CAPITAL-LABOR SUBSTITUTION IN MANUFACTURING IN A DEVELOPING ECONOMY: THE PHILIPPINES

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I. INTRODUCTION

WHILE THERE IS now extensive knowledge about production functions in industrial countries,[1] production function research in the less developed economies suffers from a serious lag. For instance, much *a priori* reasoning about the nature of production functions, or of capital-labor substitution, has plagued the literature on economic development. The state of discussion about capital-labor substitution has not advanced from the interesting empirical hypotheses presented by Eckaus [4] in the mid-fifties that industrial processes have fixed coefficients and therefore factor proportions problems result from the disparity between the capital-labor requirements of modern industrial production and the factor endowment of the developing economies. Some models of development, for instance, the Fei-Ranis [5] Lewis-type model of the labor surplus economy, have production functions which allow smooth factor substitution possibilities. One can make a good case for production function research in the developing economies, as Williamson [14] has done recently.

This paper presents estimates of constant elasticities of substitution between capital and labor for two-digit Philippine manufacturing industry. The manufacturing sector of the Philippines contributed about 28 per cent of national income in 1960. A decade earlier the share of manufacturing was only about 8 to 10 per cent. Philippine per capita GNP has been placed in the vicinity of \$150 to \$180 per year in a country of 33 million persons. A policy of industrial import substitution characterized conscious economic policy since the postwar period. The evidence thus reported will be for a developing economy which has engaged in a drive to set up an industrial sector.

The family of production functions with constant elasticity of substitution (CES) between capital and labor was introduced and analyzed fully in the classic paper of Arrow, Chenery, Minhas, and Solow, or ACMS [1]. The CES production is given by

$$Q = \gamma\{\delta K^{-\rho} + (1 - \delta)L^{-\rho}\}^{-1/\rho}$$

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[1] See, for instance, the conference volume on production functions [2].

where Q, K, and L represent measures of output, capital, and labor and γ is a technological parameter, δ as distribution parameter, and ρ the factor substitution parameter. This production function is estimated by the regression

$$\ln \frac{Q}{L} = \ln A + b \ln W$$

where W is wage per man and A and b regression constants. The CES production function assumes competitive factor pricing so that factor incomes are equated with their marginal products. The production function is also homogeneous of degree one. Under special assumptions that the efficiency of the industry is not affected by the wage rate,[2] the estimate of b corresponds to the elasticity of substitution, σ. This elasticity is related to the substitution parameter, ρ, since $b = \sigma = 1/(1 + \rho)$, or $\rho = (1/\sigma) - 1$. It is a major task of our research to have the value of σ estimated.

II. DATA

The data utilized in the computation of the production functions were derived from an establishment-by-establishment tabulation of the 1960 Survey of Manufactures which was especially prepared for this writer by the Philippine Bureau of the Census and Statistics. The establishments, of which there were 1,688, were reclassified first into two-digit Standard Industrial Classification. The establishments in each industry group were then classified into seventeen groups, by using employment size as the classifying variable. The observations of output, capital, labor and wages were (1) aggregated by taking the arithmetic sums of observations of establishments per employment class and (2) sampled, by picking an establishment within the employment class. These two types of observations for the employment classes were then utilized to generate independent regression estimates for every two-digit industry production function.[3]

Two definitions are used for wages. The first concept of wages (W_1) includes only the wage bill for production workers, while the second (W_2) includes all wages paid by the establishments. In addition, output is measured either as gross sales or value added. Detailed experimentation with the data has led to the conclusion that it matters little if gross sales or value added is used. The use of the two measurements affect only the constant terms of the regression estimates.[4]

We experimented with two types of measures of output per man and two types of measures of wages per man, thus giving us four different estimates of the elasticity of substitution for each two-digit industry group. Since we also arranged our data so that we were able to utilize (1) aggregated observations for establishments and (2) sampled observations for establishments in our regressions, we actually ended up with a maximum of eight different estimates of the elasticity

2 [1, pp. 236–38].
3 See [11, Chapter III], for a more detailed discussion of the data and the corresponding conceptual and classification problems.
4 [11].

of substitution for every industry group. In order to make our estimates of the slopes of the wage rate per man variable distinguishable, we used the following distinction:

b_{w1} = coefficient of logarithms of yearly wages per man of "all production workers,"

b_{w2} = coefficient of logarithm of same yearly wages per man of "all workers."

