quires less restrictive assumptions, (b) it will supply us with information of a far greater number of industries since it does not require estimation by regression analysis and (c) it will allow us to distinguish between capital and labor shifts and their contribution to interindustry technical change.[28] It is the last item, interindustry technical change, which is of primary interest to us. The inflated capital stock figures may yield questionable estimates on overall rates of technical change but it should still give us an accurate evaluation of the relative importance of the inter-industry component. In the process, we intend to measure the rate of technical change by 2-digit levels of disaggregation in the present section.

Before proceeding with the estimates of technical change from (7), it seemed imperative to compare Sicat's estimates of $\beta_i$ with the non-labor shares in value added computed directly from the Annual Surveys. As we indicated earlier, Sicat has estimated (static) production functions (from cross-section) for manufacturing and his results are given in Table 3.1 by the 2-digit level. Also presented in Table 3.1 are the actual property income shares in value added which have been derived from the 1957 and 1962 Annual Surveys. Further analysis revealed a significant positive

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[28] Lave (1966, p. 28) has shown that the Solow and Johansen models produce approximately the same empirical results for the United States (1909-1949).

Table 3.1

$\beta_i$ ESTIMATED FROM PRODUCTION FUNCTION ANALYSIS AND FROM REPORTED PROPERTY INCOME SHARES: PHILIPPINE MANUFACTURING

| (1) Industry | (2) $\beta_i$: Cobb-Douglas | (3) $\beta_i$: Reported Survey |
|---|---|---|
| 20 | .545 | .788 |
| 21 | .963 | .780 |
| 22 | .566 | .800 |
| 23 | .266 | .616 |
| 24 | .257 | .541 |
| 25 | .362 | .528 |
| 26 | .643 | .408 |
| 27 | .258 | .727 |
| 28 | .247 | .507 |
| 29 | .481 | .545 |
| 30 | .542 | .781 |
| 31 | .296 | .744 |
| 33 | .520 | .706 |
| 34 | .300 | .581 |
| 35 | .447 | .556 |
| 36 | .305 | .569 |
| 37 | .367 | .685 |
| 38 | .226 | .605 |

Sources: Col. (2): G.P. Sicat (1968), Table 4.11.

Col. (3) is computed from the Annual Survey of Manufactures, 1957 and 1962, where

$$\frac{\beta_{i,57} + \beta_{i,62}}{2} = \beta_i .$$

We have imputed wages to unpaid family workers and included extra benefits in our calculation of labor's share.

correlation between the estimates of $\beta_i$. In general, Sicat's estimates of the output elasticity of capital are lower than the reported property share, with the exception of 21 (beverages) and 26 (furniture and fixtures). A regression of the estimates of the output elasticity of capital on the reported property share yields a slope of 0.53 with a negligible intercept term. Thus, when the reported property share is 0.75, the output elasticity of capital is 0.40. In any case, we estimated $\dot{A}_{it}/A_{it}$ by utilizing both of these estimates of $\beta_i$ while expecting only minor differences in results. This is in fact what we find in Table 3.2: the estimates of $\dot{A}_{it}/A_{it}$ using the output elasticity weights exhibit high positive correlation with those using reported Survey weights. For the remainder of this section, we shall be using the $\beta_i$ as computed directly from the Surveys.

3.1 Results Using the Denison-Solow Model, 1957-1962. Recall from Section 2 that the Massell approach allows us to decompose technical change into its intraindustry and interindustry components. Using the results of the Johansen model, intraindustry technical change exceeded by far overall technical change since interindustry technical change was negative from 1957 to 1962. Do we find the same results using the estimates generated by the D-S model? Not only can we answer this question but we can go farther. In Section 2 we showed that

$$\{8\} \quad \frac{\dot{A}}{A} = \Sigma\left(\frac{Q_i}{Q}\right)\left(\frac{\dot{A}_i}{A_i}\right) + \Sigma\left(\frac{Q_i}{Q}\right) \beta_i \left(\frac{\dot{\gamma K_i}}{\gamma K_i}\right) + \Sigma\left(\frac{Q_i}{Q}\right)(1-\beta_i)\left(\frac{\dot{\gamma L_i}}{\gamma L_i}\right)$$

