Table 6.4. COBB-DOUGLAS PRODUCTION FUNCTIONS BY BUSINESS ORGANIZATIONS
(Capital Measure in Fixed Assets)

Period	N	Constant	α_K	α_L	R	$\alpha_K + \alpha_L$
A. Proprietorships						
1957	15	0.395 (0.596)	0.638 (0.101)	0.391 (0.115)	0.968	1.029
1958	16	1.220 (0.587)	0.332 (0.124)	0.616 (0.124)	0.956	0.948
1959	16	3.222 (2.255)	0.953 (0.363)	*	0.618	0.953
B. Partnerships						
1957	14	0.593 (0.467)	0.176 (0.105)	0.905 (0.129)	0.977	1.081
1958	15	0.012 (0.564)	0.476 (0.161)	0.494 (0.160)	0.961	0.970
1959	16	0.018 (0.791)	0.573 (0.145)	0.308 (0.188)	0.916	0.881
C. Corporations						
1957	18	0.916 (0.014)	0.613 (0.193)	0.386 (0.231)	0.866	0.999
1958	17	0.176 (0.865)	1.010 (0.197)	-0.033 (0.233)	0.955	1.067
1959	19	0.081 (0.967)	0.871 (0.197)	0.176 (0.225)	0.939	1.047

Standard errors of coefficients in parentheses.

Table 6.5. COBB-DOUGLAS PRODUCTION FUNCTIONS BY BUSINESS ORGANIZATIONS (Capital Measure, K^*)

Period	N	Constant	α_K	α_L	R	$\alpha_K + \alpha_L$
A. Proprietorships						
1957	15	0.973 (0.966)	.619 (.090)	.398 (.105)	.973	1.017
1958	16	1.144 (0.582)	.340 (.112)	.614 (.120)	.958	0.954
1959	16	4.351 (2.625)	.545 (.468)	-.129 (1.526)	.378	0.545
B. Partnerships						
1957	14	0.554 (0.449)	0.191 (0.095)	0.890 (0.119)	0.979	1.081
1958	15	0.012 (0.529)	0.406 (0.125)	0.553 (0.132)	0.964	0.959
1959	16	0.013 (0.905)	0.492 (0.149)	0.460 (0.183)	0.899	0.952
C. Corporations						
1957	18	0.899 (0.015)	0.580 (0.193)	0.415 (0.233)	0.860	0.995
1958	17	-0.055 (0.986)	1.010 (0.221)	0.022 (0.248)	0.948	1.032
1959	19	-0.057 (0.010)	0.866 (0.206)	0.182 (0.234)	0.936	1.048

Standard errors of coefficients in parentheses.

estimates use book value of fixed assets as a measure of capital. The second use fixed assets plus capital expenditures during the year. As in the previous Cobb-Douglas production functions reported in this chapter, the sum of the input elasticities, α_L and α_K, are very close to 1, whatever the nature of the business organizations studied. They suggest that the linear and homogeneous Cobb-Douglas production function is an appropriate specification of the production function for Philippine manufacturing industries.

There is a pattern which appears obvious, however, as we examine the production functions by business organizations. This is in terms of the changes in the relative shares implied, by estimates of production functions as shown in Table 6.6. Only estimates from regressions involving only fixed assets are used in deriving the relative share ratios, α_K/α_L, so that these could be more compatible with findings from the earlier study. The ratios of the capital-labor relative shares appear to be smaller for proprietorships and partnerships and much larger for corporations. A high ratio, of course, implies a high share of capital relative to labor. The estimates of shares for corporations approach the ones which were arrived at for the whole manufacturing sectors, as reported in my 1963

Table 6.6. RELATIVE SHARES BY TYPE OF BUSINESS ORGANIZATIONS (α_K/α_L) FROM COBB-DOUGLAS

	1957	1958	1959
Proprietorships	1.63	0.54	*
Partnerships	0.19	0.96	1.86
Corporations	1.59	*	4.95
Whole Large Mfg.	1.75	4.58	4.58
Pooled Production Function, 1956-1959	2.38		

*One of the coefficient estimates not significant.

