The value added of industry $\underline{i}$ is just a transformation from gross sales. It is given by (dropping all subscripts for $\underline{i}$ in the subsequent discussion)

$$V = \left(\frac{G - C}{G}\right) G$$

where C is the cost of total materials purchased.

$$V = (1-C/G)G$$

Let $c = C/G$ where c is a constant value added ratio. Therefore

$$V = (1-c)G$$

$$(4.3) \qquad = (1-c)G.$$

Substituting (4.3) and (4.2) into (4.1), we have

$$(4.4) \qquad V = (1-c)\, B\, K^{\alpha_{Ki}^{*}} L^{1-\alpha_i^{*}} u$$

Dividing (4.1) by (4.4), we have

$$\frac{V}{V} \overset{?}{=} \frac{A K^{\alpha_K} L^{1-\alpha_K} v}{(1-c) B K^{\alpha_K^{*}} L^{1-\alpha_K^{*}} u}$$

$$1 \overset{?}{=} \left\{ \frac{A}{(1-c)\ B} \right\} \frac{K^{\alpha_K} L^{1-\alpha_K} v}{K^{\alpha_K^*} L^{1-\alpha_K^*} u}$$

$$1 \overset{?}{=} K^{\alpha_K - \alpha_K^*} L^{(1-\alpha_K) - (1-\alpha_K^*)} \left\{ \frac{v}{u} \right\}$$

$$(4.5) \qquad 1 = \{1\}\ K^{\alpha_K - \alpha_K^*} L^{\alpha_K^* - \alpha_{iK}} v'$$

$$1 = \{1\}\ K^{o} L^{o} v' = 1$$

where $v' = \left(\frac{v}{u} \right)$, also with $E(v') = 0$, $E(v'^2) = \text{constant}$. Provided our assumptions about the residual terms for each regression hold the result shown in (4.5) will be equal to 1, for in those cases, $\alpha_K = \alpha_K^*$. Figure 4.1 would illustrate the results.

If the value added ratio <u>c</u> is not a constant, but some function of size of the enterprise, complications arise. Suppose this is written as

$$c = f(G)$$

where G serves as the proxy for size of enterprise, such that

$$(4.6) \qquad c = \beta G.$$

The production function for V would no lonqer be linear in the

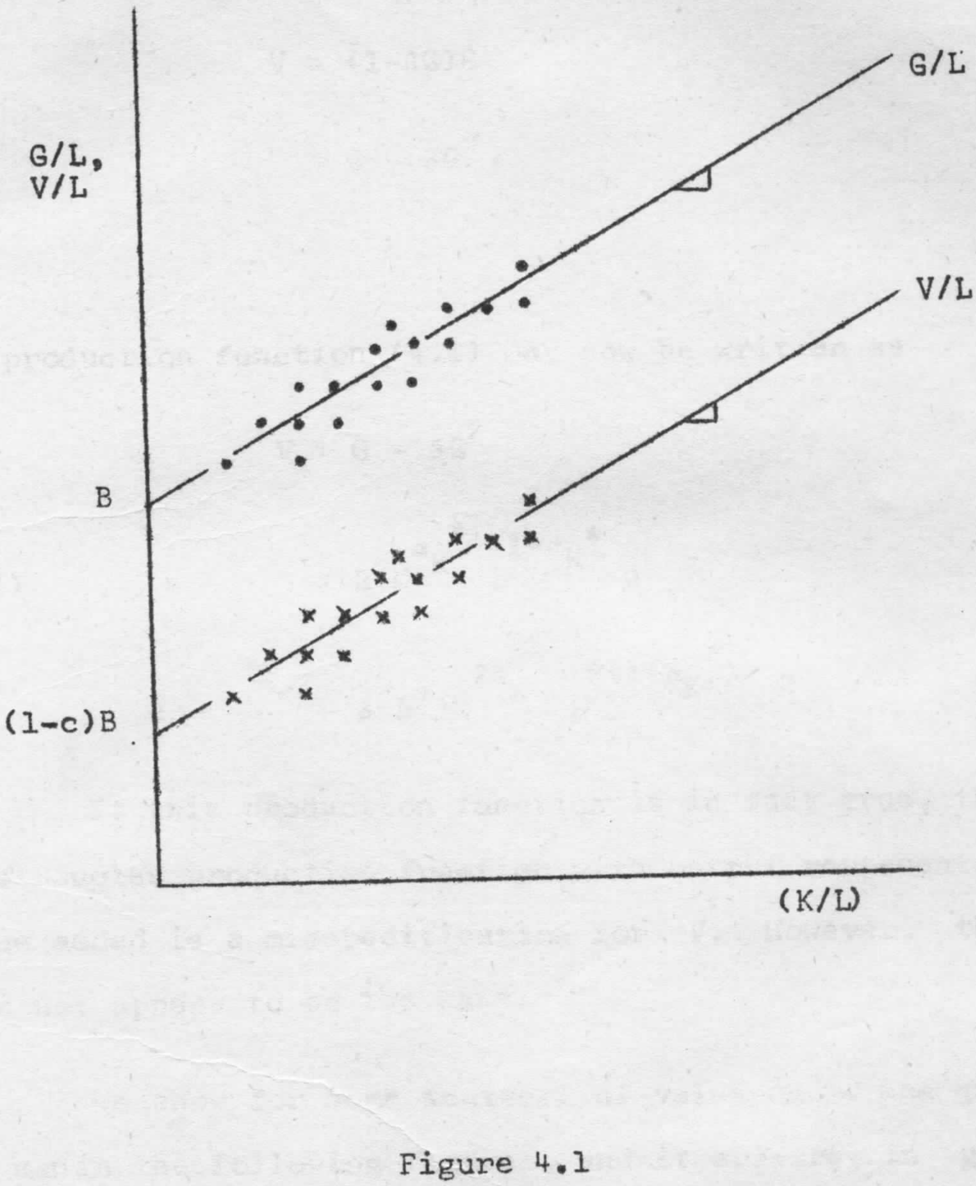


Figure 4.1

Gross Sales and Value Added Regressions With Equal Slopes, $\alpha_K = \alpha_K^*$

logarithms, and therefore specifying (4.1) will be incorrect. We may write V as

$$V = (1-\beta G)G$$

$$= G - \beta G^2.$$

The production function (4.1) may now be written as

$$V = G - \beta G^2$$

$$(4.7) \qquad = B\,K^{\alpha_K^*}\,L^{1-\alpha_K^*}\,u$$

$$- \beta\,B^2\,K^{2\alpha_K^*}\,L^{2(1-\alpha_K^*)}\,u^2.$$

If this production function is in fact true, then the Cobb-Douglas production function with output represented as value added is a misspecification for V. However, the above does not appear to be the case.

