CAPITAL-LABOR SUBSTITUTION IN THE ETHIOPIAN MANUFACTURING INDUSTRIES

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I. INTRODUCTION

STUDIES made during the past two decades show that in many less developed countries (LDCs) industry employment growth rates have trailed behind the growth rates of investment and output [10] [18] [30]. In Ethiopia, industry employment increased by only 2 per cent per annum during the period 1965–71 while the average annual growth rate for investment was estimated at 9 per cent for the same period [12] [29]. Calculations also showed that employment has remained output inelastic [29].

Among the many explanations for the poor performance of industry in the employment field, a recurring theme has been "use of industrial technology ill-suited to the needs of poor countries" [3] [4] [13] [18] [27]. The argument in some circles is that the LDCs themselves cause the "employment problem" by following policies that encourage wide use of capital-intensive techniques in production. Contrary to the observed practice of uncritically going for a capital-intensive technology and after a capital deepening growth process, the appropriate course of action for these economies, it is further suggested, lies in the pursuit of policies favoring extensive use of the abundant factor (namely labor) in production. The obvious implication is that technological choice is possible and that with the adoption of the "proper" policy and strategy a less developed econ omy can always introduce production technology that is consistent with its factor endowments. Indeed, such has been the thinking behind the ever increasing literature on the subject by the Intermediate Technology Group [25], the ILO [11], World Bank [32], and other groups with research undertakings on technological choice in LDCs [3] [7] [17].

The discussions on the relationship between technology and (labor) employment necessarily take several forms. Part of the issues raised in the above theses is empirical in character and one central issue concerns the measurement of the elasticity of substitution. If in a given system measured substitution possibilities exist in fact and are of considerable scope, then the policy parameters are to blame for the slow growth rates in employment. On the other hand, if factor substitution possibilities are shown to be null (or nearly so), the empirical bases for the policy recommendations usually accompanying expert missions to poor countries (which include removal of capital subsidy, a raise in capital interest, maintainance of low and rigid wage policies, and other approaches aimed at distortions of factor prices to stimulate employment growth) would be shown to be rather shaky.

Empirical estimates of elasticities of substitution for many LDCs do suggest the existence of considerable potential for the substitution of labor for capital in industry [10] [19] [5]. Such estimates have never been produced for the Ethiopian manufacturing sector. The purpose of this short paper is to produce estimates of elasticities of substitution for Ethiopia, compare these with results obtained in other LDCs, and draw some lessons for industrial policy.

II. CONCEPT AND METHODOLOGY

A. *The Concept of Elasticity of Substitution (σ)*

The elasticity of substitution (one of the parametric measurements characterizing a production function) measures the ease with which one factor input is substituted for another in production.

Consider movements along a normally sloped isoquant involving two inputs, capital (K) and labor (L). The ratio of the inputs (L/K) varies with the ratio of the marginal productivities of the inputs (i.e., with the rate of technical substitution, M_s).

$$\frac{L}{K}=g(M_s). \tag{1}$$

Taking derivatives and computing corresponding elasticity in (1) we obtain the elasticity of substitution (designated σ).

$$\sigma=\frac{\partial(L/K)}{\partial M_s}\cdot\frac{M_s}{(L/K)}. \tag{2}$$

Thus σ measures the proportionate changes in factor ratios for proportionate changes in the rate of technical substitution. Assuming factors are paid the values of their marginal productivity, we may reformulate σ thus:

$$\sigma=\frac{\partial(L/K)}{\partial(r/W)}\cdot\frac{r/W}{L/K}, \tag{3}$$

where W is the wage rate and r is the unit price of capital. Definition (3) is significant in that σ now measures the substitution between the factor inputs (factor ratios) that obtains in response to changes in relative factor prices.[1]

B. *The Estimation Models*

The basic assumption of the input-output model is that factor inputs are combined in fixed proportions in production. The isoquant in such production functions are L-shaped and the elasticity of substitution coefficient is thus zero. Another estimation model would be the Cobb-Douglas production function

[1] Where σ is relatively high, a rise in wage rate will cause significant substitutions of capital for labor and (therefore) yield considerable increase in labor productivity (since compliments to labor i.e., capital stock is increased).