III. ESTIMATES OF CONSTANT ELASTICITY OF SUBSTITUTION, BY INDUSTRY

We shall report only the estimates of b, since we are interested largely in the magnitude of the elasticity of substitution. Table I shows all the estimates of b which were statistically significant.[5] The astonishing results from all the regressions performed are the relatively high value of the estimate for b. In Table II, all the estimates are summarized in terms of whether they exceed the value one. (We note, in reminder, that $b = \sigma = 1$ is the Cobb-Douglas case.)

Out of a total of 109 CES regressions, 60 estimates had $b > 1$. This represents 55 per cent of all significant estimates arrived at. Of the eighteen two-digit ISIC industries, nine (or one-half as many) yielded estimates greater than one. Industries with less than one elasticities of substitution are: textiles (ISIC 23), footwear and apparel (ISIC 24), wood and cork (ISIC 25), printing (ISIC 28), basic metal (ISIC 34), electric machinery (ISIC 37), and transportation (ISIC 38). Industries with only few statistically significant estimates of b are only a small minority of all the industries studied. In fact, only textiles (ISIC 23) had one relatively good estimate. The other industry, which had only four to eight possible estimates coming out relatively significant, is basic metals (ISIC 34).

A comparison of estimates of the elasticity of substitution drawn from aggregates for employment sizes and from a sampling of these employment sizes are easily compared by drawing a scatter of the average of the estimates. It is seen from this information that the two estimates tend to have the same value, with the significant exception of paper (ISIC 27), leather (ISIC 28), and nonmetallic mineral (ISIC 33). The scatter also dramatizes the relatively high values of the elasticity of substitution found for most of two-digit manufacturing.

Thus, most of the estimates for the elasticity of substitution in Philippine manufacturing are greater than one. These results incidentally confirm the generally high value of the CES estimates for Philippine manufacturing, which were reported in an earlier study of this author [10]. There the CES for the whole Philippine manufacturing sector, for the years 1957 to 1959 ranged between 1.3 to 1.5. In the next section, we shall review the estimates found in other studies and try to pass judgment on how reliable these estimates for the Philippines appear to be.

[5] Many are significant at the 1 and 5 per cent probability level; a few are significant at the 10 per cent level.

TABLE I
CES PRODUCTION FUNCTIONS ESTIMATES FOR THE ELASTICITY OF SUBSTITUTION

ISIC Code	Industry	Aggregated Establishments				Sampled Establishments			
		Output Concept				Output Concept			
		Value Added		Gross Sales		Value Added		Gross Sales	
		b_{w1}	b_{w2}	b_{w1}	b_{w2}	b_{w1}	b_{w2}	b_{w1}	b_{w2}
20	Manufactured food	1.696	1.698	0.711	0.939	1.413	1.709	1.369	1.396
		(0.281)	(0.317)	(0.289)	(0.256)	(0.442)	(0.264)	(0.300)	(0.211)
21	Beverages	1.626	1.357	1.253	0.979	0.953	1.146	0.763	0.809
		(0.129)	(0.214)	(0.123)	(0.203)	(0.165)	(0.226)	(0.117)	(0.203)
22	Tobacco	1.585	1.499	1.604	1.427	1.528	1.564	1.697	1.662
		(0.432)	(0.320)	(0.296)	(0.223)	(0.406)	(0.318)	(0.377)	(0.306)
23	Textiles	—	—	—	—	—	—	—	0.444
									(0.375)
24	Footwear and apparel	0.542	0.512	—	0.673	0.536	0.591	0.641	0.635
		(0.268)	(0.196)		(0.468)	(0.234)	(0.192)	(0.291)	(0.260)
25	Wood and cork	—	0.631	—	—	0.899	1.166	0.688	0.903
			(0.468)			(0.220)	(0.117)	(0.193)	(0.128)
26	Furniture and fixtures	1.390	1.256	1.806	1.617	1.235	1.307	1.372	1.453
		(0.230)	(0.133)	(0.262)	(0.142)	(0.269)	(0.177)	(0.291)	(0.183)
27	Paper products	—	1.967	—	1.594	0.565	1.184	0.875	1.297
			(0.689)		(0.603)	(0.482)	(0.336)	(0.402)	(0.247)
28	Printed and published materials	0.540	—	0.368	—	0.818	0.910	0.741	1.341
		(0.238)		(0.222)		(0.217)	(0.600)	(0.269)	(0.595)
29	Leather products	1.101	—	1.259	0.836	1.218	—	1.105	0.556
		(0.386)		(0.246)	(0.760)	(0.410)		(0.312)	(0.600)
30	Rubber products	1.533	1.726	1.325	1.560	1.559	1.798	1.519	1.609
		(0.379)	(0.208)	(0.372)	(0.198)	(0.592)	(0.272)	(0.525)	(0.284)
31	Chemical products	1.477	1.324	0.874	0.624	—	1.500	—	0.726
		(0.461)	(0.336)	(0.575)	(0.473)		(0.400)		(0.588)
33	Nonmetallic mineral	—	2.035	—	1.711	1.191	1.249	0.939	0.964
			(0.309)		(0.304)	(0.256)	(0.235)	(0.269)	(0.264)
34	Basic metal	0.435	1.362	—	0.955	—	0.974	—	—
		(0.336)	(0.409)		(0.399)		(0.723)		
35	Metal products	1.578	0.875	1.395	—	0.810	1.827	—	1.664
		(0.614)	(0.626)	(0.944)		(0.753)	(0.612)		(0.617)
36	Machinery, non-electric	—	1.488	—	0.903	1.143	1.045	1.060	0.746
			(0.644)		(0.744)	(0.706)	(0.522)	(0.762)	(0.604)
37	Electric machinery	—	1.216	—	0.959	0.492	0.796	—	—
			(0.432)		(0.550)	(0.384)	(0.590)		
38	Transportation	0.453	0.674	0.794	1.158	—	0.608	—	0.838
		(0.195)	(0.313)	(0.307)	(0.500)		(0.321)		(0.481)