We show for some scatters of value-added and gross sales per man in the following figures, and it appears, in general, that for any specific industry group, the value added ratio can be assumed as a constant, without damage to the specification. The group of scatter diagrams of value added per man gross receipts per man which we collectively call Figure 4.2, however, suggest the following relationship,

$$\ln (V/L) = \ln C + \gamma \ln (G/L) + u$$

where u is a random error term with zero mean and constant variance, C a constant and γ slope parameter. Removing the error term and taking the antilogarithms, we have

$$(V/L) = C\,(G/L)^{\gamma}$$

$$V = C\,G^{\gamma}\,L^{1-\gamma},$$

which is a Cobb-Douglas relationship. Substituting (4.2), we get

$$V = C \left\{ B\,K^{\alpha_K^*}\,L^{1-\alpha_K^*} \right\}^{\gamma} L^{1-\gamma}.$$

Note that γ in the scatters is generally parallel to the 45° line, which implies that $\gamma = 1$. Thus,

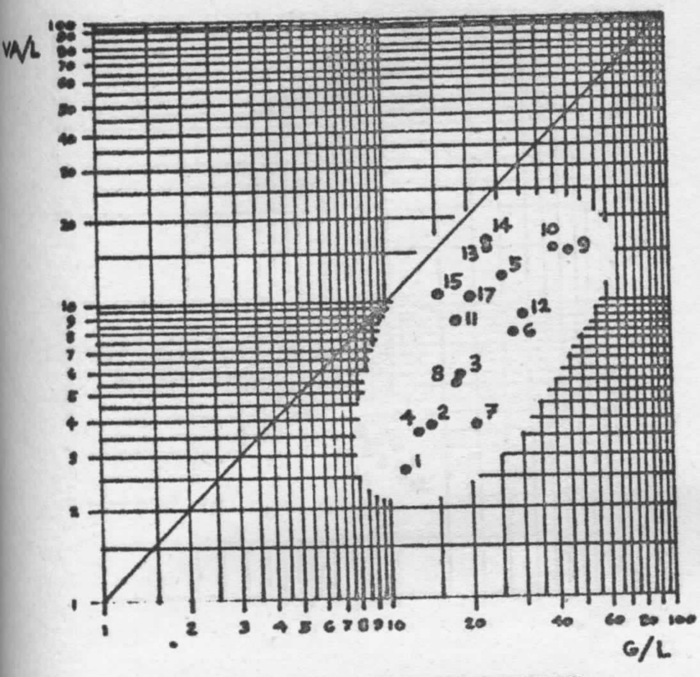
$$V = C \left\{ B\,K^{\alpha_K^*}\,L^{1-\alpha_K^*} \right\}^{1} L^{\circ}$$

(4.8) $$V = C\,B\,K^{\alpha_K^*}\,L^{1-\alpha_K^*}.$$

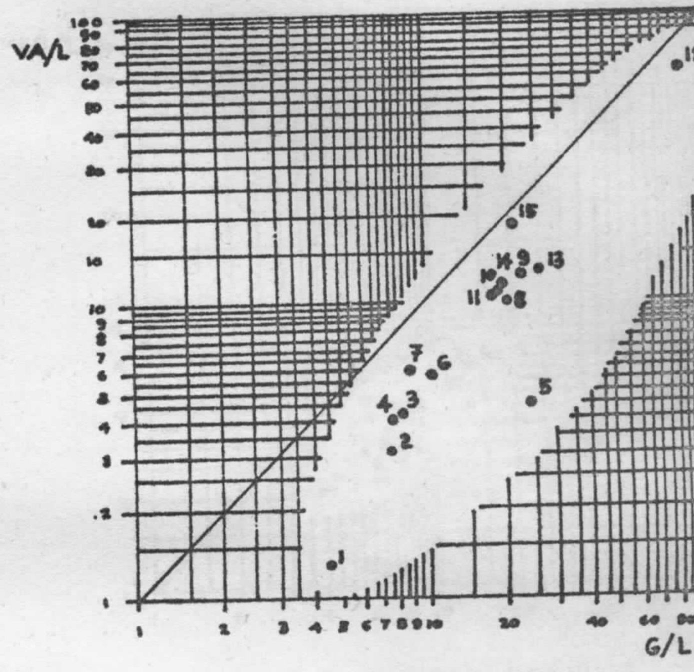
If the assumptions about the error variance is correct, it is clear that, following a reasoning developed up to equation (4.5) [redacted],