Sources: Table 6.4;

G.P. Sicat (1963), Table 1, p. 113;

Table 4 (The regressions utilized here are for establishments with at least 20 workers, "large" by description in this earlier study.)

study. The "grand" regression derived for all manufacturing establishments from 1956 to 1959, found in the same study, has a capital share which is 2 2/5 larger than that of labor. The corporate production functions dominate the total regression effects, as can be shown by the near similarity of the relative capital shares implied for both corporations and all establishments with at least 20 workers. This should not be at all surprising because a great proportion -- up to 90 per cent -- of the respondents to the manufacturing surveys are corporations. What is interesting is the "reversal" of the relative share positions of capital and labor as we move from non-corporate enterprises to corporate. This suggests something more important. In view of the greater incidence of unpaid family workers in non-corporate enterprises, it is interesting that this pattern of capital shares being relatively more than labor shares is observed. It may be expected that the relative wage component of non-corporate enterprises would be less than capital shares because these wages are treated as non-wage income, so that they accrue to the capital input. The only logical explanations to this result would be the relatively higher rates of returns to capital of corporate enterprises. This is easy to believe considering the industrial promotion policies of the Philippines during the period considered (Sicat

1965). We note, however, that some manufacturing establishments did not receive benefits from these policies. Another reason would be the relative shares of other non-wage incomes which get attributed to capital, as we have noted already in Chapter 4.[2]

(b) CES Production Functions by Business Types

Table 6.7 shows CES production functions by business organizations. The values of b go wild for single proprietorships. For partnerships the implied elasticities of substitution exceed unity, but they are somewhat smaller than the values obtained for corporations. We note that these estimates are similar in general to most of what we have obtained in Chapter 5 and that the ones obtained for corporate enterprises appear to be somewhat higher than the estimates made for Philippine manufacturing reported in the 1963 study.

In general, we close this section giving further strength to the usefulness of the Cobb-Douglas production function, with the exponents of the inputs restricted to 1 for the Philippine manufacturing sector. In the following section, a few further words will be made concerning Cobb-Douglas production functions.

---

[2]See p. 4-47 ff., below.

Table 6.7. CES PRODUCTION FUNCTIONS BY BUSINESS ORGANIZATIONS

Period	N	Constant	b	R
A. Proprietorships				
1957	15	.875 (1.119)	.977 (.154)	.869
1958	16	.155 (2.060)	1.094 (.284)	.717
1959	16	-15.481 (12.006)	3.204 (1.664)	.458
B. Partnerships				
1957	14	1.754 (1.806)	.856 (.244)	.712
1958	15	-.206 (1.412)	1.140 (.190)	.857
1959	16	-1.775 (2.292)	1.366 (.310)	.762
C. Corporations				
1957	18	-3.529 (4.633)	1.604 (.601)	.355
1958	17	-3.608 (3.836)	1.611 (.496)	.642
1959	19	-3.157 (3.547)	1.555 (.455)	.638

Philippine Manufacturing, "Large" Enterprises*

	b
1957	1.305 (0.416)
1958	1.340 (0.422)
1959	1.494 (0.394)

*Source for results for Philippine Manufacturing: G.P. Sicat (1963), Table 2.

An International Comparison of Cobb-Douglas Production Function Estimates

We close this study with an international comparison of Cobb-Douglas estimates. In the 1963 study, some comparisons were made with estimates for the U.S., India, and Pakistan Cobb-Douglas production functions. Estimates for India are reported by Murti and Sastry (1957), for Pakistan by Ranis (1962), and for the US, in spite of the abundance of recent estimates, we refer to the work of Bronfenbrenner and Douglas (1939). We also try to report those made for Australia and New Zealand manufacturing. These are presented in Table 6.8.