[31]. But the σ value for this function is unity. In applying this model, one is in effect forcing data into a mould which automatically yields a σ value of unity. The generalized production function most widely used in the estimation of σ is the CES production function developed by Arrow, Chenery, Minhas, and Solow (for short ACMS) [1].[2] This function makes σ an empirically determinable parameter. It also allows the identification of production situations governed by the factor substitution rules of the Leontief and Cobb-Douglas production functions. ACMS's CES production function is written as,

$$Y=\theta[\delta_K{}^{-\beta}+(1-\delta)_L{}^{-\beta}]^{-\nu/\beta}. \tag{4}$$

Where Y is output, θ, δ, β, and ν are non-negative constants representing respectively, the efficiency, distributive, substitution, and scale parameters. With $\nu=1$ (i.e., assuming constant returns to scale) the application of definition (2) to the function in (4) yields

$$\sigma=\frac{1}{1+\beta}. \tag{5}$$

The marginal productivities of labor (L) and capital (K) can be derived from the CES function.

$$\begin{aligned}\frac{\partial Y}{\partial L}&=\frac{1-\delta}{\theta^{\beta}}\left(\frac{Y}{L}\right)^{1+\beta}.\\ \frac{\partial Y}{\partial K}&=\frac{\delta}{\theta^{\beta}}\left(\frac{Y}{K}\right)^{1+\beta}.\end{aligned} \tag{6}$$

Assuming the competitive factor and product market equilibrium, the value of factor productivity equals factor price, i.e.,

$$P\left(\frac{\partial Y}{\partial L}\right)=\frac{1+\delta}{\theta^{\beta}}\left(\frac{Y}{L}\right)^{1+\beta}=w. \tag{7}$$

$$P\left(\frac{\partial Y}{\partial K}\right)=\frac{\delta}{\theta^{\beta}}\left(\frac{Y}{K}\right)^{1+\beta}=r. \tag{8}$$

Where w and r are as defined before and where P is the unit commodity price.[3] Taking logs and rearranging (7) we have,

$$\log\left(\frac{Y}{L}\right)=\frac{1}{1+\beta}\log\frac{\theta^{\beta}}{1-\delta}+\frac{1}{1+\beta}\log w,$$

or simply,

$$\log\left(\frac{Y}{L}\right)=a_0+a_1\log w. \tag{9}$$

Similarly from (8),

2 Other estimation models would be of the Variable Elasticity of Substitution (VES) types. In general, the VES function is difficult to generalize to more than two inputs and would have nonlinear parameters that are difficult to estimate. (see, for example, [15]).

3 Capital price (r) is approximately by v–w/k, where v=value added, w=wage bill, and k=capital stock.

$$\log\left(\frac{Y}{K}\right)=-\frac{1}{1+\beta}\log\frac{\delta}{\theta^{\beta}}+\frac{1}{1+\beta}\log r\,,$$

or simply,

$$\log\left(\frac{Y}{K}\right)b_0+b_1\log r\,. \tag{10}$$

(9) is what in ACMS's CES function is called the indirect method of estimating the elasticity of substitution and note that in this case it is given by the coefficient of log w in (9). Model (9) can be estimated by LSE method and requires data only on output (value added), labor input, and wage rate to compute. Where reliable data on capital and capital pricing can be obtained, formulation (10) can be used instead. In that case $\sigma=b_1$.