Notes: 1. Standard errors of coefficient in parentheses.
2. Number in parentheses under average is number of estimates from which average is derived.

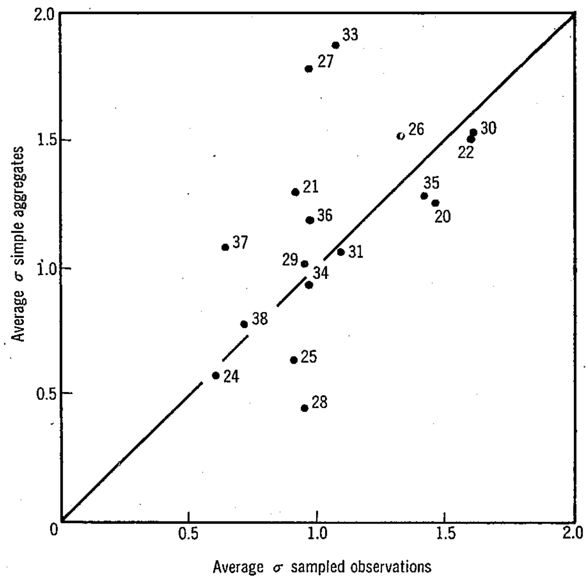
TABLE II

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 and fixtures	8	8	1.430
27	Paper products	3	6	1.247
28	Printed and published materials	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	Nonmetallic 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.

Fig. 1. Comparison of Average Elasticities of Substitution by Industry



IV. PHILIPPINE CES ESTIMATES COMPARED WITH OTHER FINDINGS

These estimates of Philippine capital-labor elasticities of substitution can be appreciated better by comparing them with estimates made for the same industry groups elsewhere. Since these Philippine estimates are from cross-sections we only compare them with the cross-section estimates for other countries. A number of time series estimates have been made since 1961, and the Nerlove [9] review of CES production functions has already covered a wide ground in summarizing these time series estimates. Briefly, most time-series CES elasticities estimates have relatively lower values compared to their cross-section counterparts.