Table 3.2

TECHNICAL CHANGE IN PHILIPPINE MANUFACTURING,

1957-1962: DENISON-SOLOW MODEL

| Industry Code | $\dot{K}_i / K_i$ | $\dot{L}_i / L_i$ | $\dot{Q}_i / Q_i$ | $\dot{A}_i / A_i$ Cobb-Douglas $\beta_i$'s | $\dot{A}_i / A_i$ Survey's $\beta_i$'s |
|---|---|---|---|---|---|
| | Per Annum Rates of Change | | | | |
| 20 | .059 | .030 | .149 | .103 | .096 |
| 21 | .058 | .058 | .075 | .017 | .029 |
| 22 | .080 | .018 | .015 | -.038 | -.053 |
| 23 | .335 | .168 | .134 | -.078 | -.137 |
| 24 | -.041 | -.049 | -.036 | .011 | .009 |
| 25 | .098 | .014 | .075 | .031 | .017 |
| 26 | .295 | .017 | .018 | -.178 | -.129 |
| 27 | .315 | .125 | .138 | -.036 | -.125 |
| 28 | .059 | .026 | -.019 | -.054 | -.024 |
| 29 | .179 | .107 | .102 | -.040 | -.044 |
| 30 | -.089 | .102 | .129 | .130 | .166 |
| 31 | .024 | .104 | .104 | .024 | .060 |
| 33 | .134 | .088 | .162 | .050 | .042 |
| 34 | .500 | .280 | .440 | .094 | .032 |
| 35 | .197 | .111 | .155 | .006 | -.004 |
| 36 | -.064 | -.051 | .064 | .119 | .122 |
| 37 | .370 | .425 | .355 | -.050 | -.003 |
| 38 | -.080 | .110 | .060 | -.007 | .017 |
| ALL | .114 | .059 | .109 | | .011 |

Source: See text and Table 3.1.

where $\gamma^{K_i}$ is the $i^{th}$ industry's share of the total capital stock in manufacturing, and $\gamma^{L_i}$ is a similar measure for labor.

Our first step is to combine the last two elements of expression (8) and estimate intraindustry and interindustry technical change. Using 1957 value added weights, <u>intraindustry</u> technical change was .0245 per annum from 1957 to 1962 while for manufacturing as a whole technical change averaged .0113 per annum. <u>Interindustry</u> technical change must have been -.0132 per annum over the period. Again we find evidence suggesting that capital and labor were shifting to less productive employment. Furthermore, the drag which this increasingly poor resource use placed upon total factor productivity growth was highly significant: it reduced the rate of technical change in manufacturing by more than 50 per cent. These conclusions remain unchanged if 1962 value added weights are used. Intraindustry technical change is .0307 per annum and thus interindustry technical change is -.0194 per annum: increasingly poor resources use reduced the rate of technical change in manufacturing by about 60 per cent. These results are strikingly consistent with those of the Johansen model.

Expression (8) also allows us to estimate the relative contributions of capital and labor shifts to interindustry technical change. These shifts are very large for so short a time period. Table 3.3 reveals that industries (23), (26), (27), and (37) more than double their share of the total capital stock in manufacturing; industries (34) more than quadruples its relative share of capital resources. Industry (33) remains unchanged, but all other industries underwent significant declines in relative capital shares over the period. Thus food, beverages, tobacco, footwear, wood and cork products, printed materials, rubber products, chemicals, machinery and transport equipment all suffered a decline in their relative share of capital resources in manufacturing over the period prior to decontrol. Textiles, furniture, paper products, basic metals and electrical machinery all enjoyed relatively rapid growth in their capital stocks so that their shares increased. The allocative shift in labor within manufacturing is not terribly different, but it is different enough to require some comment and also to indicate the intraindustry variety in changing factor mix. All of the following industries suffered reductions in capital shares but improvements in labor shares, indicating a relative shift to more labor intensive technique: industries (30), (31), and (38). The opposite is the case for furniture and fixtures (26).

