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ECONOMIES OF SCALE, INCOME DISTRIBUTION, AND SMALL-ENTERPRISE PROMOTION IN GHANA'S TIMBER INDUSTRY

Small-scale enterprises have recently become a major area of interest for development economists and development assistance agencies. Substantial research has been directed toward evaluating the role of small firms in the process of economic development, and programs of small-enterprise promotion have been advocated as efficient means of achieving increased industrial employment and improved distribution of income.¹ An important issue of industrial policy which has received relatively little empirical attention, however, is the extent to which production technologies may limit potential distributional gains from the promotion of small enterprise.

This essay evaluates the success of a program undertaken by the Government of Ghana to promote the development of small-scale, indigenously owned firms in tropical timber production. The Ghanaian case is of particular interest because the central government through its timber concession and leasing policies chose to promote small enterprises in an industry characterized by modest but significant economies of scale. Social evaluation of the program, therefore, involves explicit comparison of the increased social costs incurred by small firms with the presumed gains in social welfare arising from more equitable distribution of resource-based rents.

The first section of the paper briefly describes the principal instruments of public policy employed to promote the development of small logging firms in Ghana and assesses their consequences for the structure of the industry. Criteria for evaluating the success of the industrial promotion scheme are discussed in the second section. The subsequent two sections present the empirical results required to evaluate the program. The third portion of the paper employs a body of engineering and economic data to estimate market and social costs of production for firms of differing size. The data provide some important insights into the

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¹ See, for example, the studies by Steel (16) and Berry (1). The World Bank (19) has recently advocated a program of small-enterprise promotion, based upon employment and income distribution criteria.

nature and extent of economies of scale in tropical forestry and allow the computation of private and social rents to the timber resource. These estimates are followed by a simple model designed to establish the social value of incomes retained by private capitalists and to evaluate the welfare gains associated with rents retained by each size category of firm. The fifth section focuses on application of the investment criteria to the data developed in the preceding sections. Estimates of revenues, costs, and the welfare valuation of increments to the incomes of small entrepreneurs are combined to evaluate the social returns to small enterprise promotion. Judgments concerning the success of the industrial promotion scheme are presented in a concluding section.

THE PROMOTION OF SMALL-SCALE LOGGING ENTERPRISES: CONCESSIONS POLICY AND PUBLIC LENDING

Timber has been exported from Ghana since Elizabethan times, but major investments in tropical hardwood production and processing did not take place until after the Second World War.² Prior to independence, concessions for timber exploitation were granted principally to large-scale, foreign-owned enterprises which established integrated logging and processing operations. In 1961, however, the Nkrumah government undertook to increase the total number of firms engaged in tropical timber production and to encourage the development of small- and medium-scale logging enterprises owned and operated by Ghanaians.

The principal instrument of public policy employed to alter the structure and ownership of the timber industry was control over the allocation of timber concessions. In 1962 the central government removed all jurisdiction and control over forested areas from tribal authorities and the courts. It also centralized decisions concerning the allocation of timberlands in the Ministry of Lands and Mineral Resources.

Promotion of Ghanaian enterprises was accomplished by systematic discrimination in favor of Ghanaian applicants. Between 1961 and 1971, 100 applications from Ghanaian citizens for timber concessions were approved, compared with two approvals for non-Ghanaians, and in 1965 a major government initiative resulted in the reallocation of 539 square miles—5 percent of Ghana's total commercial forest area—from one single foreign-owned firm to 19 Ghanaian enterprises. Foreign-owned firms were prevented from expanding existing holdings, and expatriate investors were prohibited from obtaining timber leases.

Concession agreements were subject to discretionary control and were not allocated in accordance with any competitive procedure. As a result, the central government was confronted with a large number of potential claimants and a declining resource base. Its response to this rationing problem was to reduce progressively the average size of concessions issued. For example, in 1963 the Ministry of Lands and Mineral Resources restricted the aggregate forest holdings of all timber producers to 240 square miles and limited the size of any single concession to 40 square miles. The policy resulted in a sharp decline in the average size of concessions issued to new firms. Between 1961 and 1965 the average area of forest granted to concessionaires declined from 265 to 41 square miles. By 1967, however, more than 75 percent of reserved forests and all forest

² For a brief history of timber extraction and processing, see Page (6).

areas outside reserves had been allocated, and the Ministry further restricted the size of concessions issued to applicants. Between 1966 and 1970 the average area of concessions granted to newly established firms declined to 16 square miles.