FIGURE 4.2 A

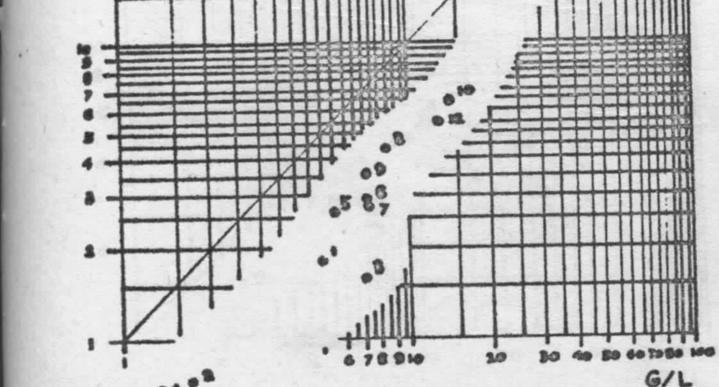
VALUE ADDED AND GROSS SALES PER MAN, BY 2-DIGIT INDUSTRY



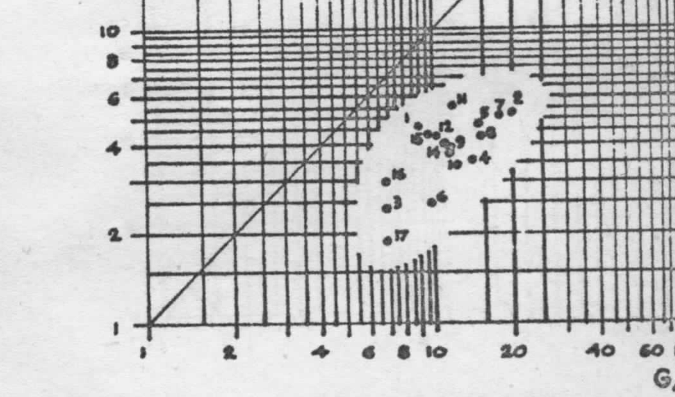
20 FOOD, MANUFACTURED



21 BEVERAGES

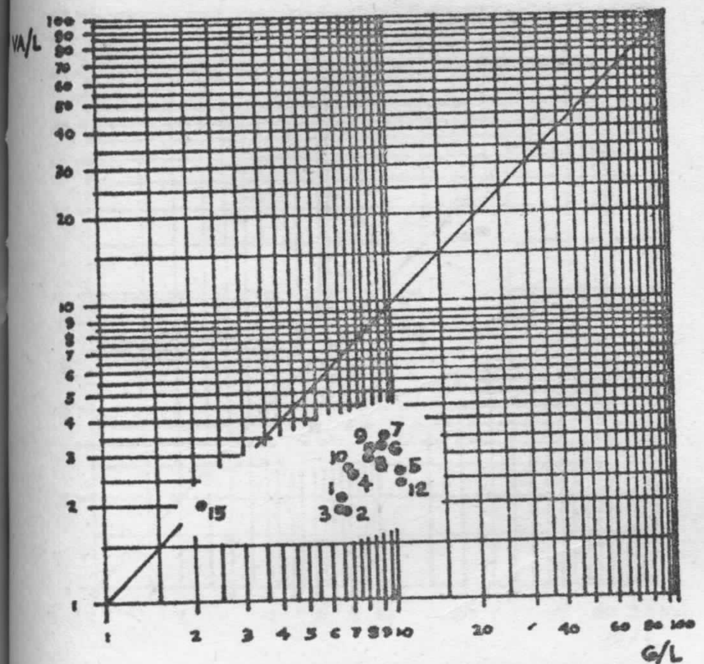


22 TOBACCO PRODUCTS

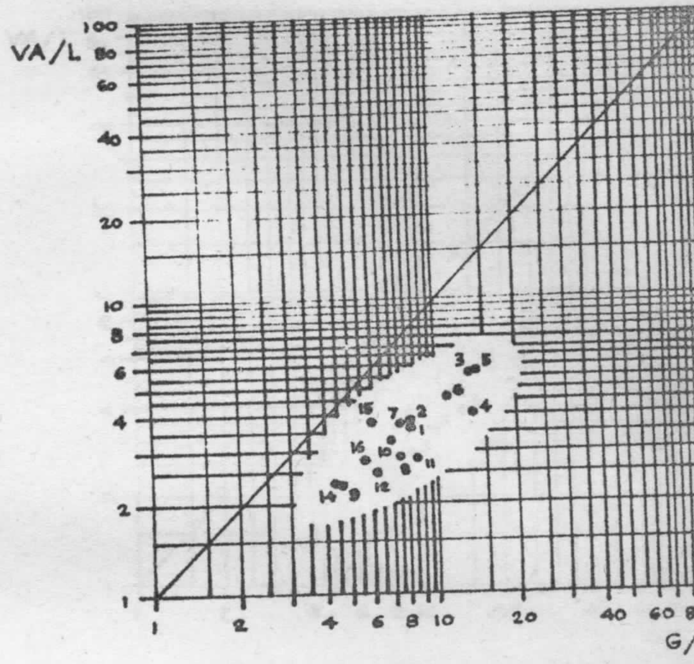


23 TEXTILES

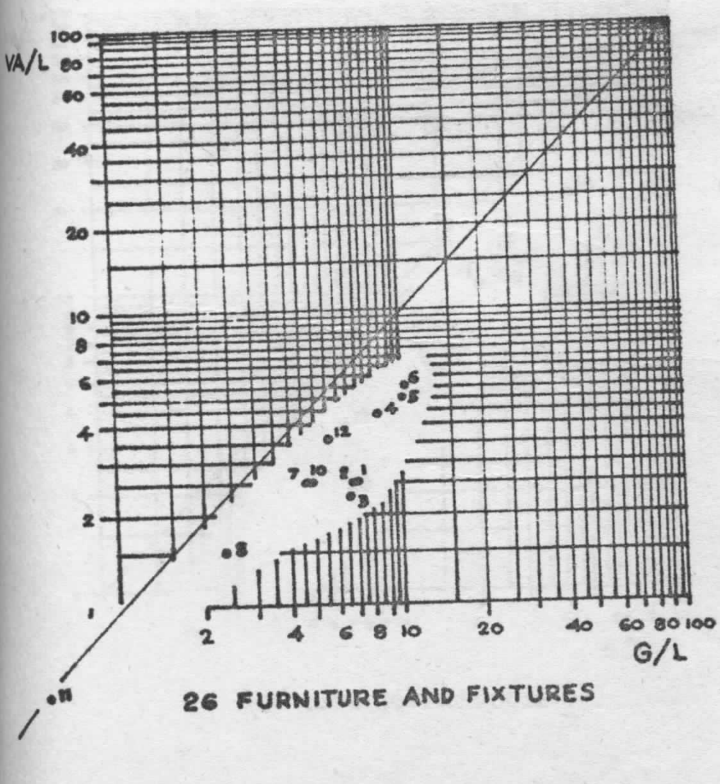
FIGURE 4.2 B
VALUE ADDED AND GROSS SALES PER MAN,
BY 2 - DIGIT INDUSTRY



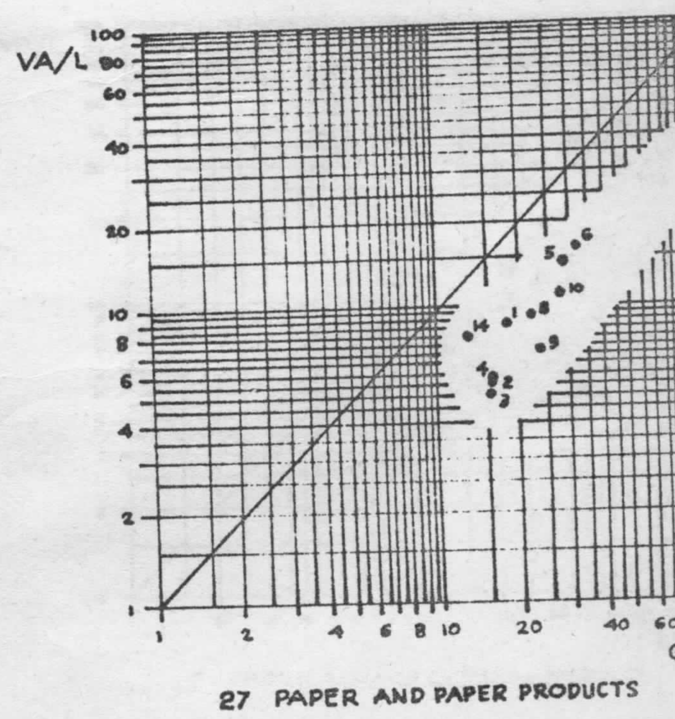