I also made a minor attempt at estimating Indian production functions in an effort to parallel the production functions reported in this chapter. Indian manufacturing establishments were classified in terms of employment sizes, unlike in the Philippines, in the Thirteenth Indian Census of Manufactures 1958. The results of this attempt, which are reported here for the first time, are shown in Table 6.9.

The most recent Cobb-Douglas estimates for particular industries for the United States are those estimated by Hildebrand-Liu (1964), which were just one set of esti-

Table 6.8. COBB-DOUGLAS PRODUCTION FUNCTIONS ESTIMATED FOR OTHER COUNTRIES

	α_L	α_K	$\alpha_L + \alpha_K$	α_K/α_L
India				
1) Tewari, J.N.				
1946	0.66	0.31	0.97	0.47
1947	0.68	0.47	1.15	0.69
2) M.M. Butt				
1946	0.77	0.23	1.00	0.30
1947	0.57	0.50	1.07	0.77
3) R.J. Bhatia				
1948 (I)	0.67	0.26	0.93	0.39
(II)	0.59	0.44	1.03	0.75
4) Murti and Sastry (1957)				
1951 All Pooled	0.59	0.40	0.99	0.68
1952 All Pooled	0.53	0.50	1.03	0.94
1951 Cotton	0.92	0.12	1.04	0.13
1952 Cotton	0.66	0.34	1.00	0.52
1951 Jute	0.84	0.14	0.98	0.17
1952 Jute	0.91	0.34	1.25	0.37
1951 Sugar	0.59	0.33	0.92	0.56
1952 Sugar	0.24	0.94	1.18	3.92
1951 Coal	0.71	0.44	1.15	0.62
1952 Coal	0.58	0.58	1.16	1.00
1951 Paper	0.64	0.45	1.09	0.70
1952 Paper	0.59	0.49	1.08	0.83
1951 Basic	0.80	0.37	1.17	0.46
1952 Chemicals	0.82	0.40	1.22	0.48
1951 Electricity	0.20	0.67	0.87	3.35
1952 Electricity	0.02	1.00	1.02	50.00
Pakistan				
G. Ranis (1962)				
Textiles	0.64	0.37	1.01	0.58
Light Engineering	0.84	0.18	1.02	0.21
Plastics	0.42	0.37	0.79	0.88
Leather & Leather Goods	0.55	0.32	0.89	0.58

	α_L	α_K	$\alpha_L + \alpha_K$	α_K/α_L
United States				
1) Bronfenbrenner & Douglas (1939)				
All manufacturing	0.86	0.08	0.94	0.09
Clothing & Textiles	1.09	-0.17*	1.09	1.09
Foods & Beverages	0.79	0.24	1.03	0.30
Metals & Machinery	0.70	0.24	0.94	0.34
2) Douglas (1948)				
1889	0.51	0.43	0.94	0.84
1899	0.62	0.33	0.95	0.53
1904	0.65	0.31	0.96	0.48
1909	0.63	0.34	0.97	0.54
1914	0.61	0.37	0.98	0.61
1919	0.76	0.25	1.01	0.33
3) Marschak & Andrews (1944)				
1909	0.74	0.32	1.06	0.43
Australia				
1) Gunn and Douglas (1941)				
1926-7	0.59	0.34	0.93	0.58
1934-5	0.64	0.36	1.00	0.56
1936-7	0.49	0.49	0.98	1.00
New Zealand				
Williams (1945)				
1938-9	0.46	0.51	0.97	1.11
United Kingdom				
Lomax (1950)				
1924	0.72	0.18	0.90	0.25
1930	0.75	0.13	0.88	0.17

*Assume as zero; poor fit.

Sources:

G.P. Sicat (1963), p. 123; A.A. Walters (1963), Tables III and V, p. 31, 36.