Despite the reduction in the size of concession holdings and the concomitant increase in the number of firms engaged in logging, no mechanism was created by the central government to allow secondary transfers of concessions among firms. Each firm was confined to its existing allocation of forest and was unable to consolidate holdings or to increase its total area under lease. The concessions policy thus limited firms to the scale of operations dictated by allowable yields on the area under concession. By restricting new leases to extremely small parcels, the central government effectively limited the size and growth of newly created logging firms.

The other widely used instrument of government policy affecting the logging industry was a producer's loan scheme administered by the Ghana Timber Marketing Board and the Timber Cooperatives Union. The loan program, financed by a share of the proceeds from an export tax on logs, was initiated to provide financial and working capital to small- and medium-scale Ghanaian timber producers. Loans varying from more than ₵100,000 (Ghanaian *cedis* or US\$140,000) to as little as ₵600 were advanced to 302 Ghanaian logging firms between 1963 and 1967, the year of the last public accounting of the program. In addition to cash disbursements the Timber Marketing Board also provided capital equipment, including trucks and tractors, directly to small-scale firms. Because of the ambiguous nature of the repayment terms and the limited administrative resources devoted to enforce repayment, the loan program became in effect a grant scheme, and small-scale Ghanaian firms became highly dependent on the Timber Marketing Board for investment and working capital.

The combined effects of the concessions policy and the loan program radically altered the structure of Ghana's logging industry between 1960 and 1970. Table 1 summarizes data on the distribution of firms by size, age, and ownership in 1971. The impacts of the program on the growth of small-scale enterprises are apparent. Between 1963 and 1970 the number of active logging enterprises increased from 121 to 361. Of these firms 65 were small-scale producers operating under their own concession agreements and an additional 200 were subcontractors to concessionaires. Very small-scale producers increased their share of industry output from 5.5 percent in 1963 to 20 percent in 1971.

EVALUATING SMALL-ENTERPRISE PROMOTION: CRITERIA

Control of the distribution of timber concessions afforded the central government a vehicle for restricting both the size and expansion of firms in the logging industry. Evaluation of the success or failure of the policies discriminating in favor of small- and very small-scale Ghanaian producers hinges, therefore, on specifying criteria for the efficient allocation of forest lands by the public sector.

If the government is unconstrained in its behavior, it should attempt to maximize the present social value of rents to the timber resource. In general these will equal the excess of revenue over the long-run costs of production, including capital costs, evaluated at accounting prices. If production is undertaken by the public sector, resource-based rents represent a net addition to uncommitted

TABLE 1.—DISTRIBUTION OF FIRMS IN GHANA'S LOGGING INDUSTRY, 1971*

	Large scale		Medium scale		Small scale		Very small scale	
	Non-Ghanaian	Ghanaian	Non-Ghanaian	Ghanaian	Non-Ghanaian	Ghanaian	Non-Ghanaian	Ghanaian
Number of firms	4	1	7	13	3	68	0	265
Percent of total output	37.4	4.8	6.5	14.4	1.0	15.9	—	20.0
Average age of firm (years)	24.0	15.0	16.5	7.0	7.7	6.0	—	4.8
Output range (tons/annum)	More than 40,000		39,999 to 10,000		9,999 to 2,500		Less than 2,500	

*Republic of Ghana, Ministry of Labor and Mineral Resources, Division of Forestry, Accra, unpublished data.

public income.³ The public sector would act in effect as a multiplant enterprise varying the scale of individual harvesting operations and the harvesting rate in each time period to obtain optimum economic yields.

Two factors, however, constrain public sector behavior in Ghana. First the acceptance of a sustainable yield policy based upon biological criteria alone removes the harvesting rate as a control variable, and the optimization problem reduces to one of maximizing annual social income arising from the predetermined sustainable yield. Second, limitations on the availability of timberlands make harvesting operations of differing scale mutually exclusive. Thus, when the land constraint is binding, the appropriate decision criterion for efficient allocation of timberlands should be to maximize annual social income per unit of land area.⁴

Criteria for the allocation of public lands to private enterprise are derived along similar lines, but are complicated by two considerations. First, the opportunity cost of capital funds provided by the private sector may differ from the opportunity cost of public savings and, second, because a portion of the resource-based rents accrue to the private investor, the government may value these additions to the incomes of individuals more or less highly than increments to uncommitted public income.