24 FOOTWEAR, OTHER WEARING APPAREL AND MADE-UP TEXTILE GOODS



25 WOOD AND CORK PRODUCTS, EXCEPT FURNITURE

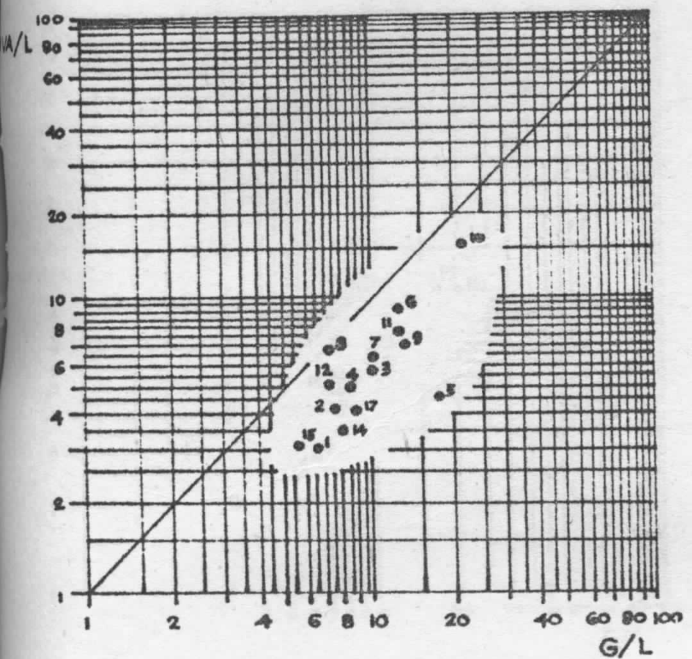


26 FURNITURE AND FIXTURES

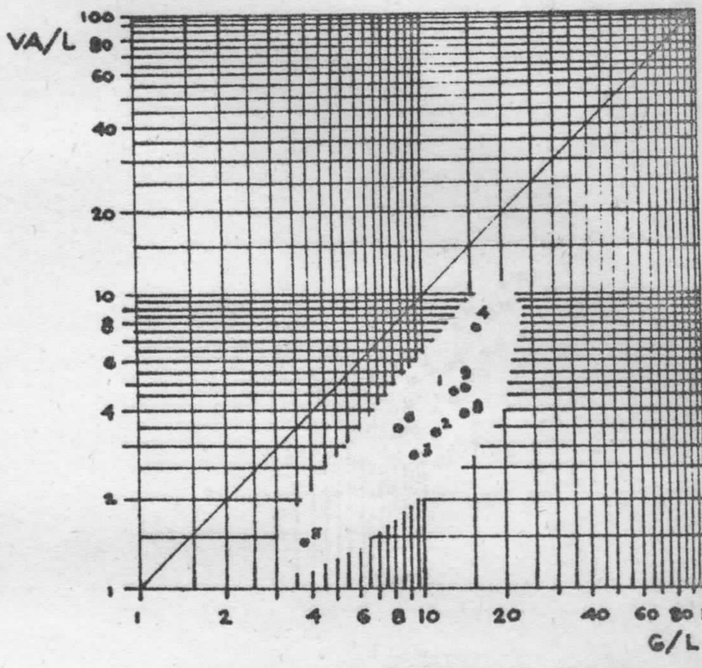


27 PAPER AND PAPER PRODUCTS

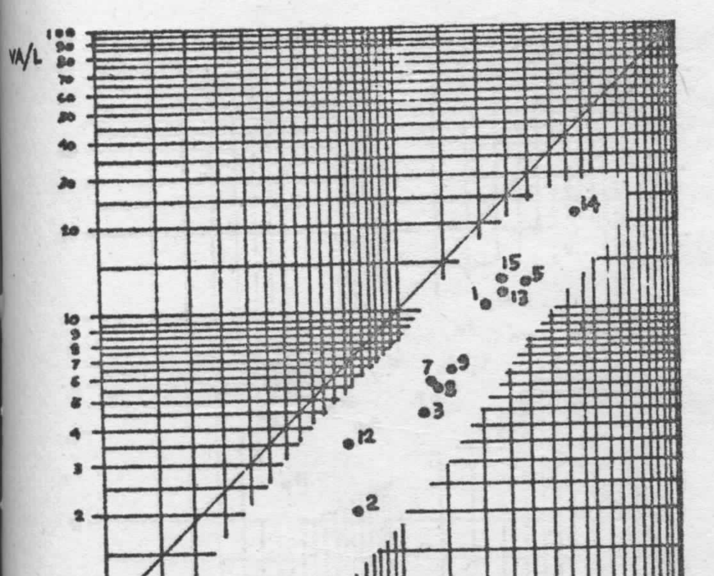
FIGURE 4.2 C
VALUE ADDED AND GROSS SALES PER MAN,
BY 2-DIGIT INDUSTRY



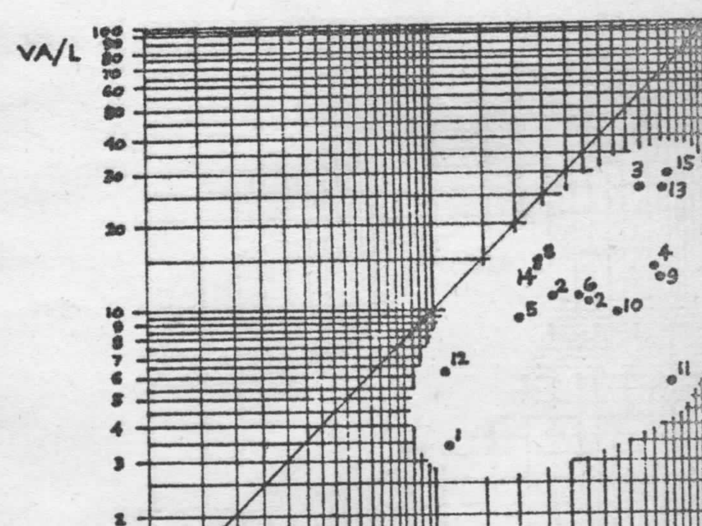
28 PRINTED AND PUBLISHED MATERIALS AND ALLIED PRODUCTS