Consider, instead, the marginal rate of substitution (M_s) between labor and capital in equation (4)

$$M_s=\frac{\partial Y/\partial L}{\partial Y/\partial K}=\frac{1-\delta}{\delta}(K/L)^{1+\beta}\,. \tag{11}$$

Assuming once again the competitive market equilibrium, the marginal rate of substitution (equals the negative of the slope of the isoquant) is equated to the ratio of factor prices.

$$\frac{w}{r}=\frac{1-\delta}{\delta}(K/L)^{1+\beta}\,, \tag{12}$$

taking logs and rearranging,

$$\log(K/L)=-\frac{1}{1+\beta}\log\frac{1-\delta}{\delta}+\frac{1}{1+\beta}\log(w/r)\,,$$

or simply,

$$\log(K/L)=C_0+C_1\log(w/r)\,. \tag{13}$$

The elasticity of substitution equals C_1 in the last equation and can be estimated using the LSE method. While formulation (13) gives yet another estimation of σ, it requires information on capital-labor ratios, wage rates, and capital prices for its computation.

It is of course possible to relax some of the restrictive assumptions in the derivations of the estimation models above. Jacob Paroush generalized the CES function to permit estimation of the degree of homogeneity [22]. Instead of limiting the estimation of σ to a homogeneous production function of degree one, his model makes the degree of homogeneity an empirically determinable quantity. His estimating model is derived as,

$$\log Y=d_0+d_1\log w+d_2\log L\,. \tag{14}$$

Where d_0, d_1, and d_2 are constants, $\sigma=d_1/d_2$ and where the degree of homogeneity (h) is given by $(d_2-d_1)/(1-d_1)$. The CES function of ACMS then becomes a special case where $d_2=1$ (we then have $h=1$ and $\sigma=d_1$). A major problem with estimation model (14) is that it would be difficult to test the significance of σ since it is derived as a ratio of two coefficients.

P. Dhrymes has derived under somewhat less restrictive assumptions the following estimation model [8].

$$\log L = E_0 + E_1 \log w + E_2 \log Y, \qquad (15)$$

where E_0, E_1, and E_2 are constants and where $E_1 = \sigma$. This model is widely used in a number of studies aiming at the estimation of the static elasticity of substitution parameters.

Next, an attempt is made to obtain some estimates of elasticity of substitution for the manufacturing industries of Ethiopia by applying models (9), (10), (13), (14), and (15).

III. DATA AND TECHNICAL RESULTS

The data used in this study are taken from the Annual Establishment Surveys for Manufacturing Industries compiled by the Central Statistical Office (CSO) and the (then) Ministry of Commerce and Industry. Industry classifications follow the ISIC scheme and the statistics for the years 1968–75 in particular show consistency in the definitions and classifications of industry groupings. However, the industry statistics for 1964–65 were put together by the author from unpublished in the CSO.

Estimates of elasticities of substitution (σ) are obtained for each industry group (3 digit clarifications) and for the manufacturing sector as a whole for the three years, 1964–65, 1969–70, and 1974–75. The decade 1965–75 covers the period associated with the growth of import substituting industries in Ethiopia under the past Feudo-Bourgeois Regime. It would be reasonable to assume that this phase of Ethiopia's industrialization has taken place under more or less similar institutional circumstances as in most LDCs for which estimates of elasticities of substitution are obtained.

The estimates of σ from the cross-sectional data are reported in Table I. Model (15) works rather poorly, yielding mostly statistically insignificant and negative estimates of σ. Models (9), (10), and (12) fit the Ethiopian data reasonably well. For almost all industrial groups and years, the σ estimates are statistically significant at the 1 to 5 per cent levels. The only exceptions being paper, leather, textiles, and fabricated metals for which statistically insignificant (at the 5 per cent level) estimates are obtained for some years. From a casual comparison of R^2 and standard error of estimates it appears that Models (10) and (14) fit the Ethiopian data best. Additional advantages are to be derived from the application of model (14) since it also estimates returns to scale.