Using 1957 value added weights in expression (8), we get the following components of interindustry technical change:

| | |
|---|---|
| due to K shifts: | -.0376 per annum |
| due to L shifts: | +.0244 per annum |
| total interindustry technical change: | -.0132 per annum |

Table 3.3

INTERINDUSTRY SHIFT IN CAPITAL AND LABOR: PHILIPPINE MANUFACTURING, 1957-1965

| ISIC Code | 1960 $\gamma_{Ki}$ | 1962 $\gamma_{Ki}$ | 1965 $\gamma_{Ki}$ | 1957 $\gamma_{Ki}$ | 1960 $\gamma_{Li}$ | 1962 $\gamma_{Li}$ | 1965 $\gamma_{Li}$ | 1957 $\gamma_{Li}$ | 1960-65 $\dot{\gamma}_{Ki}/\gamma_{Ki}$ | 1962-65 $\dot{\gamma}_{Ki}/\gamma_{Ki}$ | 1957-62 $\dot{\gamma}_{Ki}/\gamma_{Ki}$ | 1960-65 $\dot{\gamma}_{Li}/\gamma_{Li}$ | 1962-65 $\dot{\gamma}_{Li}/\gamma_{Li}$ | 1957-62 $\dot{\gamma}_{Li}/\gamma_{Li}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | .2364 | .2160 | .2322 | .2796 | .2197 | .2021 | .1984 | .2326 | -.018 | .075 | -.229 | -.097 | -.018 | -.131 |
| 21 | .0425 | .0430 | .0339 | .0563 | .0454 | .0494 | .0439 | .0499 | -.203 | -.212 | -.236 | -.033 | -.111 | -.010 |
| 22 | .0308 | .0247 | .0270 | .0291 | .0663 | .0557 | .0514 | .0680 | -.123 | .093 | -.151 | -.225 | -.077 | -.181 |
| 23 | .1410 | .2133 | .1995 | .0876 | .1254 | .1338 | .1247 | .0821 | .415 | -.065 | 1.435 | -.006 | -.068 | .630 |
| 24 | .0200 | .0175 | .0120 | .0382 | .0838 | .0725 | .0630 | .1284 | -.400 | -.314 | -.542 | -.248 | -.131 | -.435 |
| 25 | .0807 | .0754 | .0697 | .0818 | .0900 | .0966 | .1139 | .1207 | -.136 | -.076 | -.078 | .265 | .179 | -.200 |
| 26 | .0056 | .0124 | .0122 | .0059 | .0156 | .0167 | .0196 | .0206 | 1.178 | -.016 | 1.085 | .256 | .174 | -.189 |
| 27 | .0527 | .0520 | .0581 | .0230 | .0231 | .0239 | .0228 | .0177 | .102 | .117 | 1.257 | -.013 | -.046 | .350 |
| 28 | .0271 | .0280 | .0266 | .0364 | .0468 | .0431 | .0418 | .0507 | -.019 | -.050 | -.231 | -.107 | -.030 | -.150 |
| 29 | .0039 | .0036 | .0024 | .0027 | .0060 | .0059 | .0071 | .0047 | -.385 | -.333 | .296 | .183 | .203 | .255 |
| 30 | .0336 | .0180 | .0222 | .0563 | .0254 | .0257 | .0244 | .0212 | -.339 | .233 | -.682 | -.039 | -.051 | .212 |
| 31 | .0818 | .0694 | .0787 | .1065 | .0566 | .0616 | .0670 | .0502 | -.038 | .134 | -.348 | .184 | .088 | .227 |
| 33 | .0775 | .0849 | .0990 | .0782 | .0373 | .0391 | .0419 | .0343 | .277 | .166 | .087 | .123 | .072 | .140 |
| 34 | .0307 | .0285 | .0310 | .0065 | .0173 | .0173 | .0181 | .0067 | .010 | .088 | 3.385 | .046 | .046 | 1.582 |
| 35 | .0798 | .0547 | .0414 | .0385 | .0595 | .0561 | .0607 | .0443 | -.481 | -.243 | .418 | .020 | .082 | .266 |
| 36 | .0117 | .0083 | .0057 | .0210 | .0175 | .0148 | .0105 | .0265 | -.513 | -.313 | -.605 | -.400 | -.291 | -.441 |
| 37 | .0206 | .0265 | .0287 | .0095 | .0353 | .0470 | .0494 | .0108 | .393 | .083 | 1.779 | .399 | .051 | 3.352 |
| 38 | .0236 | .0238 | .0197 | .0429 | .0290 | .0387 | .0414 | .0306 | -.165 | -.172 | -.445 | .427 | .070 | .265 |

Source: Derived from the <u>Annual Surveys</u>.