Evaluation of the distribution of public lands to private firms, therefore, requires that the cost-benefit calculation consider both the social costs of production of each size and ownership category of firm and the welfare valuation to be placed on the rents retained by the private investor. The annual social profit from private exploitation of the resource by a firm, i , is

$$\pi_i = R(q_i, A_i) - C_i^s(q_i, A_i) - f_R(R(q_i, A_i) - C_i^p(q_i, A_i)) \quad (1)$$

where $R(q_i, A_i)$ = annual social revenue, which is a function of output per unit of area, q_i , and area harvested, A_i ;

$C_i^s(q_i, A_i)$ = annual social costs of production for a firm of category i , which are a function of output per unit of area and area exploited;

f_R = the social cost of rents retained by the private sector in terms of uncommitted public income;

$R^p(q_i, A_i)$ = annual private revenue; and

$C_i^p(q_i, A_i)$ = annual private costs.

³ The unit of account used is Little and Mirrlees numeraire (q), public-sector savings denominated in terms of convertible currency. The shadow price of a commodity or factor of production is the total effect of a change in its public production on uncommitted social income. For tradable commodities this shadow price is the border price; for nontraded goods and factors of production the shadow prices are found by estimating the social opportunity cost of the good in terms of border prices.

(9).
⁴ A formal model of the optimal allocation of public lands using methods of nonlinear programming is presented in Page (9).

TABLE 2.—ANNUAL COSTS FOR LOGGING PROCESSES AT
MARKET AND ACCOUNTING PRICES, 1971*
(costs are in cedis per annum unless otherwise indicated)

Process	Man-days	Wage costs		Machine costs		Materials costs		Productivity (thousand tons/year)	
		Market	Accounting	Market	Accounting	Market	Accounting	Estimated	Range
Hand felling	1,250	1,562	1,142	—	—	250	227	2.75	1.13- 4.25
Machine felling	1,000	1,250	914	545	467	580	497	7.50	3.65-11.00
Hand crosscutting	1,000	1,000	765	—	—	250	227	—	—
Machine crosscutting	500	750	494	545	467	580	497	8.00	4.00-12.00
Skidding tractor	500	800	622	2,100	2,027	5,400	4,622	16.50	3.25-20.00
Skidding lorry	1,500	1,800	1,316	5,350	4,194	8,150	6,976	8.25	4.13-10.00
Skidding crawler	500	1,000	778	21,750	20,989	25,250	21,589	15.00	12.50-22.50
Loading tractor	1,750	2,100	1,216	2,100	2,027	5,400	4,622	20.00	10.00-30.00
Loading winch	1,000	1,200	860	8,350	7,632	10,450	8,945	50.00	37.50-62.50
Lorry, 10-ton	500	720	526	5,360	4,202	13,620	9,929	2.50	1.25- 4.00
Lorry, 20-ton	500	720	526	10,000	7,840	18,080	13,180	5.00	2.50- 7.50

*Data are from Swan-Wooster Engineering Company, *Ghana Forest Products Transport Study*, Report to the Canadian International Development Agency, Vancouver, B.C., 1972. Wage costs are estimated using engineers' man-hour estimates and wage data from sample survey. Overhead costs are from sample survey. Survey costs are from Ghana Forestry Division.

If the land constraint is binding the government should attempt to maximize annual social income per unit of area by allocating concessions to those classes of firms which exhibit the highest social profit, including the welfare value of retained rents, per square mile.

By the mid-1960s the Government of Ghana clearly faced constraints on the availability of forest lands. The success of its policy of small-enterprise promotion thus depended upon the extent to which the allocation of timber concessions to small producers maximized social profit per unit area. In the following section engineering data on tropical timber extraction are combined with market and accounting price data to estimate private and social costs of production at varying levels of output. These estimates, when combined with data on total revenues, provide the empirical basis for evaluating the program of industrial promotion.

MARKET AND SOCIAL COSTS IN LOGGING: AN ENGINEERING APPROACH

Engineering data on individual processes in tropical timber production can be used to identify efficient activities at alternative levels of output and, hence, to establish the structure of long-run average costs.⁵ These data possess some advantages over accounting data for the identification of efficient techniques of production and for the specification of average and marginal costs at varying levels of output. The engineering approach allows output to be treated as a predetermined variable while relative prices, managerial efficiency, and location are held constant. In addition, by focusing attention on the individual processes which make up the total logging operation, engineering cost functions highlight the determinants of increasing or decreasing costs within individual firms. The average costs of production for efficient plants at different scales of output are used to estimate a long-run average cost curve at both market and accounting prices and to investigate the extent of economies of scale in tropical timber production.