Table III summarizes the estimates of CES functions from international and

TABLE III
INTERNATIONAL AND US CROSS-SECTION ESTIMATES FOR TWO-DIGIT MANUFACTURING, COMPARED WITH THE PHILIPPINES

ISIC Code	Industry	International Cross-section: Ave. of Murata-Arrow (Data for 1953–56 and 1957–59)	International Cross-section: ACMS (1961)	International Cross-section: Fuchs (1963)	US Cross-section: Solow (1963)	US Cross-section: Griliches (1967)	Philippine Average (Sicat)
20	Food		0.83[1]	1.06[1]	0.69	0.98	1.37
21	Beverages	0.724* (20–22)	—	—	—	—	1.11
22	Tobacco		0.75	1.22	1.96	—	1.57
23	Textiles	0.810	0.80[2]	0.96[2]	1.27	0.94	0.44
24	Apparel and related materials	0.732	—	—	1.01	1.06	0.60
25	Wood and lumber	0.868 (25–26)	0.86	1.08	0.99	1.07	0.86
26	Furniture and fixtures		0.89	1.04	1.12	1.04	1.43
27	Paper products	0.846	0.97	0.91	1.77	1.67	1.25
28	Printing and publishing	0.881	0.87	1.02	1.02	0.83	0.79
29	Leather products	0.705	0.86	0.98	0.89	0.84	1.01
30	Rubber products	0.798	—	—	1.48	1.28	1.58
31	Chemicals and products	0.836	0.86[3]	1.08[3]	0.14	0.71	1.09
32	Petroleum and coal	—	—	—	1.45	—	—
33	Stone, clay, glass	0.853	0.94[4]	1.08[4]	0.32	0.91	1.35
34	Primary metals	0.864	0.91[5]	0.85[5]	1.87	1.41	0.94
35	Metal products	0.920	0.90	1.01	0.80	0.85	1.36
36	Non-electrical machinery	—	—	—	0.64	1.24	1.06
37	Electrical machinery	—	0.87	1.03	0.37	0.66	0.87
38	Transportation equipment	—	—	—	0.06	0.91	0.75
39	Instruments and related products	—	—	—	1.59	0.75	—

Sources: Nerlove [9], for summary tables of ACMS, Murata-Arrow and Fuchs estimates; R. M. Solow [12]; Griliches [7].

* Includes beverages and tobacco.

[1] Average of dairy products, fruits and vegetables, grain and mill products, bakery products, and sugar.

[2] Average of spinning and weaving and knitting mills.

[3] Average of basic chemicals, miscellaneous chemicals, fats and oils.

[4] Average of clay, glass, ceramics, and cement.

[5] Average of iron and steel and nonferrous metals.

US data by reproducing, with minor changes, the table prepared by Nerlove comparing these estimates. The original estimates of ACMS were found to be in general less than one, although they are relatively close to unity. A reestimation by Fuchs [6] of the same data, with the exception that some account was taken of the degree of development of the countries whose observations were used with the application of dummy variables, led to estimates which are much closer to unity. An attempt by Murata and Arrow (1965) have reconfirmed the results obtained originally by ACMS.

However, the results of Solow [12], utilizing cross-section data by US regions in 1956, and Griliches [7], who used regional data in 1958, provide an additional basis for comparison; these are reported also in Table III. Except in the case of some industries for which Solow derived statistically nonsignificant estimates (chemicals, stone, clay [nonmetallic mineral], electrical machinery, and transport equipment), his results are close to those obtained by Griliches.[6] On the other hand, the average elasticities of substitution by industries directly obtained for the Philippines do not appear to be any smaller compared to those obtained for American manufacturing using relatively the same level of aggregation. This may appear surprising especially because, as we have stated at the beginning, it is generally believed that in the less developed economies there are much narrower degrees of capital-labor substitution.

Upward Bias in CES Estimates

As early as the original paper on CES production functions of ACMS, it was recognized that estimates of the elasticity of substitution from standard regressions have upward bias. ACMS [1, esp. pp. 236–37] have suggested that if efficiency levels of the observations vary directly with the wage rate—as in general they should—the elasticity of substitution would no longer be equal to b. In this case,

$$\sigma = \frac{b-e}{1-e}$$

where $e(\geqq 0)$ is an elasticity parameter relating the wage rate to the efficiency parameter, γ. It is clear that b is upwardly biased here if $1 > b > e$. However, if $b > 1$, as the case is for the estimates in this study, the elasticity of substitution will still be higher, in which case the elasticity of substitution appears to be underestimated.

It has been shown by a number of writers, however, that there is an upward bias for estimates of b even when they exceed *unity*. Some review of the literature on upward bias can be found in the CES production function survey by Nerlove [9]. Following a lead that product prices influence the elasticity of substitution, Nerlove obtained an expression for this upward bias and concludes that it is due to a positive correlation between the price index of output and the wage rate.

This explanation is with reference to the fact that the observations used in

6 [7] made a variety of CES estimates, including those which involved lagged variables. We report only those which were estimated on the basis of the same estimating equation.

the studies referred to are regional statistics. We note that the estimates of ACMS [1], Murata-Arrow (1965) and those for the US by Solow and Griliches are based on observations per region. It was not possible to utilize regional prices and wages to explain any upward bias. About one half of total organized manufacturing in the Philippines is done in the greater Manila region. Moreover, our observations were grouped by employment sizes rather than by regional locations, and in view of this, it was not possible to isolate regional price characteristics unambiguously.