$\gamma_{Ki} = \frac{K_i}{K}$, $\dot{\gamma}_{Ki} = \left(\frac{K_{i62}}{K_{62}}\right) \div \left(\frac{K_{i57}}{K_{57}}\right)$

$\gamma_{Li} = \frac{L_i}{L}$, $\dot{\gamma}_{Li} = \left(\frac{L_{i62}}{L_{62}}\right) \div \left(\frac{L_{i57}}{L_{57}}\right)$

The prime cause of negative rates of interindustry technical change in Philippine manufacturing prior to decontrol is the mal-allocation of capital resources. Labor, on the other hand, shifted to more productive uses and thus made a positive contribution to Philippine manufacturing productivity improvements.

Before passing on to Section 3.2, we should note that these results raise a further question: to what extent are the negative rates of interindustry technical change attributable to (1) a shift in the product mix in manufacturing, (2) a shift in the factor mix within industries and (3) a combination of (1) and (2)? We shall not attempt in this paper a full scale assault on this question but rather only discuss changing capital-labor mixes in manufacturing.

We have already argued in the preceding section that the capital stock figures for manufacturing must be utilized with great caution at least, if for no other reason, because they are inflated values. Proper deflators were derived indirectly in Section 2.1 but only for large industry groups. Perhaps the figures in Table 3.4 are more meaningful if related to the industry average. Column (3) in that table presents estimates of the change in capital intensity by industry over the five year period. The largest increases

Table 3.4

CAPITAL-LABOR RATIOS IN PHILIPPINE MANUFACTURING USING UNADJUSTED REPORTED CAPITAL STOCK DATA: 1957 and 1962

| Industry Code | (1) $\left(\frac{K}{L}\right)_{i,62}$ | (2) $\left(\frac{K}{L}\right)_{i,57}$ | (3) = $\frac{(1)}{(2)}$ | Industry K/L change relative to All (Per cent) |
|---|---|---|---|---|
| 20 | ₱ 6648 | ₱ 5567 | 1.194 | 83.0 |
| 21 | 5530 | 5222 | 1.058 | 73.5 |
| 22 | 2716 | 1982 | 1.370 | 95.2 |
| 23 | 10669 | 4939 | 2.160 | 150.1 |
| 24 | 1929 | 1376 | 1.401 | 97.4 |
| 25 | 4748 | 3139 | 1.512 | 105.1 |
| 26 | 4843 | 1321 | 3.666 | 254.8 |
| 27 | 14640 | 6036 | 2.425 | 168.5 |
| 28 | 4929 | 3324 | 1.485 | 103.2 |
| 29 | 4049 | 2662 | 1.521 | 105.7 |
| 30 | 6571 | 12296 | .534 | 37.1 |
| 31 | 8464 | 9827 | .861 | 59.8 |
| 33 | 13643 | 10547 | 1.293 | 89.9 |
| 34 | 8954 | 4472 | 2.002 | 139.1 |
| 35 | 6475 | 4033 | 1.605 | 111.5 |
| 36 | 4993 | 3666 | 1.361 | 94.6 |
| 37 | 4826 | 4077 | 1.183 | 82.2 |
| 38 | 6650 | 6487 | 1.025 | 71.2 |
| 39 | 5568 | 15665 | .355 | 24.7 |
| All | 7027 | 4883 | 1.439 | 100 |

Source: Original data from <u>Annual Survey of Manufactures</u>, 1957 and 1962.

in industry capital-labor ratios appear in textiles, furniture and fixtures, paper and paper products, basic metals, and, to a smaller extent, metal products. Significant relative declines in capital-labor ratios appear in food, beverages, rubber products, chemicals and chemical products, non-metallic mineral products, electrical machinery, transport equipment and miscellaneous manufactures.