Logging production in Ghana consists of locating marketable timber, felling and crosscutting, moving logs from the stump to a feeder road, and road haulage. At each stage of production several techniques are available involving progressive substitution of capital for labor. Tree felling and crosscutting may be done by hand or power saw. Movement of logs from stump to roadside is accomplished by means of a winch-equipped farm tractor and four-wheel-drive lorry, wheeled tractor, or crawler tractor. Line haulage may be accomplished by either 10- or 20-ton lorries, but use of the larger vehicle requires concurrent investment in gantry-loading equipment and improved roads. Increased mechanization at each level permits higher volumes of log output to be achieved per unit of time, and use of crawler tractors also permits more intensive exploitation per unit of forest area by reducing the limitations imposed by adverse topography and forest density.

The cost structure of each logging process identified as technically feasible in Ghana is set out in Table 2 and 3. A process is defined as the minimum combination of current and capital inputs, divided among machinery costs, labor costs, and materials costs required to achieve the average annual level of produc-

⁵ Engineering data are drawn from Swan-Wooster Engineering Co. (18).

TABLE 3.—LAND RELATED COSTS FOR LOGGING PROCESSES
AT MARKET AND ACCOUNTING PRICES, 1971*
(*cedis per square mile per annum unless otherwise indicated*)

Logging processes	Market cost	Accounting cost
Survey	913	732
Trails	1,020	732
Roads	2,111	1,558
Roads (improved)	5,000	3,690

*Data are from Swan-Wooster Engineering Company, *Ghana Forest Products Transport Study*, Report to the Canadian International Development Agency, Vancouver, B.C., 1972. Wage costs are estimated using engineers' man-hour estimates and wage data from sample survey. Overhead costs are from sample survey. Survey costs are from Ghana Forestry Division.

tivity listed in the table. Capital and current input estimates and the levels of productivity are drawn from the engineering study. Annual costs at market prices are based upon those prevailing in 1971, the year to which the engineering data refer, and costs at accounting prices have been calculated according to the method developed by Little and Mirrlees.⁶

The cost estimates depart from strict adherence to the data provided in the engineering report in two respects. First, wage rates given in the engineering study were noted to be relatively crude approximations to actual wages paid in Ghana's logging industry. For this reason the man-hour estimates provided by the engineering data were combined with wage data from a survey of logging firms conducted by the author to provide revised estimates of wage costs for each process.⁷ The revised estimates of wage costs were below those derived from the engineering data.

Second, in the engineering study, unit administrative and overhead costs were assumed to be constant at all levels of output. This assumption was found to be consistent when checked against data from the sample survey, but the engineering estimates appeared to be low compared with actual overhead costs encountered in Ghana. Because the level of constant average costs affects the height and not the slope of the long-run average cost curve, constant unit administrative and overhead costs based on Ghanaian data were substituted for the engineering estimates.

Systems costs for plants of different size are presented in Tables 4 and 5. Each system represents the combination of processes yielding minimum unit cost at the given level of output. Because of the relatively small number of processes considered, minimum systems costs were found by an iterative procedure. At levels of output below 50,000 tons per Year considerable substitution among individual processes occurs as output increases, but above that level increases in

⁶ Details of the derivation of accounting prices and estimates of accounting ratios for commodities and factors of production in Ghana are presented in Page (8). An accounting ratio is the ratio of the social price of a commodity or factor in terms of the unit of account to its market price in terms of domestic currency. Estimates of the social opportunity cost of capital funds provided by the private sector are found in Page (9).

⁷ Other results of the sample survey appear in Page (7, 8) and Page, Pearson, and Leland (10).

TABLE 4.—COMPOSITION OF LEAST COST SYSTEMS, 1971*
(tons of log output per annum)

	625	1,250	2,500	5,000	7,500	15,000	30,000	50,000	100,000	150,000
Hand felling	1	1								
Machine felling			1	1	1	2	4	6	12	18
Hand crosscutting	1	1								
Machine crosscutting			1	1	1	2	4	6	12	18
Skidding tractor	1 ^a	1 ^a	1 ^a	1 ^a						
Skidding lorry	1	1	1	1	1					
Skidding crawler						1	2	3	6	9
Loading tractor					1					
Loading winch						1	1	1	2	3
Line haul, 10-ton	1	1	1	2	3					
Line haul, 20-ton						3	6	10	20	30
Area harvested square mile	.5	1	2	4	6	7.5	15	25	50	75

*Computed from Tables 2 and 3.

^aOne tractor is used for both skidding and loading.