The (statistically significant) values of σ coefficients obtained for an industry group by the various estimating models are also about the same in many cases, which suggests the possible existence of stable elasticity measures for the Ethiopian industries for the period 1965–75. Another interesting feature of the results obtained in Table I is that while most σ values are significantly greater than zero, it is only in very few cases that σ assumes a value in the neighborhood of one or higher (fabricated and basic metals, nonmetallic minerals, chemicals,

TABLE I

ESTIMATES OF σ FROM MODELS (9), (10), (13), (14), AND (15) (MONETARY VALUES)

		(9)	(10)	(13)	(14)	(15)
All manufacturing	1964–65	0.59086	0.80462	0.57715	0.6071	−0.35584
		(5.0309)	(20.5139)	(8.9417)		(−3.7761)
	1969–70	0.49521	0.63295	0.42201	0.52618	−0.32481
		(11.8753)	(25.7240)	(14.6359)		(−7.8254)
	1974–75	0.73372	0.68368	0.44992	0.59322	−0.18806
		(12.4389)	(24.1709)	(14.7438)		(−3.2603)
Food	1964–65	0.59284	0.85430	0.56402	0.6128	−0.31932
		(2.4833)	(19.3724)	(4.9684)		(−1.8262)
	1969–70	0.40910	0.82211	0.55479	0.36106	−0.19236
		(5.8788)	(29.6582)	(12.1719)		(−2.9486)
	1974–75	0.79312	0.76424	0.53909	0.88854	−0.44008
		(6.0598)	(21.2019)	(9.0711)		(−3.3726)
Beverages	1964–65	0.22894	0.39803	0.15735	0.2335	0.04618
		(0.8324)	(1.9325)	(0.6115)		(−0.2650)
	1969–70	0.57369	0.80264	0.52641	0.62714	−0.32361
		(3.7796)	(17.3951)	(5.8682)		(−1.7537)
	1974–75	0.57838	0.83341	0.56448	0.20748	−0.04758
		(1.5103)	(20.9283)	(4.4768)		(0.1915)
Leather and shoes	1964–65	0.80275	0.91851	0.87246	0.4388	−0.21392
		(1.6746)	(5.5582)	(3.5930)		(−0.5468)
	1969–70	0.54899	0.68302	0.30952	1.10966	−0.50438
		(3.0249)	(6.7356)	(1.8735)		(−1.8628)
	1974–75	−0.13366	0.71325	0.18048	−0.12317	0.18664
		(−0.6385)	(12.3416)	(1.1686)		(0.8770)
Textiles	1964–65	−0.13510	1.06804	0.68441	−0.1650	0.12163
		(−0.4775)	(11.0639)	(3.9594)		(0.4188)
	1969–70	0.34801	0.56719	0.38984	0.44915	−0.15656
		(2.7858)	(6.2541)	(5.2029)		(−0.9687)
	1974–75	0.95191	0.60856	0.48061	0.74329	0.44160
		(5.0531)	(3.6805)	(5.8704)		(1.9149)
Wood and wood products	1964–65	1.25840	0.88262	0.87975	1.2622	−0.65313
		(4.0637)	(8.7784)	(2.3763)		(−1.7723)
	1969–70	0.58463	0.39147	0.23607	0.54826	−0.41495
		(7.5707)	(5.5260)	(3.7430)		(−4.7656)
	1974–75	0.61386	0.43685	0.25761	0.76572	−0.25765
		(4.9006)	(9.9269)	(4.8628)		(−2.0677)
Paper and paper products	1964–65	0.27983	0.82304	0.51124	0.2602	−0.01941
		(0.9767)	(10.8474)	(3.7349)		(−0.0674)
	1969–70	0.50785	0.63435	0.57059	0.66257	−0.47282
		(3.4165)	(5.7089)	(5.7802)		(−3.5660)
	1974–75	0.78678	0.62223	0.30376	0.44522	−0.28817
		(3.9605)	(6.6358)	(2.9953)		(−1.79973)
Chemicals	1964–65	0.88984	1.28866	1.37805	0.6861	−0.64237
		(2.6381)	(5.3523)	(1.8649)		(−1.8186)
	1969–70	0.68353	0.49576	0.35057	0.69193	−0.63443
		(5.6702)	(7.5595)	(4.2071)		(−5.62317)
	1974–75	0.81766	0.86997	0.51715	0.78199	−0.53817
		(5.1859)	(26.6869)	(5.3728)		(−3.4360)

TABLE I (Continued)