If one is willing to accept the computed changes in capital-labor ratios in Table 3.4 as accurate indices of the rate of substitution of capital for labor,[29] then it is but a short step to compute the labor displacement effects associated with such movements along an isoquant away from the factor combinations which would be ideal under conditions of equilibrium factor prices. Table 3.5 constructs such measures. If we assume that the $(L/K)_{i57}$ ratio is "ideal" (in the sense that it is an optimal combination of productive factors given equilibrium factor prices or shadow prices), and if we further assume that this ideal condition would have prevailed in 1962 were it not for imperfections and government interference, then we can compare the optimum level of 1962 employment $(L^*_{i62})$

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[29]We are not so willing but other apparently are, judging from the recent literature on the Philippines. Ruprecht does not use the Survey data the way we have but his method of estimating capital-labor ratios for manufacturing as a whole seem somewhat weak. Nevertheless, he gets a capital-labor ratio in 1962 2.37 times the 1957 ratio. This value appears to be rather too high. See T.K. Ruprecht (1966).

Table 3.5

LABOR DISPLACEMENT AND EMPLOYMENT EFFECTS IN PHILIPPINE MANUFACTURING: 1957-1962

| ISIC Code | $K_{i62}$ (₱1,000) | $\frac{L}{K}_{i,57}$ | $L^*_{i62}$ | $L_{i62}$ | $L^*_{i62}-L_{i62}$ | $\frac{L^*_{i62}-L_{i62}}{L_{i62}}$ | $L^*_{i65}-L_{i65}$ | $\frac{L^*_{i65}-L_{i65}}{L_{i65}}$ |
|---|---|---|---|---|---|---|---|---|
| 20 | 314,325 | .1796 | 56,453 | 47,280 | 9,173 | .1940 | 36,430 | .6856 |
| 21 | 61,627 | .1914 | 11,795 | 11,144 | 651 | .0584 | 3,536 | .3005 |
| 22 | 34,123 | .5043 | 17,208 | 12,562 | 4,646 | .3698 | 6,102 | .4433 |
| 23 | 321,837 | .2024 | 65,140 | 30,164 | 34,976 | 1.1595 | 10,885 | .3259 |
| 24 | 31,500 | .7264 | 22,882 | 16,328 | 6,554 | .2489 | 1,719 | .1018 |
| 25 | 105,789 | .3185 | 33,694 | 22,279 | 11,415 | .5123 | 3,062 | .1003 |
| 26 | 18,285 | .7566 | 13,834 | 3,775 | 10,059 | 2.6646 | 746 | .1421 |
| 27 | 78,783 | .1656 | 13,046 | 5,381 | 7,665 | 1.4244 | 2,349 | .3843 |
| 28 | 47,885 | .3008 | 14,404 | 9,713 | 4,691 | .4829 | 3,149 | .2815 |
| 29 | 5,402 | .3755 | 2,028 | 1,334 | 694 | .5202 | 277 | .1457 |
| 30 | 38,148 | .0813 | 3,101 | 5,805 | -2,704 | -.4658 | 3,730 | .5712 |
| 31 | 117,602 | .1017 | 11,960 | 13,893 | -1,933 | -.1391 | 6,439 | .3591 |
| 33 | 120,073 | .0948 | 11,383 | 8,801 | 2,582 | .2933 | 5,398 | .4808 |
| 34 | 34,957 | .2235 | 7,813 | 3,904 | 3,909 | 1.0013 | 2,313 | .4782 |
| 35 | 81,828 | .2479 | 20,285 | 12,636 | 7,649 | .6053 | -609 | -.0374 |
| 36 | 16,643 | .2727 | 4,538 | 3,333 | 1,205 | .3615 | 634 | .2251 |
| 37 | 51,170 | .2452 | 12,547 | 10,602 | 1,945 | .1834 | 4,826 | .3648 |
| 38 | 57,907 | .1541 | 8,923 | 8,707 | 216 | .0248 | 197 | .0177 |
| ALL | 1,537,884 | .2159 | 332,029 | 225,438 | 106,681 | .4734 | 95,562 | .3568 |

Source and Notes: Table 3.4 and Annual Surveys.

