic theory, but they do utilize totally different estimation procedures. We are introducing the D-S model to complement our earlier results. The D-S model is inferior to the Johansen model to the extent (a) that it requires accurate estimates of the real capital stock by industry and (b) it does not generate any useful information about factor mix response to relative factor price changes. Its advantages, however, are (a) that it re-