TABLE 5.—UNIT COSTS OF LEAST-COST SYSTEMS, 1971*
(unit costs *cedis* per ton)

	Unit total costs	Unit value added costs	Unit capital costs	Unit land related costs
625 tons				
Market	76.37	45.42	20.49	4.64
Accounting	60.45	35.83	18.03	3.38
1,250 tons				
Market	41.73	24.82	15.38	4.64
Accounting	32.92	19.58	13.53	3.38
2,500 tons				
Market	23.19	10.59	6.18	4.64
Accounting	18.16	8.35	5.43	3.38
5,000 tons				
Market	18.10	5.33	3.80	4.64
Accounting	14.19	4.20	3.37	3.38
7,500 tons				
Market	16.21	4.65	3.27	4.64
Accounting	12.57	3.67	2.88	3.38
15,000 tons				
Market	15.20	4.18	2.93	4.36
Accounting	11.95	3.30	2.59	3.18
30,000 tons				
Market	14.55	3.85	2.70	4.36
Accounting	11.37	2.77	2.38	3.18
50,000 tons				
Market	14.22	3.80	2.56	4.36
Accounting	11.08	2.74	2.25	3.18
100,000 tons				
Market	14.10	3.75	2.50	4.36
Accounting	11.00	2.69	2.21	3.18
150,000 tons				
Market	14.10	3.75	2.50	4.36
Accounting	11.00	2.69	2.21	3.18

*Computed from Tables 2 and 3.

output are achieved by replication of the components of the 50,000-ton system.

Because equipment of different capacity may be required for concurrent use, a number of efficient systems exhibit individual components which are not the least-cost alternative at the specified level of output. For example, full utilization of 20-ton lorries for line haul requires both improved standards of roads and use of winch and gantry loading at the forest site. Thus, although unit costs for 20-ton lorries fall below those for 10-ton vehicles above 5,000 tons of output per year, unit costs for the "linked" system of 20-ton lorries, improved roads, and winch loading do not fall below those for the 10-ton system until levels of output exceeding 15,000 tons are achieved.

Reduction in unit costs can arise from increases in output in several dimensions.⁸ The principal dimensions of scale affecting production costs in logging are annual volume of log output and output per unit of land. Indivisible costs of production are linked to both dimensions. Larger-scale capital inputs, such as crawler tractors, double-drum winches, and lorries are indivisible with respect to the annual volume of output on which they are employed. Set-up costs—survey, road construction, and administration—are independent of the output per square mile but vary directly with area. Indivisibilities with respect to capital equipment are also sources of diseconomies of scale over some ranges of output, giving rise to increasing short-run average costs in individual "plants."

Scale coefficients for long-run costs were computed according to the cost function:⁹

$$C_{ij} = aX_j^n \quad (2)$$

where C_{ij} is total cost per annum of items of plant j , and X_j is scale of output in tons per annum of plant j . The equation was fitted by a log-linear regression to the observations in Tables 4 and 5 using ordinary least squares. Results for several cost categories are reported in Table 6. The scale coefficient, n , shows the presence and extent of economies of scale, in total costs and in individual cost components. Scale coefficients less than one indicate increasing returns; decreasing returns are reflected by coefficients greater than one.

If a multiplicative error with normal distribution, zero mean, and finite variance is assumed, it is possible to apply the standard tests of significance to the hypothesis $n = 1$. Confidence intervals for the individual scale coefficient are contained in Table 6. The results are indicative of increasing returns to scale in total costs and individual cost items at both market and accounting prices.

Minimum-efficient scale is defined as the level of output above which any

⁸ For a recent discussion of the dimensions of scale, see Silberston (14, pp. 371-73). In addition to the two dimensions considered above, scale effects may arise from a shift from batch to continuous process operation, from the length of production runs for a given type of product—by spreading research and marketing costs over a greater total output—or from a standardization among products in multiproduct plants. None of these considerations, however, is relevant to the analysis of scale effects in logging.

⁹ This formula for the scale coefficient is frequently encountered in engineering estimates of economies of scale. (See, for example, Haldi and Whitcombe (2)). Lau and Tamura have recently demonstrated that a cost function of this form may be derived from a nonhomothetic Leontief production function (3). Such a production function exhibits zero elasticities of substitution between all pairs of inputs and may show differing returns to scale in each input.