		(9)	(10)	(13)	(14)	(15)
Nonmetallic	1964–65	1.26692	0.85870	0.74322	0.7093	−0.58009
mineral		(6.1021)	(17.7788)	(7.0295)		(−3.7842)
products	1969–70	0.92063	0.76106	0.50540	0.93354	−0.49066
		(6.0247)	(10.5610)	(6.2239)		(−2.63173)
	1974–75	0.60321	0.69403	0.48584	0.55108	−0.11904
		(4.0524)	(12.9241)	(4.4098)		(−0.8072)
Fabricated	1964–65	1.14389	0.99613	1.04522	0.6891	−0.43002
and basic		(2.1261)	(18.7179)	(5.0263)		(−1.2481)
metals	1969–70	0.18710	0.45617	0.16848	0.39592	−0.32551
		(0.6958)	(4.21847)	(0.9931)		(−2.1632)
	1974–75	0.87211	0.79771	0.52104	0.79439	−0.44726
		(3.4094)	(10.1720)	(4.6803)		(−1.9687)

Note: The figures in parentheses are computed *t*-statistics.

wood, and textiles and all in the 1964–65 estimates only).[4] In all other cases, the estimated values fall in the range $0 < \sigma < 1$.

One other use of the results for policy would be to measure the magnitude as well as the direction (sign) changes of σ over the three points in time for each industry group. A systematic decline in the value of σ may indicate that the system has been adjusting properly to factor substitution possibilities. On the other hand, an upward progression in the value of σ with time may be indicative of adjustment difficulties and possible lack of effective policy generation in the system.

However, such overtime comparisons of σ must be carried out using estimates of the coefficient that are free of the biases introduced by inflation.[5] Table II represents estimates of σ computed using real (as opposed to monetary) values of variables in the estimation models.[6] As can be seen, the estimates of σ in both tables are similar in most cases which may suggest that inflation has not distorted the structure of prices i.e., has left relative prices intact. Even with

4 Note that 1964–65 establishment data were collected from unpublished notes. In addition, the CSO has introduced during 1966/67 some changes in the definitions and classifications of industries. This may render some comparisons between post and pre-1966 industry figures meaningless.

5 One aspect of such biases is to push the value of σ towards unity (see [20]).

6 For purposes of computing wages, productivity, value added, etc. in real terms published index series were used, where necessary adjusted to a common base. For deflating capital prices and capital stock, the following index series were developed and used.

Year	Price Indexes of Imported Machinery and Equipment 1968=100	Year	Price Indexes of Imported Machinery and Equipment 1968=100
1965	94.3	1971	116.6
1966	96.3	1972	124.0
1967	97.5	1973	131.8
1968	100.0	1974	135.7
1969	103.1	1975	146.1
1970	107.2		

TABLE II
ESTIMATES OF σ FROM MODELS (9), (10), (13), (14), AND (15) (REAL VALUES)