We refer, however, to Solow's explanation of upward bias in comparing his estimates with those derived in the earlier ACMS study. Solow [12] has observed that the international cross-section carried a wide variety of countries with different wage rates and productivity of labor. The range of wage rates was such that the highest ran as much as twenty times the lowest wage rates. In his US regional samples, the variation was more limited, with "the highest wage as twice the lowest and almost always the range is much narrower."[7] This appears to be the case for Philippine manufacturing. In fact, in some of the observations, on the whole, the variations in wage rates (per man) are perhaps more narrow than the ones one would expect to find in the United States.

It is probably fitting to describe the Philippine labor situation as a Lewis-type "labor-surplus" economy.[8] In view of this, there would tend to be less variations in wage rates, because of the large pool of labor resources that can be attracted to enter the labor market in the industrial sector at a relatively constant wage rate. *Average* labor productivity in value added terms have relatively much wider variations than the wage rates. Aside from productivity related wage levels, it is plausible to assume that as firm size increases (as evidenced by its employment size), the value added per man would increase relatively faster than average wage rates. Wage rates would tend to be pulled down by the large supply of labor notwithstanding the presence of minimum wage and social security legislation in the Philippines. At the lower level of wage rates are found establishments which have probably the lowest rate of compliance with these laws. Thus, the average payments per labor per year would be relatively nearer the equilibrium wage for labor for the economy. As the establishment size increases, the rate of compliance with these laws increases. The strong effects of capital-labor substitution induced by these laws may be most felt among firms with relatively large sizes, since they are directly confronted with the burden of compliance for these laws. Moreover, in view of many industrial promotion incentives which cheapened the relative price of capital, the inducements for capital-labor substitution have been strengthened. On the one hand, the labor surplus economy explanation rules out any wide variation of wage rates even when labor productivity admits of wider variability, on the other, the presence of minimum wage and social security legislation has tended to encourage the presence of more establishments which require relatively more capital per man and therefore higher value added produc-

[7] [12, p. 118]; cited also in [9].
[8] See [8].

tivity for labor. In a study by Williamson and Sicat [15], a rank correlation test has yielded the conclusion that industries which underwent high rates of change in their capital-labor ratios were positively related to those with relatively high elasticities of substitution as found in this study.

The evidence shows therefore that capital-labor elasticities of substitution in the Philippines (and perhaps for other less developed countries as well) are at least as great in degree as those found in the industrially advanced countries. The traditional assumption that there exist less possibilities of substitution probably springs from the belief that since manufacturing processes are imported, the firm's factor combinations get frozen into adopting the capital-intensity of the process. But the manufacturing process is just one phase of operation in a manufacturing enterprise. There are ancillary activities—moving inputs and outputs, packaging, etc.—around the process which complement the operation, where greater degrees of capital-labor substitution exist. If we look at an industry as a whole, as one composed of firms, the areas of capital-labor substitution appears even greater. While internal capital-labor substitution may exist within firms, within industries, the presence of interfirm trade in inputs and outputs allows for greater degrees of input substitution. We refer here to subcontracting activities that may be undertaken within firms, especially as between the highly complex, capital-intensive firms and the smaller scale labor-intensive manufacturing firm. Such subcontracting may be in the form of (a) producing an output, which is needed as intermediate input by a buying firm, or (b) supplying basic factor inputs—for instance, subcontracting labor. The instances we have enumerated allow us to accept the conclusion that capital-labor substitution elasticities are at least as high as those found by other researchers for the United States or the world industrial economy.

There are of course some qualifications to these. We have already pointed out the upward bias in the CES estimates. The second, and perhaps more important qualification, refers to market imperfections which are more prevalent in the poorer countries. As a matter of fact, some theories of development begin with assumptions about market imperfections. Insofar as the data limitations of this study are concerned, no further experimentations were possible which would allow us, for instance, to drop the assumptions of marginal product pricing of inputs, an inherent assumption in the CES production model. Interesting work has recently been performed, notably by Bruno [3] for Israel and L.C. Thurow [13] for the U.S., which attempts to remove the unusually restrictive assumption of perfect markets. But the special tabulation of 1960 establishments from the survey of manufactures cannot carry us any farther than what was attempted above (except in terms of what follows in the next section). It is reassuring, however, to note that J. G. Williamson,[9] utilizing temporal cross-sections in estimating dynamic CES production functions for Philippine manufacturing, has found relatively the same degrees of elasticities of substitution as reported in this study.

[9] Personal communication.