TABLE 6.—SCALE COEFFICIENTS IN LOGGING PRODUCTION*

Cost item	Intercept	Scale coefficient	95 percent confidence interval	R ²
Total costs	3.66 (.16)	.73 (.06)	.60 to .86	.96
Value-added costs	2.95 (.24)	.57 (.08)	.38 to .76	.86
Capital costs	2.40 (.20)	.62 (.06)	.46 to .77	.91
Total social costs	3.42 (.16)	.73 (.06)	.61 to .86	.96
Social-value-added costs	2.73 (.26)	.55 (.08)	.36 to .73	.86
Social capital costs	2.27 (.20)	.62 (.07)	.47 to .77	.92

*Computed from Tables 4 and 5. Standard errors are in parentheses.

subsequent doubling in scale will reduce total unit costs by less than 5 percent and will reduce "value-added costs" per unit by less than 10 percent.¹⁰ Including value-added costs in the measure of minimum-efficient scale serves to point out situations where materials are used essentially in constant proportions but where there may be substantial economies in capital or labor inputs as output increases.

Minimum-efficient scale in logging production for unit total cost and unit-value-added cost occurs at 15,000 tons of output per annum at both market and accounting prices. Percentage increases in total unit costs and value-added costs at 50 percent of minimum-efficient scale are modest, 23.3 percent and 8.6 percent, respectively. However, unit costs increase quite sharply at levels of output below 5,000 tons per year, suggesting that at low output levels the average cost curve has a marked "L" shape in which the penalties for operation at "abnormally" small levels of output may be substantial.¹¹

In sum the estimates indicate that reductions in unit costs due to economies of scale are significant at low levels of output, becoming progressively less important as output is increased. Minimum-efficient scale has been estimated at 15,000 tons per year. Increases in unit costs of production at 50 percent of minimum-

¹⁰ "Value added costs" are defined as total production costs less the costs of purchased material inputs and services. The definition of minimum-efficient scale and value added costs are drawn from Pratten (11).

¹¹ The process analysis indicated that, due to indivisibilities in current and capital inputs, the techniques available in logging production are not well adapted to firms operating at very low levels of output. In order to test the sensitivity of the scale coefficients to the presence of very small-scale firms in the engineering data, a second set of scale coefficients was run on data for plants with annual output equal to or exceeding 5,000 tons per annum. Comparison of the scale coefficients for this subset of firms with the results in Table 7 indicated that in all cases the scale coefficients moved in the direction of constant returns, but remained significantly different from one at the 5 percent level.

efficient scale are moderate, but the scale curve appears to rise quite steeply below levels of output in the range of 7,500 to 5,000 tons per year.

The presence of modest but significant economies of scale raises the issue of trade-offs between small-enterprise promotion and increased social costs of production. Seventy-one percent of the firms enumerated in the 1972 sample survey (producing 42 percent of sample output) were operating at levels of output below minimum-efficient scale. Fifty-seven percent of the firms in the sample (representing 35 percent of total output) were producing at levels of output below 50 percent of minimum-efficient scale, and 29 percent of firms in the sample (representing 15 percent of output) were producing less than 5,000 tons per year.

Under current yield policies the minimum land area required to sustain an annual output of 15,000 tons is 112.5 square miles at a productivity of 2,000 tons per square mile. This area represents 0.9 percent of the total forest area under concession in 1971, but exceeds the total holdings of 84 percent of all concessionaires in Ghana. Thus Ghana's concession policies, coupled with the capital subsidies provided by the producer's loan program, created and sustained a significant number of firms operating at very low levels of output and high average social costs.¹²

The willingness of the Government of Ghana to license and subsidize large numbers of relatively high-cost enterprises reflects a positive valuation placed on the incomes of small entrepreneurs. In the next section a simple model is developed to establish the social value of income accruing to private capitalists relative to uncommitted public income. The model is then applied to the evaluation of resource-based rents retained by private logging firms.

THE SOCIAL VALUE OF RESOURCE-BASED RENTS

Economic rent is the scarcity value of a factor of production which is in fixed supply—for example, a natural resource such as timber. Rent is measured as the residual after all production costs, including the opportunity cost of capital, have been subtracted from the value of output, and thus it represents extra income accruing to the investor as a result of his access to the resource. In order to assess the efficacy of policies designed to encourage small-scale private enterprise, it is essential to have a means of valuing rents retained by a private enterprise relative to those retained by other classes of private firms and to the unit of account—uncommitted social income.