29 LEATHER AND LEATHER PRODUCTS, EXCEPT FOOTWEAR AND OTHER WEARING APPAREL

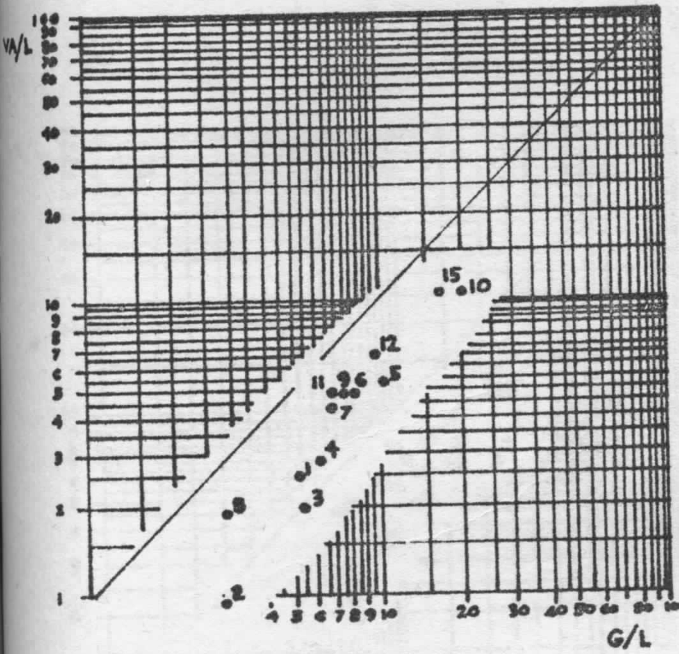


30 RUBBER PRODUCTS

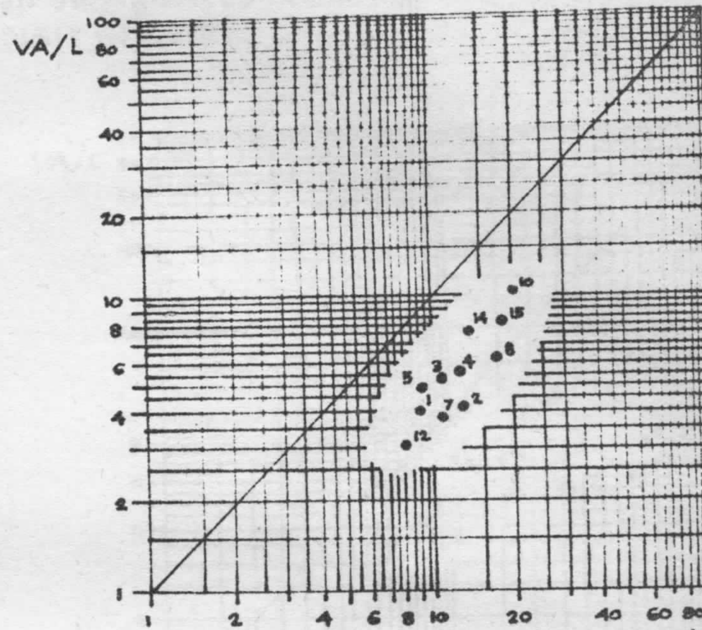


31 CHEMICALS AND CHEMICAL PRODUCTS

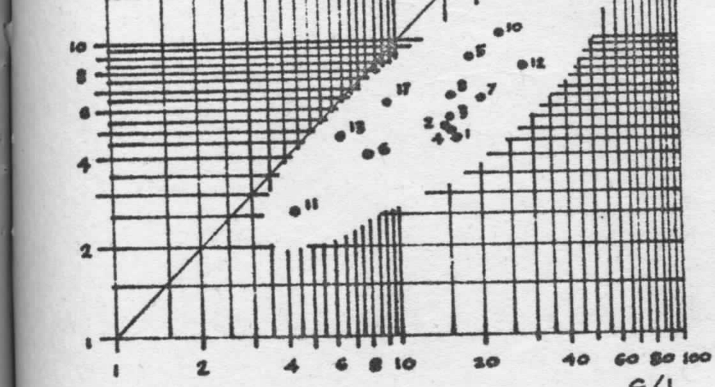
FIGURE 4.2 D
VALUE ADDED AND GROSS SALES PER MAN, BY 2-DIGIT INDUSTRY



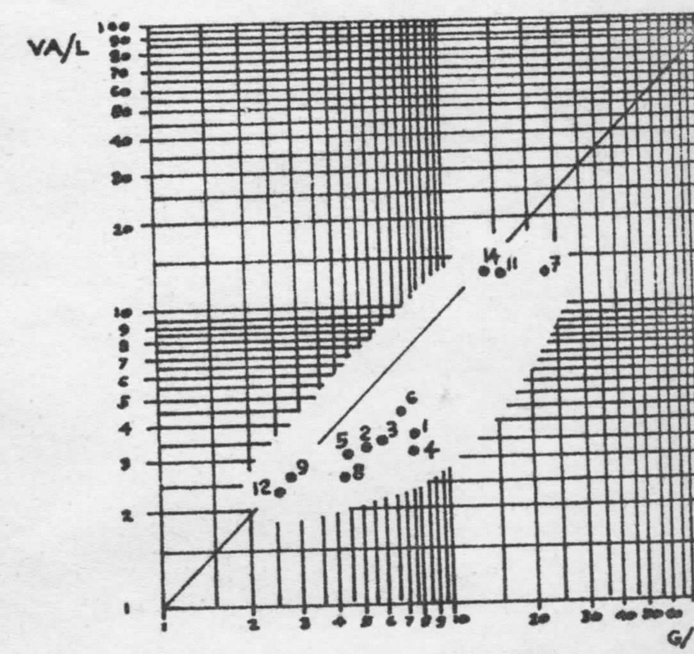
33 NON-METALLIC MINERAL PRODUCTS EXCEPT PRODUCTS OF PETROLEUM AND COAL



34 BASIC METAL PRODUCTS



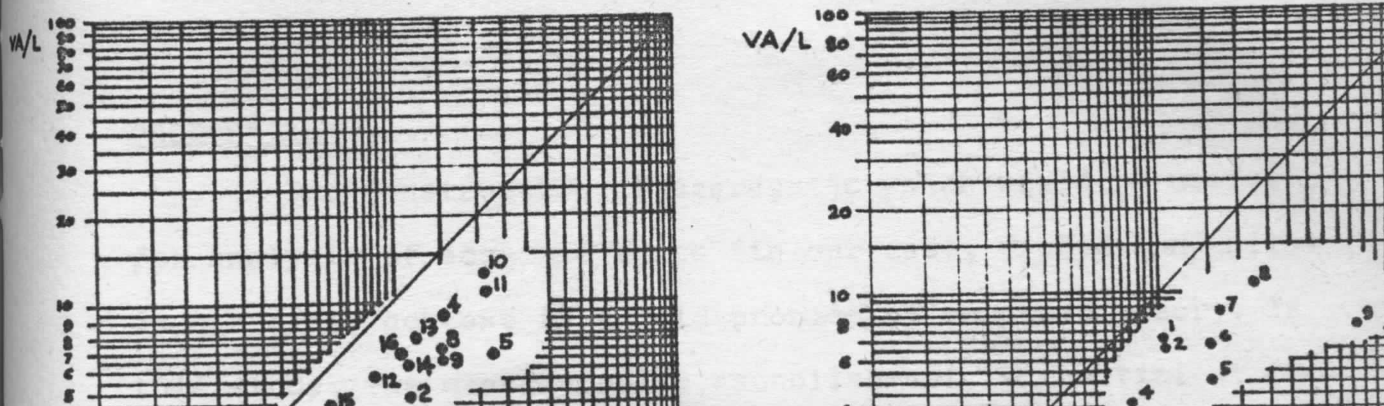
35 METAL PRODUCTS, EXCEPT MACHINERY AND TRANSPORT EQUIPMENT



36 MACHINERY, EXCEPT ELECTRICAL MACHINERY

FIGURE 4.2E

VALUE ADDED AND GROSS SALES PER MAN, BY 2-DIGIT INDUSTRY



37 ELECTRICAL MACHINERY, APPARATUS, APPLIANCES AND SUPPLIES

38 TRANSPORT EQUIPMENT

$$C\,B = A$$

and

$$\alpha_K^* = \alpha_K.$$

Aggregation

The construction of aggregates which would be useful for analysis of economic units (in our case, production units) in a broader context is an old problem of economic theory. In this study, the manufacturing establishment is the tiniest production unit under consideration. The grouping of the data per industry group was briefly spelled out in the previous chapter. As a prelude to the aggregation utilized in the rest of the paper, it is helpful to review the relevant aggregation which is done here.

Let us write the production function for a given industry i more generally as in equation (2.1a)

$$Q_{ij} = f(K_{ij}, L_{ij}, \ldots). \tag{4.9}$$

Each variable has many observations. Suppose we set an index j ($j = 1, \ldots, m$) of all observations in subgroups under each i. For each industry i and subgroup j, there will be micro-units whose data compose the jth subgroup. Using small letters to represent observations concerning each variable for the microunits, and deleting the industry subscript for convenience, it is possible to represent (for j = 1, 2,..., n) the aggregated variables as respective functions of the microvariables, observed; thus,