V. FURTHER CES ESTIMATES FOR PHILIPPINE MANUFACTURING

A CES production function which is more general than the one studied by ACMS is given below,

$$\frac{Q}{L} = \gamma\left\{\beta\left(\frac{K}{L}\right)^{-\rho} + \alpha\left(\frac{K}{L}\right)^{-m\rho}\right\}^{-1/\rho}$$

where Q, L, K, γ, and ρ are defined as before and β and α take on the role of the distribution parameter, and m is another parameter, which will be defined later. This function is due to Michael Bruno (1962) and independently estimated by Hildebrand and Liu (1965). If $m = 0$, the production function is equivalent to the ACMS CES function.

This production function can be estimated by the following regression equation

$$\ln\frac{Q}{L} = A + b\ln W + g\ln\frac{K}{L}$$

where K/L is fixed assets per man, g its slope parameter, and all other symbols as defined before. The estimation of this equation was pursued, utilizing all the concepts for the data inputs employed in estimating the earlier CES production function. It is now clear that neither b nor g represents any straightforward estimate of the elasticity of substitution. Nerlove[10] has shown that the "true" elasticity of substitution is

$$\sigma = \frac{1}{\{1 + \rho - (\rho m/s_k)\}},$$

where ρ is the substitution parameter in the CES function, $m = g/(1-b)$, and s_k the share of capital from total output. As Nerlove-Bruno have shown,

$$b = \frac{1}{(1 + \rho)}$$

and

$$g = \frac{\rho m}{(1 + \rho)}.$$

In the usual cases of $\rho \geqq 0$ and $m \gtreqqless 0$, it can be shown from the above relations that

$$\sigma \gtreqqless b$$

according as

$$g \gtreqqless 0.$$

In the more usual case of $g > 0$ (Hildebrand-Liu's findings), the true elasticity of substitution is underestimated by b. In reporting the estimates of this production function, we use the same notation for b_{w1} and b_{w2}.[11] However, we

[10] See [9, pp. 75–82].
[11] See p. 26 of this article.

should define the distinction between g_1 and g_2, which are estimates of the coefficient of the fixed assets per man variable. Briefly,

g_1 = coefficient in the regression containing an estimate of b_{w1},

g_2 = coefficient in the regression containing an estimate of b_{w2}.

Table IV presents the results of all these estimates. We eliminate all non-significant estimates. We note that quite a few of the industries did not have any regression estimates worth reporting for the coefficient of K/L. Only manufactured food (ISIC 20), tobacco (ISIC 22), metal products (ISIC 35), and non-electric machinery (ISIC 36) had estimates of g which were significant all

TABLE

GENERALIZED

ISIC Code	Industry	Aggregated Establishments					
		Output=Value Added/Man				Output=Gross	
		b_{w1}	g_1	b_{w2}	g_2	b_{w1}	g_1
20	Food	1.248 (0.208)	0.467 (0.104)	1.172 (0.307)	0.444 (0.148)	0.243 (0.208)	0.487 (0.104)
21	Beverages	1.701 (0.197)	—	1.094 (0.209)	0.476 (0.188)	0.880 (0.128)	0.420 (0.107)
22	Tobacco	0.808 (0.540)	0.375 (0.182)	0.980 (0.454)	0.278 (0.180)	1.188 (0.394)	0.201 (0.133)
23	Textiles	—	—	—	0.032 (0.164)	—	0.166 (0.121)
24	Footwear and apparel	0.436 (0.336)	—	0.570 (0.306)	—	—	—
25	Wood and cork	0.310 (0.288)	−0.394 (0.138)	0.728 (0.366)	−0.363 (0.118)	—	−0.389 (0.188)
26	Furniture and fixtures	1.453 (0.301)	—	1.281 (0.166)	—	1.943 (0.335)	—
27	Paper products	—	—	3.078 (0.685)	−0.490 (0.187)	—	—
28	Printing	0.624 (0.272)	—	—	—	0.460 (0.251)	—
29	Leather products	0.911 (0.696)	—	—	0.463 (0.233)	0.860 (0.389)	0.202 (0.158)
30	Rubber products	1.349 (0.491)	—	1.631 (0.254)	—	1.168 (0.485)	—
31	Chemical	1.462 (0.493)	—	1.388 (0.321)	−0.386 (0.246)	0.753 (0.598)	—
33	Nonmetallic mineral	—	0.519 (0.161)	1.641 (0.314)	0.235 (0.101)	—	0.408 (0.153)
34	Basic metals	0.548 (0.406)	—	1.662 (0.453)	−0.097 (0.073)	—	—
35	Metal products	1.411 (0.693)	—	—	—	1.365 (1.082)	—
36	Machinery, non-electric	1.028 (0.953)	0.323 (0.209)	1.838 (0.500)	0.422 (0.144)	—	0.321 (0.216)
37	Electric machinery	—	0.360 (0.099)	0.733 (0.382)	0.285 (0.098)	—	0.417 (0.111)
38	Transportation	0.355 (0.196)	−0.230 (0.151)	0.609 (0.278)	−0.287 (0.136)	0.783 (0.339)	—

Notes: 1. Standard errors of coefficients in parentheses.