$K_{i62}$ = book value of fixed assets (₱1,000) in 1962 in $i^{th}$ industry,

$L_{i62}$ = actual employment in $i^{th}$ industry (1962),

$L^*_{i,62}$ = "ideal" employment in $i^{th}$ industry (1962) if 1957 $(L/K)_i$ prevailed,

$L^*_{i62}-L_{i62}$ = labor displacement effect of increasing capital intensity.

with actual employment levels ($L_{i62}$). The difference between the two can be termed a "labor displacement effect." The effect appears to be enormous. For manufacturing as a whole, the labor displacement effect is about 50 per cent of actual employment in 1962. Part of this is due to a shift of capital into capital-intensive industries, but the largest part is due to an apparent industry-wide shift to more capital intensive technique. If we were to plot the change in capital intensity against the rate of capital stock growth, we would expect a very poor correlation since value added growth (shifts to higher isoquants) should play an equally important role in influencing capital stock growth as changes in capital-labor ratios (shifts along isoquants). What we find is a very significant positive correlation -- with the exception of industries (37), (36) and (24). Thus, relative capital stock growth is influenced primarily by rates of substitution of capital for labor rather than heterogeneous sectoral output growth.[30]

To return to the main theme, we have found that overall manufacturing rates of technical change were reduced 50 to 60 per cent by negative interindustry technical change:

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[30]This conclusion holds only if the proper capital stock deflators -- if they were available -- are roughly the same for all 2-digit industries. Given the evidence presented early in Section 2, this assumption is highly reasonable.

productive factors were being increasingly poorly allocated during the years 1957-1962. A misallocation of capital resources appears to play the major role here. This, in turn, was brought about by differential rates of capital-labor substitution and, to a much lesser extent, by differential rates of value added growth. Thus we have abundant empirical evidence that resources were utilized badly <u>within</u> industries (in terms of shadow prices: firm decision-making was probably quite rational) and <u>between</u> industries. These effects were strong enough to reduce rates of total factor productivity improvement significantly and thus in part to allow only disappointing rates of economy-wide labor productivity growth in spite of exceedingly rapid rates of capital formation.[31]

3.3 <u>A Further Note on Capital-Labor Substitution: the CES Production Function</u>. It becomes increasingly relevant that some results reported so far would be more convincing if interpreted in terms of a different specification of the production function. The constant-elasticity-of-substitution (CES) production function provides us with a relatively simple specification. This section presents what has been learned thus far and relates it to the results in section 3.

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[31] We are referring here to Williamson's results regarding the decline in the industrial sector's ability to draw resources out of low marginal productivity employment (in agriculture) since 1957 and up to 1965.

Suppose that all industries are characterized by a CES production function.[32] Then, we may write the production function, for any industry, i, as

$$Q_i = \phi_i \{\delta_i K_i^{-\rho_i} + (1 - \delta_i) L_i^{-\rho_i}\}^{-1/\rho_i} , \qquad (5)$$

where $\rho$ is a substitution parameter, $\delta$ a distribution parameter, and $\phi$ a neutral efficiency parameter, and Q, L, and K defined as before.

These production functions can be derived from a simple regression model,

$$Q_i/L_i = \log a_i + b_i \log W_i + e_i , \qquad (6)$$

where Q/L is value added per worker and W is annual wage rate per worker. The CES function makes the usual assumptions that constant returns to scale prevail, that factors are paid their marginal products, and that firms adjust instantaneously to relative product and factor price changes. Under these assumptions, b is an estimate of the elasticity of substitution and the substitution parameter, $\rho$, is $(1/b) - 1$. Thus, when $b=1$, we have $\rho = 0$ and the production function becomes the stand-

---

[32] K.J. Arrow, H.B. Chenery, B.S. Minhas and R.M. Solow (1961). For a review of empirical evidence, see M. Nerlove (1967).

ard Cobb-Douglas version which we have thus far been utilizing.