$$Q_j = f(q_{j1}, q_{j2}, q_{j3}, \ldots, q_{jn})$$

(4.10) $$K_j = f(k_{j1}, k_{j2}, k_{j3}, \ldots, k_{jn})$$

$$L_j = f(l_{j1}, l_{j2}, l_{j3}, \ldots, l_{jn}).$$

The standard aggregation performed in census and surveys is to assume that the variables are the sum of the microvariables within the jth subclass. Thus, this simple aggregation yields the following aggregates for all j subclasses;

$$Q_j = \sum_{k=1}^{n} q_{jk}$$

(4.11) $$K_j = \sum_{k=1}^{n} k_{jk}$$

$$L_j = \sum_{k=1}^{n} l_{jk}$$

Sometimes the aggregation utilized is to get the mean value of all the microvariables, so that units, and deleting the industry subscript for convenience, it is possible to represent (for j = 1, 2,..., n) the aggregated variables as respective functions of the microvariables, observed; thus,

$$Q_j = f(q_{j1}, q_{j2}, q_{j3}, \ldots, q_{jn})$$

(4.10)
$$K_j = f(k_{j1}, k_{j2}, k_{j3}, \ldots, k_{jn})$$

$$L_j = f(l_{j1}, l_{j2}, l_{j3}, \ldots, l_{jn}).$$

The standard aggregation performed in census and surveys is to assume that the variables are the sum of the microvariables within the jth subclass. Thus, this simple aggregation yields the following aggregates for all j subclasses;

$$Q_j = \sum_{k=1}^{n} q_{jk}$$

(4.11)
$$K_j = \sum_{k=1}^{n} k_{jk}$$

$$L_j = \sum_{k=1}^{n} l_{jk}$$

Sometimes the aggregation utilized is to get the mean value of all the microvariables, so that

$$Q_j = \sum_k q_{jk}/n \tag{4.12}$$

$$K_j = \sum_k k_{jk}/n$$

and $$L_j = \sum_k l_{jk}/n.$$

The Philippine Surveys of Manufactures use the above aggregation methods, with special emphasis on (4.11).