2. —Estimate is not significant.

throughout. Beverages (ISIC 21), leather (ISIC 29), rubber (ISIC 30), and electric machinery (ISIC 37) had significant estimates for the g coefficients, whatever the regression model.

The next step is to revise the estimates of the elasticity of substitution in accordance with the correction contained in formula derived by Nerlove-Bruno. As mentioned earlier, these computations are dependent on the estimate of the capital share. The capital share used in these estimates is the fraction of value added which is not accounted for by the actual total wage bill as a fraction of value added. Table V shows the different estimates of the corrected more

IV
CES FUNCTION

		Sampled Establishments							
Sales/Man		Output=Value Added/Man				Output=Gross Sales/Man			
b_{w2}	g_2	b_{w1}	g_1	b_{w2}	g_2	b_{w1}	g_1	b_{w2}	g_2
0.433 (0.210)	0.427 (0.101)	0.720 (0.328)	0.367 (0.082)	1.106 (0.321)	0.231 (0.089)	0.956 (0.257)	0.219 (0.065)	1.104 (0.297)	0.112 (0.082)
0.593 (0.112)	0.698 (0.100)	1.014 (0.194)	—	1.097 (0.237)	—	0.696 (0.134)	0.102 (0.100)	0.701 (0.182)	0.252 (0.109)
1.172 (0.332)	0.136 (0.132)	1.480 (0.428)	—	1.534 (0.314)	0.148 (0.124)	1.666 (0.400)	—	1.635 (0.304)	0.130 (0.120)
—	0.241 (0.157)	—	0.281 (0.213)	—	0.226 (0.219)	—	—	—	—
0.742 (0.731)	—	0.597 (0.269)	—	0.602 (0.208)	—	0.662 (0.339)	—	0.618 (0.281)	—
—	−0.398 (0.175)	0.844 (0.279)	—	1.207 (0.146)	—	0.547 (0.236)	0.158 (0.153)	0.842 (0.158)	—
1.683 (0.173)	—	1.054 (0.405)	—	1.322 (0.283)	—	1.008 (0.411)	0.262 (0.214)	1.300 (0.284)	—
2.656 (0.549)	−0.468 (0.150)	0.564 (0.493)	—	1.152 (0.356)	—	0.873 (0.385)	−0.442 (0.326)	1.244 (0.241)	−0.265 (0.204)
—	—	0.819 (0.247)	—	0.789 (0.630)	—	0.855 (0.295)	—	1.397 (0.636)	—
—	0.518 (0.160)	1.216 (0.500)	—	—	—	0.874 (0.301)	0.199 (0.115)	—	0.324 (0.180)
1.508 (0.247)	—	1.411 (0.703)	—	1.833 (0.325)	—	1.456 (0.629)	—	1.666 (0.338)	—
0.707 (0.460)	−0.497 (0.352)	—	—	1.819 (0.446)	−0.266 (0.158)	—	—	0.797 (0.706)	—
1.447 (0.347)	0.158 (0.112)	1.190 (0.263)	—	1.248 (0.248)	—	0.940 (0.281)	—	0.982 (0.275)	—
1.073 (0.481)	—	—	—	1.051 (0.864)	—	—	—	—	—
—	—	0.581 (0.574)	0.390 (0.124)	0.986 (0.743)	0.271 (0.157)	—	0.434 (0.103)	—	0.381 (0.136)
1.226 (0.670)	0.389 (0.193)	1.578 (0.781)	0.260 (0.217)	1.552 (0.560)	0.346 (0.200)	1.496 (0.851)	0.261 (0.236)	1.164 (0.698)	0.285 (0.249)
—	0.379 (0.120)	0.440 (0.273)	0.439 (0.118)	—	0.426 (0.140)	—	0.463 (0.170)	—	0.448 (0.190)
1.121 (0.516)	—	—	—	0.598 (0.336)	—	—	—	0.888 (0.489)	—