		(9)	(10)	(13)	(14)	(15)
All manufacturing	1964–65	0.28880	0.82344	0.50714	0.25329	−0.13217
		(3.3923)	(14.4106)	(7.4901)		(−1.8524)
	1969–70	0.47968	0.59640	0.40804	0.53441	−0.37491
		(11.1780)	(25.5659)	(14.0211)		(−8.55134)
	1974–75	0.76792	0.67573	0.41355	0.67363	−0.33162
		(13.6758)	(25.5295)	(13.6218)		(−6.2702)
Food	1964–65	0.10784	0.72653	0.25430	0.03834	−0.02296
		(0.8900)	(5.5474)	(2.3131)		(−0.2481)
	1969–70	0.31502	0.77979	0.54885	0.36906	−0.19622
		(4.2101)	(20.8860)	(11.9150)		(−2.9790)
	1974–75	0.83101	0.74615	0.52311	0.88839	−0.44029
		(6.4864)	(17.7409)	(8.4573)		(−0.3751)
Beverages	1964–65	0.22799	0.96823	0.65083	0.23248	−0.4597
		(0.8300)	(9.2670)	(2.0457)		(−0.2642)
	1969–70	0.57346	0.80470	0.52913	0.62155	−0.31998
		(3.7797)	(17.3760)	(5.8419)		(−1.7392)
	1974–75	0.57854	0.83341	0.30515	0.20727	0.04769
		(1.5106)	(20.9149)	(2.7756)		(0.1920)
Leather and shoes	1964–65	0.80345	0.91874	0.87307	0.43940	−0.21428
		(1.6764)	(5.5582)	(3.5952)		(−0.5477)
	1969–70	0.54849	0.67675	0.30930	1.14834	−0.52501
		(3.0240)	(6.6421)	(1.8723)		(−1.91220)
	1974–75	−0.13388	0.03847	0.18031	−0.49944	0.40573
		(−0.6401)	(0.0778)	(1.1678)		(1.16216)
Textiles	1964–65	−0.13601	0.95831	0.68543	−0.44096	0.17259
		(−0.4798)	(3.2290)	(3.9664)		(0.3849)
	1969–70	0.40786	0.63320	0.39201	0.79346	−0.25823
		(2.8806)	(9.1215)	(4.6173)		(−1.0915)
	1974–75	1.00626	0.81459	0.43073	0.90485	−0.29020
		(5.9750)	(10.5429)	(3.6491)		(−1.5513)
Wood and wood products	1964–65	1.25901	0.88261	0.87889	1.26340	−0.65327
		(4.0622)	(8.7787)	(2.3702)		(−1.7708)
	1969–70	0.58441	0.31863	0.19880	0.54915	−0.41419
		(7.5710)	(5.6983)	(8.2294)		(−4.7303)
	1974–75	0.61359	0.3901	0.25620	0.76540	−0.25760
		(4.9007)	(6.3446)	(4.8542)		(−2.0678)
Paper and paper products	1964–65	0.27905	0.94974	0.69670	0.25823	−0.02064
		(0.9752)	(11.3669)	(2.0954)		(−0.0719)
	1969–70	0.50789	0.67329	0.57074	1.11367	−0.68776
		(3.4178)	(6.9425)	(5.7809)		(−3.4206)
	1974–75	0.76928	0.63288	0.30357	0.44572	−0.28964
		(3.8370)	(6.8673)	(2.9947)		(−1.8088)
Chemicals	1964–65	0.88958	1.28869	1.37844	0.68584	−0.64197
		(2.6373)	(5.3529)	(1.8645)		(−1.8174)
	1969–70	0.68299	0.49593	0.29959	0.69132	−0.63393
		(5.6677)	(7.5625)	(3.4577)		(−5.6221)
	1974–75	0.81776	0.86820	0.51737	0.78204	−0.53828
		(5.1860)	(26.6730)	(5.3722)		(−3.4366)

TABLE II (Continued)

		(9)	(10)	(13)	(14)	(15)
Nonmetallic	1964–65	1.2738	0.85831	0.74340	0.71762	−0.58413
minerals		(6.1330)	(17.7177)	(7.0900)		(−3.7477)
produc-	1969–70	1.06102	0.71015	0.54074	1.17815	−0.85516
tion		(8.4348)	(14.0520)	(6.6777)		(−5.3634)
	1974–75	0.60330	0.68498	0.47780	0.57197	−0.08520
		(4.0507)	(11.1580)	(4.2651)		(−0.5601)
Fabricated	1964–65	1.14385	0.99606	1.04529	0.68915	−0.43010
basic metals		(2.1264)	(18.6643)	(5.0296)		(−1.2484)
and elec-	1969–70	0.18936	0.45703	0.17021	0.39648	−0.32575
tricals		(0.7050)	(4.2263)	(1.0031)		(−2.1658)
	1974–75	0.87439	0.81224	0.44956	0.80813	−0.44856
		(3.4194)	(10.3744)	(4.1902)		(−1.9494)

Note: The figures in parentheses are computed *t*-statistics.

the introduction of real measurements, however, no "systematic" directions for σ can be obtained for most industry groups. Model (9) indicates a rise in σ for the manufacturing sector as a whole as well as for the food industry. For non-metallic mineral industries, on the other hand, estimating models (9), (10), as well as (13) give σ values that apparently declined with time. These isolated examples do not encourage one to use the results obtained for the study of trend characteristics of σ in the Ethiopian industries.