This section employs a simple model to determine the social value of rents retained by several classes of firms in Ghana.¹³ In the case of a transfer of ₵1 to a private company, a chain of events is started that will lead to additional tax

¹² It is possible to compare the unit cost estimates from the engineering data with unit costs derived from the sample survey conducted in 1972, referring to the 1970/71 financial year. Average production costs for firms in the sample survey producing less than 5,000 tons per year were ₵.77 per cubic foot which compares with the approximate cubic cost from the engineering estimates, ₵.74. At the opposite end of the spectrum unit costs for firms in the survey producing more than 50,000 tons per year were ₵.38 compared with the approximate cost per cubic feet from the engineering data of ₵.39. In 1970/71 the exchange rate between the Ghanaian cedi and the U.S. dollar was ₵1.02/\$1.00.

¹³ The model presented draws on the work of Newbery (5) and extends his model slightly to consider firms for which the government attaches a positive welfare weight to increases in income.

payments, consumption, and savings. The simplest model of a firm that saves and grows is one of steady state growth, in which the enterprise saves a constant share of its profits and earns a constant rate of return. For such a firm the social cost of an increase in rents accruing to the firm is given by the cost in terms of the unit of account of the resources required to finance the extra consumption and savings arising from the transfer less any benefit arising from the increase in income. If the marginal propensity to consume out of extra income for a given class of investor is c , the social cost in terms of the unit of account of providing the resources to finance that consumption is $f_c c (1 - t)$, where f_c is the conversion ratio appropriate to the consumption of the class of investor, and t is the marginal rate of taxation.

The extra savings represent an increase in the equity value of the company. It is assumed for simplicity that savings out of profits are either reinvested in the existing enterprise or are invested in the manufacturing sector in general, and that the increase in equity does not permit the company to increase its borrowings from the banking system or from the central government.¹⁴ Thus the act of saving makes possible additional investment $K_0 = s (1 - t)$. If the real rate of return in the activity is r (less depreciation), the investment will generate net of tax profits annually equal to $r (1 - t) K_t$. The profits arising from net of tax income will be consumed and saved according to the marginal propensities c and s , respectively, and thus the return on the investment leads to additional saving and investment of $s (1 - t) r K_t$. In long-run equilibrium, the capital stock will grow at the rate of $n = s(1 - t)r$.

If all outputs and inputs are evaluated at accounting prices, the capital stock will produce annual social profits equal to $r K_t f_p$, where f_p is the ratio of current output less inputs (including labor and depreciation) at accounting prices to the same value at market prices. In each year social benefit from the investment will equal

$$B_t = r K_t f_p - c f_c r (1 - t) K_t - n f_k K_t; \quad (3)$$

where f_k is the accounting ratio for the capital input and f_c is the accounting ratio appropriate to capitalist's consumption. Thus the annual social benefit arising from an incremental private-sector investment consists of the social value of returns to the investment less the social costs of the extra consumption and investment made possible by the net of tax return.

Since the net social benefit grows steadily at the rate of growth of the capital stock, n , the net present value of the stream of benefits is equal in the limit to $B/(R - n)$, where R is the accounting rate of interest. The social cost of a unit of

¹⁴ An increase in equity will probably allow the firm to borrow from the banking system or from the central government. This will have two offsetting effects: first, it will commit the government, through the banking system, to provide a portion of the finance for a new investment, and the proportion of funds provided by the central government will have as its opportunity cost the accounting rate of interest. Second, interest payments on the loan will reduce net of tax income available to the capitalist for extra consumption and savings. It is possible to incorporate bank borrowing at a constant debt equity ratio into the simple model presented, but lacking data on the leverage of the firms considered, it would add little to the empirical relevance of the model.

savings in the private sector is the social cost of one cedi spent on capital goods less the present value of the social benefit generated per cedi of investment:

$$f_s = f_k - (rf_p - cf_c r(1 - t) - \pi f_k) / (R - n). \quad (4)$$

Therefore, the social cost of the increment of savings made possible by the transfer is equal to $s(1 - t)f_s$, which may be positive (a social cost) or negative (a social benefit) depending upon the social returns to private investment.

Finally, there is a potential benefit from extra incomes accruing to individual classes of investors, and the promotion of small-scale firms indicates that the Government of Ghana may attach a positive welfare weight to increases in the incomes of smaller enterprises.¹⁵ Transfers of rents to small-scale firms result in a rise in the household income of the owners of those firms. In order to estimate the social benefit which accrues when a household receives an increase in disposable income a number of assumptions concerning the Government of Ghana's attitude toward increases in the incomes of private citizens are required. First, it is assumed that there is a level of personal income expressed in terms of household income per adult equivalent at which the government is indifferent between using resources costing a unit of uncommitted social income to increase the incomes of households at that level or to increase government expenditure on other activities. This level of income is called the "base" income.