Table 6.9. COBB-DOUGLAS PRODUCTION FUNCTIONS FOR INDIAN MANUFACTURING, 1958

Number of Employees	α_L	α_K	N	R	$\alpha_L + \alpha_K$	α_K/α_L
20-49	0.874 (0.222)	0.162 (0.198)	26	0.914	1.036	0.185
50-99	0.391 (0.125)	0.591 (0.147)	26	0.978	0.982	1.512
100-249	0.440 (0.187)	0.375 (0.151)	26	0.868	0.815	0.852
250-499	0.509 (0.135)	0.495 (0.076)	27	0.936	1.004	0.972
500-999	0.471 (0.177)	0.387 (0.131)	24	0.911	0.858	0.822
1,000-1,999	0.567 (0.195)	0.335 (0.198)	16	0.874	0.902	0.591
2,000-4,999	0.644 (0.124)	0.196 (0.125)	12	0.968	0.840	0.304
5,000 and above	0.779 (0.238)	0.188 (0.184)	5	0.925	0.967	0.241

Standard errors of coefficients in parentheses.

mates among many others. In order to make the estimates made in this study with those for an advanced country, it is highly desirable to reproduce the Hildebrand-Liu estimates of Cobb-Douglas production functions. These are shown in Table 6.10. We note that these Cobb-Douglas estimates are based on regression models which were estimated by single equation least squares and which contained the same concept for capital, book value of fixed assets.

Salient comparisons

It will now be necessary to compare some of the results. More fully, we note that all production functions contain estimates of the coefficients of labor and capital, which were directly attempted. Thus they are more akin to the intertemporally pooled cross-sections reported in the first part of this chapter and to the 1963 study than to the ones which were attempted in this study. As pointed out in Chapter 3, earlier direct estimates of both input elasticity coefficients of the Cobb-Douglas production functions were not successful. So, an attempt was made to derive production functions with the sum of elasticities restricted to unity, i.e., $\alpha_L + \alpha_K = 1$. We have made the conclusion that the restricted Cobb-Douglas production function is probably as good as any specification for Philippine manufac-

Table 6.10. COBB-DOUGLAS ESTIMATES FOR THE US BY HILDEBRAND-LIU, FOR 1957

ISIC Code	Industry	α_L	α_K	$\alpha_L + \alpha_K$
20	Manufactured food	0.536 (0.139)	0.618 (0.112)	1.154
21	Beverages	n.a.	n.a.	
22	Tobacco	n.a.	n.a.	
23	Textiles	n.a.	n.a.	
24	Footwear and apparel	0.501 (0.102)	0.289 (0.080)	0.790
25	Wood and cork	0.443 (0.296)	0.462 (0.114)	0.905
26	Furniture & fixtures	n.a.	n.a.	
27	Paper products	0.669 (0.085)	0.345 (0.057)	1.014
28	Printed & published materials	n.a	n.a.	
29	Leather products	0.824 (0.115)	0.118 (0.079)	0.942
30	Rubber products	0.716 (0.161)	0.358 (0.148)	1.074
31	Chemical products	0.801 (0.163)	0.209 (0.114)	1.010
32	Petroleum and coal	0.673 (0.279)	0.291 (0.202)	0.964
33	Non-metallic mineral products	0.699 (0.085)	0.337 (0.073)	1.036
34	Basic metal	0.764 (0.186)	0.303 (0.137)	1.067

ISIC Code	Industry	α_L	α_K	$\alpha_L + \alpha_K$
35	Metal products	0.649 (0.116)	0.276 (0.079)	0.925
36	Machinery, non-electric	0.763 (0.112)	0.269 (0.095)	1.032
37	Electrical machinery	0.584 (0.111)	0.337 (0.079)	0.921
38	Transportation	0.887 (0.076)	0.252 (0.056)	1.139
39	Instruments & related products	0.666 (0.126)	0.362 (0.111)	1.028

Standard errors of coefficients in parentheses.

n.a. - estimates not available or not estimated turing industries, superior to the estimates based on CES production functions.