IV. INTERNATIONAL COMPARISONS OF σ ESTIMATES

Interindustry and intercountry comparisons of σ can only be of limited use at the present time and must be carried out on a selective basis. Some estimates of σ are obtained from cross-sectional data while some are time series estimates. The biases introduced in the estimation by either data source are well treated in the literature (see for example, [10] [20]). Estimates of σ from real value measurements are not strictly comparable to those estimated from "monetary" measurements since in the latter case the effects of inflation on σ values are included. Likewise differences in industry groupings (levels of aggregation) also render the coefficients uncomparable. Similarly, estimates of σ obtained from different estimation models are not easily comparable unless it is believed that the coefficients so obtained are invariant with respect to model specifications.

To reduce the dangers associated with comparisons of dissimilar quantities, we have put together in Table III estimates of elasticity for some countries obtained by means of model (9). We find this is the most widely used estimation model. All estimates reported in Table III are cross-sectional estimates. Three types of average (representative) estimates are produced for Ethiopia for comparison. One is the estimate for 1969/70 (assumed that it was obtained under average conditions), another is an average of results obtained by means of all estimating models for 1969/70, and a third is arrived at as an average value for all years and models.

The cross-country estimates of σ as well as the estimates from Bangladesh,

TABLE
ESTIMATES OF σ FOR SOME COUN-

	Ethiopia			Daniels	ACMS
	(1)	(2)	(3)	(4)	(5)
All manufacturing	0.5	0.52	0.59		
Food	0.41	0.54	0.65	0.75	0.83
Beverages	0.57	0.63	0.48		
Leather and shoes	0.55	0.66	0.66	0.53	0.71
Textiles	0.35	0.44	0.63	1.61	0.80
Wood & wood products	0.58	0.44	0.67		0.86
Paper & paper products	0.51	0.59	0.53		0.97
Chemicals	0.68	0.56	0.78	1.09	0.86
Nonmetallic minerals	0.92	0.78	0.75	1.11	
Fabricated, basic metals and electricals	0.19	0.34	0.77	1.8	

Note: (1) = 1969/70 model 9 estimates. (2) = 1969/70 average of statistically significant (1–5% levels) results of models 9, 10, 13, and 14 estimates. (3) = Average of all significant results using all models and years. (4) = Estimates from cross-section data for eight developing countries [6]. (5) = International cross-section estimates of ACMS (reported in [10]). (6) = The last entry of 0.81

Kenya, Nigeria, Philippines, and Pakistan are in general higher than those obtained for Ethiopia. For practically every industry group, the Ethiopian estimates are below the average of the reported coefficients in Table III. Given the fact that the σ values are statistically significant, one is inclined to accept the proposition that there have been rather limited technological possibilities (or flexibilities) for the substitution of labor for capital in the Ethiopian industries. Elsewhere it has been found that σ estimates calculated under conditions of low capital utilization rates tend to be high (see, for example, [10] [14]). The value added figures are not normally taken at full capacity levels. With most firms producing at below capacity level cross section estimates of σ tend to be high, i.e., greater than unity. In the Ethiopian data, no adjustment was made for variations in capacity utilization rates between firms and the generally low σ estimates obtained may perhaps be indicative of high capacity utilization rates in industries throughout the country.