In view of the opportunity made available by the presence of microobservations from the special per establishment tabulation of the 1960 Survey of Manufactures, an attempt was made to use a more sophisticated aggregation method. A. Nataf (1950)[2] had shown that for an aggregation relationship such as (4.8) to be exactly specified from microvariable found in (4.10), aggregation should be of the following type:

$$Q_j = \prod_k^n q_{jk} = \sum_k^n \ln q_{jk} \tag{4.13}$$

$$K_j = \prod_k^n K_{jk} = \sum_k^n \ln k_{jk}$$

$$L_j = \prod_k^n l_{jk} = \sum_k^n \ln l_{jk}.$$

---

[2]See also Hildebrand and Liu (1965).

Nataf aggregation was attempted in the computation of the Cobb-Douglas estimates. Table 4.3 presents these estimates. All the Cobb-Douglas production function fits, except for two industries, appeared to be very good from a statistical viewpoint. Note how small the standard errors are. But this aggregation affected seriously the nature of the estimate for the coefficients of capital in the production function. The capital coefficients of the production function using gross sales as the output measure were divergent from those based on value added measure for output. This is seen in column 3, where the differences between the two measures of capital shares appear to be sizable. The unweighted average difference for all these α_K and α_K^* is 1.011. In the same way, the measures of Nataf capital shares based on value added are consistently much higher than those based on simple aggregation. The average difference is 0.395 between the estimate of the Nataf α_K and the α_K based on simple aggregation.

Another aggregation method is one suggested by L.R. Klein (1946) in a wellknown study, which antedated Nataf's. In brief, Klein suggested that an appropriate aggregation of the observations for microunits is by taking their geometric means. This would involve for any subgroup j dividing all the aggregates in (4.13) by the number of microunits within each subgroup, i.e.,

Table 4.3. PRODUCTION FUNCTIONS BASED ON NATAF AGGREGATION: CAPITAL SHARES, COMPARED FOR PRODUCTION FUNCTIONS BASED ON GROSS SALES AND VALUE ADDED

ISIC Code	Industry	α_K Based on Value Added	α_K^* Based on Gross Sales	$\alpha_K - \alpha_K^*$	α_K Based on simple aggregation
20	Manufactured Food	0.594 (0.107)	0.996 (0.432)	-0.402	0.374
21	Beverages	1.029 (0.165)	1.944 (0.347)	-0.915	0.568
22	Tobacco	0.327 (0.113)	0.485 (0.275)	-0.158	0.095
23	Textiles	0.598 (0.028)	1.906 (0.143)	-1.308	0.567
24	Footwear & apparel	0.025 (0.163)	-1.149 (1.405)	1.174	0.015
25	Wood & cork	0.723 (0.189)	2.348 (0.700)	-1.625	0.594
26	Furniture & fixtures	0.122 (0.169)			-0.042
27	Paper products	0.595 (0.079)	1.292 (0.265)	-0.697	0.292
28	Printed & published mats.	0.787 (0.094)	2.276 (0.326)	-1.489	0.540
29	Leather products	0.483 (0.089)	1.780 (0.372)	-1.297	0.284
30	Rubber products	0.717 (0.114)	1.628 (0.460)	-0.911	0.673
31	Chemical products	0.867 (0.123)	1.998 (0.373)	-1.131	0.571
33	Non-metallic mineral	0.463 (0.091	1.064 (0.288)	-0.601	0.422
34	Basic metal	0.528 (0.137)	1.326 (0.423)	-0.798	0.228
35	Metal products	0.902 (0.089)	2.375 (0.427)	-1.473	0.591
36	Machinery, non-electric	0.407 (0.201)	1.387 (0.653)	-0.980	0.091
37	Electric machinery	0.634 (0.117)	1.537 (0.322)	-0.903	0.494
38	Transportation	0.780 (0.197)	2.105 (0.625)	-1.325	0.673

α_K based on simple aggregation is based on α_1 in Table 5.

Standard errors are those in parentheses.

$$(4.14) \qquad Q_j = \sum_k^n \ln q_{jk}/n$$

$$K_j = \sum_k^n \ln k_{jk}/n$$

$$L_j = \sum_k^n \ln k_{jk}/n.$$

It would have been interesting to perform this aggregation. Unfortunately, Klein aggregation was not done.[3]

In view of the above, the logarithmic aggregation has serious disadvantage. They tend to overstate the estimate of capital share. The Cobb-Douglas production functions which were estimated were therefore based on simple aggregation given by the equations (4.11) and (4.12). Because the Cobb-Douglas production functions attempted hereafter are of the variety in which the factor shares are restricted to 1 (in view of the results using unrestricted regressions), the two aggregation techniques led to identical variables.[4]

---

[3]There were attempts to perform Klein aggregation. But a "slight" error in Fortran instructions, which remained undetected until long after the computations had already been done, caused the use of data inputs in regressions which were thought at first to be Klein aggregates.

[4]The estimation techniques depended on output and capital per man, i.e., on Q/L and K/L. The average observation for any jth subgroup would be Q/n, K/n, L/n, where n represents the total establishments per subgroup j. It is obvious, for instance, that (Q/n)/(L/n) is equivalent to Q/L.

An alternative to aggregation is to adopt a randomizing technique by picking a sampled establishment and recording it to represent the observations for all establishments within the subgroup. Thus the "aggregate" variables in equations (4.10) will be represented by the choice of a microunit (anyone of 1 to n units). Then the observations of q_j, k_j, and l_j will represent the variables Q_j, K_j, and L_j for the <u>jth</u> subgroup. This randomizing technique was in fact chosen as an alternative to simple aggregation.

The rest of this monograph will therefore be based on estimates of production functions in which the basic observations are (1) simple aggregates of microunit observations and (2) the observations for specific microunits which are randomly picked.