<u>Constant Returns to Scale</u>? There does not appear to be any strong evidence of the sum of these elasticities to exceed unity. In fact, in many instances, these sums have lingered to a value less than 1. This is true for estimates of the US and other higher income countries as well. The case of more specific manufacturing industries yield differences in the sums of these coefficients. It is to be noted, for instance, that the Murti-Sastry estimates for specific Indian industries have a tendency to exceed unity, suggesting some evidence of increasing returns to scale.

However, the estimates I derived for Indian manufacturing Cobb-Douglas production functions suggest that for Indian manufacturing establishments, there is no evidence of increasing returns. In fact, the manufacturing enterprises with smaller employment sizes have the highest value for $\alpha_L + \alpha_K$, where one would expect that those with larger sizes would display more properties of increasing returns. As the employment size increased, the sum of these Cobb-Douglas input elasticities remain at less than 1. At least in terms of types of business organizations in Philippine manufacturing, to which these Indian production functions are most relevant in terms of comparisons, there seems to be no apparent difference in the values of the sum of elasticities for Cobb-Douglas production functions as far as the total sums of the elasticities are concerned.

Returns to scale in 2-digit industries. Bronfenbrenner & Douglas, Ranis, and Murti & Sastry have provided us with some production functions, which are more specific than just 2-digit levels of aggregation. But they provide a starting point. It appears that the Murti-Sastry estimates are the only ones in which $\alpha_K + \alpha_L > 1$, in some cases. The findings for Pakistan and for the US manufacturing in 1909 appear to give the evidence that the sum of these elasticities is at most equal to 1.

My estimates for two-digit manufacturing industries based in intertemporally pooled cross-sections, as reported in this chapter (Tables 6.1 and 6.2), tend to show some evidence of increasing returns which were not apparent in the estimates for the whole manufacturing sector as found in the 1963 study. However, in view of the greater reliability of the observations generated by the single cross-section of tabulated establishments, which occupies the main part of this study, it may be suggested that these evidence of increasing returns may be due to the error terms involved and to a bias resulting from aggregating temporal cross-sections. The second reason may be strongest for at least five 2-digit industries (beverages, tobacco, paper products, electrical machinery, and transportation). They had at most 15 observations, implying that at most only 5 observations were available for each year for these industries whose data were pooled intertemporally. These are also industries which appeared to show the highest implied returns to scale. With the exception of non-metallic mineral products (ISIC 33), the evidence of increasing returns from these regressions is not strong.

For the United States, Hildebrand-Liu's Cobb-Douglas production functions (Table 6.10) shows some evidence of increasing returns, especially for food and transportation, rubber products, basic metal, and non-metallic mineral (or, in US SIC, stone clay, and glass products). We note that Hildebrand-Liu did not consider the simple Cobb-Douglas production functions among the best fits as their presentation would show. But these Cobb-Douglas results tended to agree with their findings.[3]

Thus, while specific industries may reveal some increasing returns to scale, the less developed countries tend

---

[3]See Hildebrand & Liu (1964), especially pp. 104-110.

to show a structure of production which is at most of the constant returns to scale type. The aggregate cross-section manufacturing production functions for all countries support the conclusion that the aggregate production function may be closely approximated by a Cobb-Douglas production function, showing constant returns to scale. Some evidence of increasing returns to scale to specific two-digit industries are evident in the United States.

Our discussion of returns to scale should take note of some other estimates from time series data. The evidence for the United States aggregate manufacturing shows enormous increasing returns.[4] An alternative way of treating these "high returns to scale," due to technological progress, has been suggested in a pioneering paper of Solow (1957), which has since influenced more refined empirical production function research. Solow's approach reconciles the Cobb-Douglas production function with constant returns to scale and shifts in production functions due to technical change.

Relative Factor Shares

In studies of production functions, a discussion of relative factor shares comes in naturally.

---

[4] On this, see for instance, Stigler (1961) and Brown and Popkin (1962).