Again, in other empirical studies, note is taken of the implications of capacity utilization rates and economies of scale on the estimates of σ. It is observed, for example, that if most firms are producing below capacity, cross-section estimates would tend to show increasing returns to scale [10] [9] [20] [31]. Application of Model (14) also yields estimates of returns to scale in the aggregate production function. For the manufacturing sector as a whole and for many industry groups (beverages, textiles, paper, and chemicals), the scale coefficient is less than one (or nearly one)[7] indicating decreasing returns to scale. However, for wood, food, nonmetallic, and fabricated metals industries low σ values and increasing returns to scale are indicated. This asymmetry between hypothesized

[7] In all industry estimates for 1969/70, d_1 and d_2 in model (14) are statistically significant at the 1 per cent levels. Estimates of returns to scale are computed from these results and

III
TRIES RESULTS FROM MODEL (9)

Nigeria (6)	Bangladesh (7)	Philippines (8)	Pakistan (9)	Kenya (10)	Argentina (11)	India (12)
	0.66		1.57			
	0.22	1.37		} 1.34	0.87	
		1.11				
	1.42	1.01	0.46		0.71	
1.35	1.01	0.44		0.92		0.76
0.75		0.86		} 1.01		
1.43	0.46	1.25			1.63	0.30
1.60	0.43	1.09	1.86		1.01	1.15
	0.60		1.64	1.57		
0.81			0.81			

is for "electrical equipments" (see [21]). (7)=Covers the period 1962–70 and uses two-digit classifications [23]. (8)=See [26]. (9)=Estimates for 1969/70 using two-digit classifications [14]. (10)=Estimates for 1966 [16]. (11)=Reported in [10]. (12)=See [24].

and observed relations between capacity usage, returns to scale and σ values in these cases calls for caution in the interpretation of the empirical results and nothing definite can be said at this stage on these matters. Furthermore, most scale estimates are below one, but since the sampling distribution of (h) in Model (14) is not known, it is not possible to test the hypothesis that they are indeed different from one. The closeness of these estimates to unity may be indicative of the applicability of Model (9) to the Ethiopian data. A basic assumption of Model (9), it must be remembered, is that there are constant returns to scale [10] [20] [9] [31].

using the formula $h=(d_2-d_1)/1-d_1$ in Model (14).

Industry Group	Returns to Scale (1)	(2)
All manufacturing	0.99	0.90
Food	1.09	1.07
Beverages	0.92	0.93
Leather and shoes	0.35	0.36
Textiles	0.90	0.88
Wood and wood products	1.07	1.07
Paper and paper products	0.91	0.96
Chemicals	0.90	0.90
Nonmetallic mineral products	1.13	1.10
Fabricated, basic metals, & electricals	1.49	1.49

Note: (1) gives estimates from "money" measurements of the variables (Y, L, w) in Model (14). However, (2) shows that the estimates are about the same even when real measurements are used.

V. CONCLUSIONS

The restricted forms of CES functions appear to fit the Ethiopian data rather well. In particular, the estimation model suggested by Paroush [16] yields relatively high R^2 and low standard errors of estimate in most cases. While estimated coefficients of elasticity vary between industrial groups, no systematic overtime changes for σ have been discerned either. Such is the case even when computations have been performed using deflated measures.

The estimated σ all fall in the interval $0 < \sigma < 1$. A Leontief type of technology is not apparently supported by this evidence while some cases may best be fitted by a Cobb-Douglas type of production functions. In comparison to estimates from other lands, Ethiopian estimates appear to be on the low side. In fact, for all industry groups they have been below the averages of those reported in Table III. These coupled with the fact that almost all computations were significant at the 1 to 5 per cent levels suggest that factor substitution possibilities in production may have been technologically constrained and of limited scope. If such were indeed the case, one finds little comfort from the policy prescriptions by the Employment Exploratory Mission to Ethiopia in 1974, which were aimed at distorting relative factor prices to realize significant substitutions of labor for capital in industry.

Of course, everything is not satisfactorily explained. The significance of Model (14) and the asymmetry between hypothesized and observed relationships between capacity utilization rates, returns to scale and values of σ leaves the issues raised unresolved and our findings in these aspects fall out of line of experiences elsewhere. We have not convincingly shown, for example, that the low σ values for Ethiopian industries are correlated with (high capacity utilization rates for most firms and hence with) decreasing returns to scales in the production functions.

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