TABLE V

"GENERALIZED CES ESTIMATES"

ISIC Code	Industry	Based on Aggregated Establishments				Based on Sampled Establishments			
		Value Added		Gross Sales		Value Added		Gross Sales	
		σ_{w1}	σ_{w2}	σ_{w1}	σ_{w2}	σ_{w1}	σ_{w2}	σ_{w1}	σ_{w2}
20	Manufactured food	2.959	2.597	0.609	0.916	1.318	1.548	1.311	1.280
21	Beverages	—	2.755	1.880	4.237	—	—	0.799	1.029
22	Tobacco	1.592	1.548	1.613	1.429	—	1.901	—	1.972
23	Textiles	—	—	—	—	—	—	—	—
24	Footwear and apparel	—	—	—	—	—	—	—	—
25	Wood and cork	0.175	0.425	—	—	—	—	0.793	—
26	Furniture and fixtures	—	—	—	—	—	—	2.075	—
27	Paper products	—	1.832	—	2.075	—	—	0.541	0.909
28	Printed and published materials	—	—	—	—	—	—	—	—
29	Leather products	—	—	1.332	—	—	—	1.344	—
30	Rubber products	—	—	—	—	—	—	—	—
31	Chemical products	—	0.925	—	0.430	—	1.351	—	—
33	Nonmetallic mineral	—	2.451	—	1.862	—	—	—	—
34	Basic metal	—	1.441	—	—	—	—	—	—
35	Metal products	1.653	—	—	—	1.420	1.675	—	—
36	Machinery, non-electric	—	5.102	—	2.976	2.604	3.268	2.475	2.049
37	Electrical machinery	—	−1.489	—	—	1.277	—	—	—
38	Transportation	0.250	0.400	—	—	—	—	—	—

Note: σ_{w1}, σ_{w2}=elasticity of substitution implied by the use of W_1 and W_2 as wage concepts, respectively.

TABLE VI

COMPARISONS WITH RESULTS FOR THE U.S.

ISIC Code	Industry	Hildebrand-Liu-Nerlove	Average for the Philippines
20	Manufactured food	2.1524	1.567
21	Beverages		2.140
22	Tobacco		1.541
23	Textiles	1.6526	—
24	Footwear and apparel	1.4253	—
25	Wood and cork	0.9955	0.464
26	Furniture and fixtures	0.9206	2.075
27	Paper products	1.0618	1.339
28	Printed and published materials		—
29	Leather products	0.7867	1.338
30	Rubber products	1.4465	—
31	Chemical products	1.2450	0.902
33	Nonmetallic mineral products (stone, clay, etc.)	1.2783	4.313
34	Basic metal	0.9860	1.441
35	Metal products	0.6959	3.073
36	Machinery, non-electric	0.5988	2.707
37	Electrical machinery	0.7848	−0.106
38	Transportation	2.0060	0.325
39	Miscellaneous manufactures	1.2433	

Source: Nerlove [9, Table 5, p. 80] for the Hildebrand-Liu-Nerlove elasticities.

Note: Averages for the Philippines derived from estimates in Table V.

"general" elasticity of substitution. We compare the estimates of Hildebrand-Liu as recomputed by Nerlove [9] with the arithmetic means of the estimates derived.

The results that we derive tend to exaggerate the value of the elasticities of substitution, much more than the observation for the comparisons with simple estimates of the CES for the US, as computed by Griliches and Solow. As we note $g > 0$. In accordance with the formula utilized in getting the corrected elasticity of substitution, this would cause the direct estimate derived from b to be understated. Thus, we observe a relatively higher set of elasticities of substitution.

Considering the relative poorness of these statistical results, we are more comfortable with the direct estimates of the elasticity of substitution. But as we have pointed out, too, there appears to be no strong reason to assume that these estimates are better than the ones we have derived from the simple CES production function.

VI. CONCLUSION

This paper has presented estimates of the CES production function utilizing per establishment data of a Philippine manufacturing survey. It concludes that in general two-digit ISIC Philippine industries appear to have the same estimates of the elasticity of substitution, at least compared with estimates for US manufacturing. Aside from an upward bias of CES estimates and from market imperfections present especially in a less developed economy which contradict the assumptions of the CES production function it is argued that these estimates are generally plausible. In any case, these elasticities of substitution appear to contradict the well-known hypothesis in the economic development literature that less developed countries face smaller degrees of capital-labor substitution possibilities. Some attempts at deriving relatively more general results for CES parameters are made. The results are not superior to the more direct and simpler estimates.

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