As indicated above, Sicat has estimated b for Philippine manufacturing, both on an aggregative basis and for two-digit manufacturing industries. The average of two-digit estimates are given in Table 3.6 along with the number of significant estimates from which the averages were derived. These estimates are based upon an alternative data source. They were made for groups of establishments classified by employment size as collected by, but unpublished in, the 1960 <u>Survey of Manufactures</u>.[33]

What is interesting about these estimates is that they are generally higher than estimates of b reported in studies of other nations.[34] In eleven out of eighteen cases, the elasticity of substitution exceeds unity while in most other studies $b<1$. Three industry groups have average estimates of b which are relatively poor, having been based on a few regression estimates. These are textiles, wood and cork, and basic metal. As indicated, however, in a majority of cases there is more substitutability between capital and labor in Philippine manufacturing than appears to be the case for other nations. In

[33] These basic data were derived from special tabulations of the survey respondents rather than from published data.

[34] See G.P. Sicat (1968), Chapter 5. Williamson (1968c).

Table 3.6

ESTIMATES OF ELASTICITY OF SUBSTITUTION
RELATIVE TO UNITARY CES-VALUE

| ISIC Code | Industry | Number of estimates of $\sigma = b \geqq 1$ | From a total number of significant estimates | Average Estimates * |
|---|---|---|---|---|
| 20 | Manufactured Food | 6 | 8 | 1.366 |
| 21 | Beverages | 4 | 8 | 1.111 |
| 22 | Tobacco | 8 | 8 | 1.571 |
| 23 | Textiles | 0 | 1 | 0.444 |
| 24 | Footwear and apparel | 0 | 7 | 0.590 |
| 25 | Wood and cork | 1 | 5 | 0.857 |
| 26 | Furniture & fixtures | 8 | 8 | 1.430 |
| 27 | Paper products | 3 | 6 | 1.247 |
| 28 | Printed & published mats. | 1 | 6 | 0.786 |
| 29 | Leather products | 4 | 6 | 1.012 |
| 30 | Rubber products | 8 | 8 | 1.578 |
| 31 | Chemical products | 2 | 6 | 1.088 |
| 33 | Non-metallic mineral | 4 | 6 | 1.348 |
| 34 | Basic metal | 1 | 4 | 0.944 |
| 35 | Metal products | 4 | 6 | 1.358 |
| 36 | Machinery, non-electric | 4 | 6 | 1.064 |
| 37 | Electrical machinery | 1 | 5 | 0.866 |
| 38 | Transportation | 1 | 5 | 0.754 |
| | Total Estimates | 60 | 109 | |

*Number of estimates from which average is derived taken from previous column.

Source: G.P. Sicat (1968), p. 5-7.

any case, all these derived values of $b_i$ imply isoquants with the correct curvature, although they are somewhat more flat than we have been assuming up to now.

Having thrown provisional support behind the hypotheses that isoquants in Philippine manufacturing are somewhat flatter than those prevailing in Western nations, we would like to know a priori what difference it makes (a) in explaining the rate of labor displacement (and thus a major social problem in the Philippines) and (b) in influencing our measures of technical change.

We are able to answer the first query quite easily. The rate of substitution of capital for labor obviously is influenced jointly by the magnitude of industry-specific relative factor price movements as well as the magnitude of the substitution parameters. Chart 4 illustrates the considerable variety in relative factor price movements in Philippine manufacturing: furthermore, by large industry groups there is a positive correlation between the relative increase in capital intensity and the relative increase in the price of labor. Our intention now is to utilize these independent (2-digit) CES parameters to test the preliminary hypothesis that those industries with high elasticities of substitution should be those that (1) underwent unusually large increases in capital-labor ratios and thus (2) generated relatively high rates of labor displacement.

We proceeded to relate the estimates of the elasticities of substitution, first, to changes in the capital-labor ratio, and second, to the rates of labor displacement from the "ideal" capital-labor ratio pattern. The 2-digit observations were thus ranked according to $b_i$, changes in the capital-labor ratio, and rates of labor displacement. In both cases, the rank correlation coefficient was not significantly different from zero. After deleting the industries with poor estimates of the elasticity of substitution, we derive evidence, reported in Table 3,3, which offers mild confirmation of the hypothesis that the elasticity of substitution plays the key role in explaining the industry variety in capital-labor ratio changes between 1957-1962. After 1962, the evidence supporting this hypothesis is quite strong. These results suggest that the variety in relative factor price movements is at least equally important, and once again, points out the importance of economic studies which attempt to measure the impact of government policy (including commerical policy) upon factor use. We should also emphasize, however, that the generally high values of $b_i$ (exceeding unity) indicate that factor substitution is an important positive aspect of Philippine manufacturing which is usually ignored in the simple (and popular) one-sector and two-sector growth models. Furthermore, we should note that minimum wage legislation not only generates poor