<u>Estimates Based on Employment Size Observations</u>

In Chapter 3, it is pointed out that the survey data used in this study had been reclassified to 17 different groups according to the size of employment of the establishment. Although most respondent establishments covered the range of the new employment size criteria, there were a number of industry groups which had fewer than 17 employment sizes. Table 4.4 gives a summary of the number of establishments whose groups had fitted into the employment sizes. As

Table 4.4. ESTABLISHMENTS CLASSIFIED BY INDUSTRY AND EMPLOYMENT

ISIC Code	Industry	Total Establishments	EMPLOYMENT SIZE																	Numbe of No Empty Sizes
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
20	Food	310	26	111	55	19	12	10	11	21	8	5	1	8	1	3	17	0	2	16
21	Beverages	62	2	10	5	8	1	6	5	9	5	3	1	2	1	3	1	0	0	15
22	Tobacco	52	2	4	7	3	4	6	3	6	3	3	0	3	1	2	4	1	0	15
23	Textiles	80	3	6	5	5	6	6	5	11	4	2	4	8	0	6	5	3	1	16
24	Footwear & apparel	380	53	148	73	32	14	31	8	11	5	2	0	1	0	0	2	0	0	12
25	Wood & cork	179	12	25	24	27	20	30	5	9	8	6	3	6	0	1	2	1	0	15
26	Furn. & fixtures	60	4	16	13	12	6	4	1	1	0	1	1	1	0	0	0	0	0	11
27	Paper products	56	3	12	12	7	2	2	2	4	9	2	0	0	0	1	0	0	0	11
28	Printing	92	5	27	20	5	3	6	5	5	5	2	2	4	0	1	1	0	1	15
29	Leather products	21	1	4	7	2	1	3	0	2	1	0	0	0	0	0	0	0	0	8
30	Rubber products	31	3	4	2	1	1	0	4	5	5	0	0	1	3	1	1	0	0	12
31	Chemical products	110	5	24	16	11	8	10	4	16	2	4	1	5	1	2	1	0	0	15
33	Non-metallic min.	73	11	16	8	9	3	6	2	7	1	2	1	4	0	2	1	0	0	14
34	Basic Metal	25	1	4	5	2	3	0	2	3	0	2	0	1	0	1	1	0	0	11
35	Metal products	13	7	23	14	11	11	8	10	14	7	2	2	2	1	0	0	0	1	14
36	Machinery, nonelec.	42	4	11	8	3	2	7	1	1	1	0	1	1	0	2	0	0	0	12
37	Electric machinery	49	3	5	8	4	5	4	1	5	4	1	2	3	1	2	0	0	0	15
38	Transportation	53	2	11	9	6	3	4	6	5	2	0	1	1	1	1	1	0	0	14
Grand total of establishments		1,688																		

Note: For employment size codes, see Table 3.2, Chapter 3.

*Equivalent to the number of observations per regression used.

can be seen, there are some industries in which no establishment falls in specific employment sizes. In some cases only one establishment is found within the employment class. This is due to the generally smaller scale of activities of the establishments which are included in the Survey of Manufactures. Food manufacturing (ISIC 20) is the most diverse among the industries listed, but we note that the establishments are generally of very small scale, as they are concentrated in the lower employment classes. The same is true of footwear and apparel (ISIC 24). In this industry, a large batch of establishments are concentrated in sizes 1 and 2. There are a number of empty cells in the large employment groups. The industry groups which had the largest number of empty cells is leather products (ISIC 29) with empty cells, followed by furniture & fixtures (ISIC 26), paper products (ISIC 27) and basic metal products (ISIC 34), each with 6 empty cells for the employment sizes. Those with 5 empty cells are footwear & apparel (ISIC 24), rubber products (ISIC 30) and non-electric machinery (ISIC 36).

The implication of having only one microproduction unit in a specific employment size is that when the sampling of establishments from each employment size was made, the lone establishment in the employment class had to picked as the sample. In this respect, the randomizing character of sampling is lost. As one can conclude from Table 4.4, 55 cells had only one establishment. However, we should bear in mind that the table consists of 306 cells (the matrix is 18 by 17), of which 65 cells are empty. Thus, the cells with only one observation are a little over 1/5 of the non-empty cells.

Estimates Based on Simple Aggregation

We shall refer to simple aggregation as that described by equations (4.11).

Table 4.5 summarizes the results of estimates of capital shares for the Cobb-Douglas production functions, based on output measures of gross sales and value added. The coefficients derived for capital vary, but when we examine the third column in which we show the differences between the two capital shares, it is seen that there is no definite bias in the estimates. The difference between the coefficient estimates for capital in manufactured food and non-metallic mineral appear somewhat excessive. However, for any paired estimates based on both concepts, the coefficient of capital derived from the value added output concept exceeded the coefficient for capital for the gross sales output concept in as many times as the former fell short. The ratio of the constants for the two production functions is given in the last column so as to give the relative magnitudes of the intercept differences.

Table 4.5. CAPITAL SHARES, COMPARED FOR PRODUCTION FUNCTIONS BASED ON GROSS SALES AND VALUE ADDED

(Arithmetic sums per group: Simple Aggregation)

ISIC Code	Industry	α_K^* Based on Gross Sales	α_K Based on Value Added	$\alpha_K - \alpha_K^*$	Ratio of Constants V/G
20	Manufactured Food	0.545 (0.092)	0.765 (0.170)	0.220	0.252
21	Beverages	0.963 (0.149)	0.963 (0.277)		0.495
22	Tobacco	0.481 (0.121)	0.566 (0.137)	0.085	0.405
23	Textiles	0.150 (0.126)	n.s.		0.438
24	Footwear & apparel	n.s.	0.257 (0.169)		0.359
25	Wood & cork	n.s.	n.s.		0.405
26	Furniture & fixtures	0.493 (0.312)	0.404 (0.243)	-0.089	0.547
27	Paper products	n.s.	n.s.		0.370
28	Printing	n.s.	n.s.		0.561
29	Leather products	0.481 (0.122)	0.391 (0.179)	-0.090	0.372
30	Rubber products	0.468 (0.228)	0.542 (0.244)	0.074	0.378
31	Chemical products	n.s.	n.s.		0.235
33	Non-metallic mineral	0.409 (0.145)	0.520 (0.152)	0.111	0.456
34	Basic metal	n.s.	n.s.		0.423
35	Metal products	n.s.	0.240 (0.173)		0.360
36	Nonelectric machinery	0.305 (0.208)	0.296 (0.210)	-0.009	0.673
37	Electric machinery	0.414 (0.106)	0.367 (0.097)	-0.047	0.515
38	Transportation	n.s.	n.s.		0.466

n.s. - not significant

Standard errors of coefficients in parentheses.

Ratio of constants is ratio of estimated intercepts for value add to gross sales regressions.