In the last column of Table 6.8, we took the ratios α_K/α_L, for the Cobb-Douglas factor share ratios of capital to labor for all the estimates by countries which we report. When $(\alpha_K/\alpha_L) = 1$, the estimated factor shares plit the output between capital and labor. These ratios are less than 1 for those shown in Table 6.8 many of them in the range of 0.75 to 0.35. This is true for India and Pakistan as well as the advanced countries. The ratios for the Philippines exceed unity in general, and as we have found, quite high in terms of the corporate manufacturing sector (see again Table 6.6).

Thus, from what we can get from these results, the relative share of capital in the Philippines on an aggregative basis appears to exceed that of labor.

Since many of the estimates presented are on specific industries, we try to note if this pattern is reflected in production functions at lower levels of aggregation. We note that Murti and Sastry's estimates for some Indian industries yield relatively higher labor shares, except for sugar (in one year) and for electricity generation. My estimates of Indian manufacturing production functions by size of employment increases, the relative share for labor, with the exception of the medium industries (firms with 50 to 999 workers).

It is interesting to note that as the scale of employment increases, the relative share of labor to output, as shown by our estimates of Cobb-Douglas factor shares, increases. Ranis' Pakistani production functions are similar to the Indian functions.

It is of course interesting how these findings compare with the Cobb-Douglas factor shares estimates in this study and with those computed by Hildebrand & Liu. Table 6.11 summarizes the results for two-digit industries. The first three columns summarizes the findings for the Philippines. The first two are from the temporally pooled estimates reported in Tables 6.1 and 6.2 in this chapter. The third reproduces the "best" ratios obtained in Table 4.13, Chapter 4, the last shows the Hildebrand-Liu Cobb-Douglas shares ratios for the US. There is more difference that ought to be expected between the temporally pooled Philippine factor shares ratios and those derived from restricted Cobb-Douglas production functions in view of what we have already said. However, it is interesting to note the relative similarities of some estimates of these ratios for about 7 to 8 ratios out of 12 pairs of ratios which are compared. Comparing the "best" ratios for the Philippines and those for US factor shares, there are a number in which

Table 6.11. PHILIPPINE AND US COBB-DOUGLAS FACTOR SHARES RATIOS (α_K/α_L)

ISIC Code	Industry	PHILIPPINES α_K/α_L	PHILIPPINES $\alpha_K{}^*/\alpha_L$	PHILIPPINES "Best" α_K/α_L	U.S. Hildebrand-Liu α_K/α_L
20	Manufactured food	2.378	1.582	1.198	1.153
21	Beverages	*	*	26.027	n.a.
22	Tobacco	0.148	0.157	1.304	n.a.
23	Textiles	0.409	0.441	0.362	n.a.
24	Footwear & apparel	0.321	0.266	0.346	0.577
25	Wood & apparel	0.422	0.448	0.567	1.043
26	Furniture & fixtures	0.642	0.611	1.801	n.a.
27	Paper products	0.345	0.419	0.348	0.516
28	Printed & published materials	1.363	0.484	0.328	n.a.
29	Leather products	*	*	0.927	0.143
30	Rubber products	*	*	1.183	0.500
31	Chemical products	*	*	0.420	0.261
33	Non-metallic mineral	0.699	0.477	1.083	0.482
34	Basic metal	n.p.	n.p.	0.428	0.396
35	Metal products	0.644	0.680	0.808	0.425
36	Machinery, non-electric	0.886	0.499	0.439	0.352
37	Electrical machinery	0.762	0.873	0.580	0.577
38	Transportation	*	*	0.421	0.284
39	Miscellaneous manufactures[a]	1.094	1.635		

Instruments & related products	)[b]	0.544
	)	
Petroleum and coal	)	0.432

---

[a]This includes petroleum refining firms in addition to all other miscellaneous manufacturing enterprises.

[b]First ratio is for "instruments and related products; the second, for petroleum products. This classification is more compatible with the aggregations performed for Philippine manufacturing.

n.a. = means production function for this industry group not available.

*The ratio not computed, since one of the coefficients is negative and nonsignificant.

Sources: Table 4.11, Tables 6.1 and 6.2 and Table 6.10 above.