Table 3.7

SPEARMAN'S RANK CORRELATION BETWEEN ESTIMATES OF ELASTICITIES OF SUBSTITUTION AND CHANGE IN CAPITAL-LABOR RATIO AND RATE OF LABOR DISPLACEMENT

| Period | Change in capital-labor ratio | Rate of labor displacement |
|---|---|---|
| 1957-1962 | 0.27 | 0.50* |
| 1962-1965 | 0.62* | 0.72* |

*With n=15, significantly different from zero at 95 per cent level.

resource allocation but it also generates greater income inequality and thus fails even as a welfare device.

The second query involves an evaluation of the $b_i > 1$ results upon our estimates of technological change. Nelson has recently shown for the two-factor case that the CES function changes the Cobb-Douglas results but little.[35] In the CES case,

$$\{9\} \quad \frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + \beta_o \left(\frac{\dot{K}}{K}\right) + (1-\beta_o)\left(\frac{\dot{L}}{L}\right) + \frac{1}{2}\,\beta_o\,(1-\beta_o)\,\frac{b-1}{b}\left[\frac{\dot{K}}{K} - \frac{\dot{L}}{L}\right]^2$$

where $\beta_o$ is the initial share of labor in output and b the elasticity of substitution. The last term distinguishes the

[35] R. Nelson (1965), mimeo as summarized in M. Nerlove (1967). A summary appears in Williamson (1968).

CES from the Cobb-Douglas model. When b = 1 and/or when the rate of growth of capital and labor are the same, then expression {9} becomes Cobb-Douglas. Otherwise, the actual rate of technical change is that derived from Cobb-Douglas assumptions minus the last term in {9}. Since the last term in positive in our case, then we have overestimated the rate of technical change in Philippine manufacturing. The size of the error is not very significant, although it is probably not as small as originally thought.[36]

The above tests help to confirm the arguments presented in preceding sections. Nevertheless, it also argues quite strongly for an alternative approach to measurements of technical change and factor use in Philippine manufacturing which does not require restrictive assumptions regarding the degree

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[36] Nelson (1965) has shown that the elasticity of substitution hardly affects the estimates of technical change. Apparently M. Nerlove (1967) and Z. Griliches (1967) have concluded with Nelson that, since the elasticity of substitution is only a second-order parameter as a determinant of technical change, it may be disregarded. Murray Brown (1967) has pointed out correctly, however, that the Nelson result depends on the special assumption that the correct specification is a production function of Cobb-Douglas form. Since we have cast our lot tentatively on the specification of a Cobb-Douglas production function, we share the conclusion about the relative unimportance of the correction on technological progress implied by the addition of an elasticity of substitution. What is at issue is the specification error in production function estimates.

of factor substitutability and makes more reasonable assumptions regarding the speed of adjustment to relative factor price movements.

4. The Johansen Model: 1960-65

The Johansen model has been applied to this post-decontrol period first for the years 1960-1965 and second for the shorter period 1962-1965. This procedure was followed anticipating the mixed results which the crucial decontrol years would yield. The predictions are quite clear-cut. First, the results should reveal a retardation in the rate of increase in the relative cost of capital services, ($\omega_t$). Judging from the relative factor price data presented earlier in this paper, manufacturing as a whole underwent a rise in capital goods prices relative to labor costs up to 1962-1964. Since that time, the relative price of capital goods has stabilized or perhaps even declined. We argued earlier that this was a somewhat imperfect measure of relative factor prices actually facing the firm since (a) it excludes such factors as the terms of borrowing and the durability of capital, and (b) favored firms and industries may, through subsidies, pay less than the market price for imported capital equipment. Nevertheless, the Johansen model can only be accepted if

$$\omega\,(1957\text{-}62) < \omega\,(1960\text{-}65) \lesseqgtr \omega\,(1962\text{-}65).$$