Second, the government is assumed to attach less weight to marginal increases in income as household incomes per adult equivalent increase, measured at market prices. The foreign-exchange resource cost of a unit increase in net-of-tax income to a rural household is

$$f_{by} = sf_s + cf_c, \quad (5)$$

that is, the social cost of providing the resources to meet the increase in savings and consumption brought about by the unit increase in disposable income. Since at the base income level the social value of the unit increase in income is defined as equal to its resource cost, $f_{by}U'(Y_b) = f_{by}$ and $U'(Y_b) = 1$, where $dU/dY|_{Y_b}$ equals $U'(Y_b)$, the marginal valuation of income at the base income level.

The marginal valuation of income is assumed to be given by a planner's preference function exhibiting a constant elasticity of the marginal valuation of income:

$$U'(Y) = kY^{-\epsilon}, \quad (6)$$

where ϵ is the elasticity of the marginal valuation of income, $(U''/U')Y$, the proportionate fall in the marginal valuation for a proportionate rise in income.

Because $U'(Y_b) = 1$, it is possible to derive expressions for the social benefit arising from an increase in income to any household in terms of an equivalent increase to a household at the base level of income. For marginal increases in the

¹⁵ The model employed to assess the welfare weight of increases in income was developed by Maurice Scott and first applied to Kenya in Scott, McArthur, and Newbery (13). It has also appeared in Little and Mirrlees (4) and most recently in Squire and Van der Tak (15).

income of a household with income per adult equivalent of Y_n , the social benefit in terms of the unit of account is given by

$$f_{by} U'(Y_n) = f_{by} \left(\frac{Y_b}{Y_n} \right)^e, \quad (7)$$

and for nonmarginal increases in income, say from income per adult equivalent of Y_n to Y_m , by

$$f_{by}(U(Y_m) - U(Y_n)) = f_{by} Y_n \int_{Y_n}^{Y_m} \left(\frac{Y_b}{Y} \right)^e dY. \quad (8)$$

Since these values are per adult equivalent, the total benefit to the household is given by the product of the benefit per adult equivalent and the number of adult equivalents.

It is now possible to specify fully the consequences of the transfer of ϕ_1 in rents to the private sector. Its social cost is given by

$$f_r = cf_c + sf_s - f_{by} U'(Y_r), \quad (9)$$

where Y_r is the income per adult equivalent of the investor's household.

Although it seems reasonable to assert that there is some level of income, measured at market prices, at which the Government of Ghana would regard expenditure of public funds to increase private incomes as equal in value to other uses of public funds, it is difficult to establish the precise level of income per adult equivalent at which this is likely to occur. An upper bound is almost certainly established by the incidence of the tax system. A consistent government should not be prepared to levy taxes on incomes below the base income level. Administrative costs, the effects of taxation on incentives and political pressures may combine to keep the direct taxes from reaching down to the base level. In Ghana graduated income taxes begin at an income of $\phi 400$ per year. For a rural family of the size associated with that level of income, income per adult equivalent would be $\phi 103$ per annum. It is doubtful, however, that the base income level is that high.

A lower bound on the base income may be set by wages paid to agricultural laborers in the North of Ghana. It can be argued that as long as agricultural land remains in surplus in Ghana, the average product of labor in subsistence agriculture, which is approximately equal to the annual income of hired agricultural labor, may set a wage floor for the economy as a whole. The annual income of a fully employed casual worker in the Tamale region was $\phi 103$ per annum in 1970.¹⁷ For the average rural family of the lowest income class, this would represent an income per adult equivalent of $\phi 47$ per year. Because the Government of Ghana makes no special effort to supplement the incomes of subsistence agriculturalists in the North, it is conceivable that an income of approximately

¹⁶ The integral may be evaluated as:

$$\frac{(Y_b / (1-e))^{1-e} - (Y_m / (1-e))^{1-e}}{1-e} \quad e \neq 1$$

$$Y_b \ln(Y_m / Y_n) \quad e = 1$$

¹⁷ See Rourke and Obeng (12) for estimates of agricultural wages and incomes in Ghana during 1971.

Social benefit
per cedi transferred

1.25

1.00

.75

.50

.25

CHART 1.—WELFARE BENEFIT OF THE TRANSFER OF RENTS TO A PRIVATE FIRM

$e=5$

$e=1$

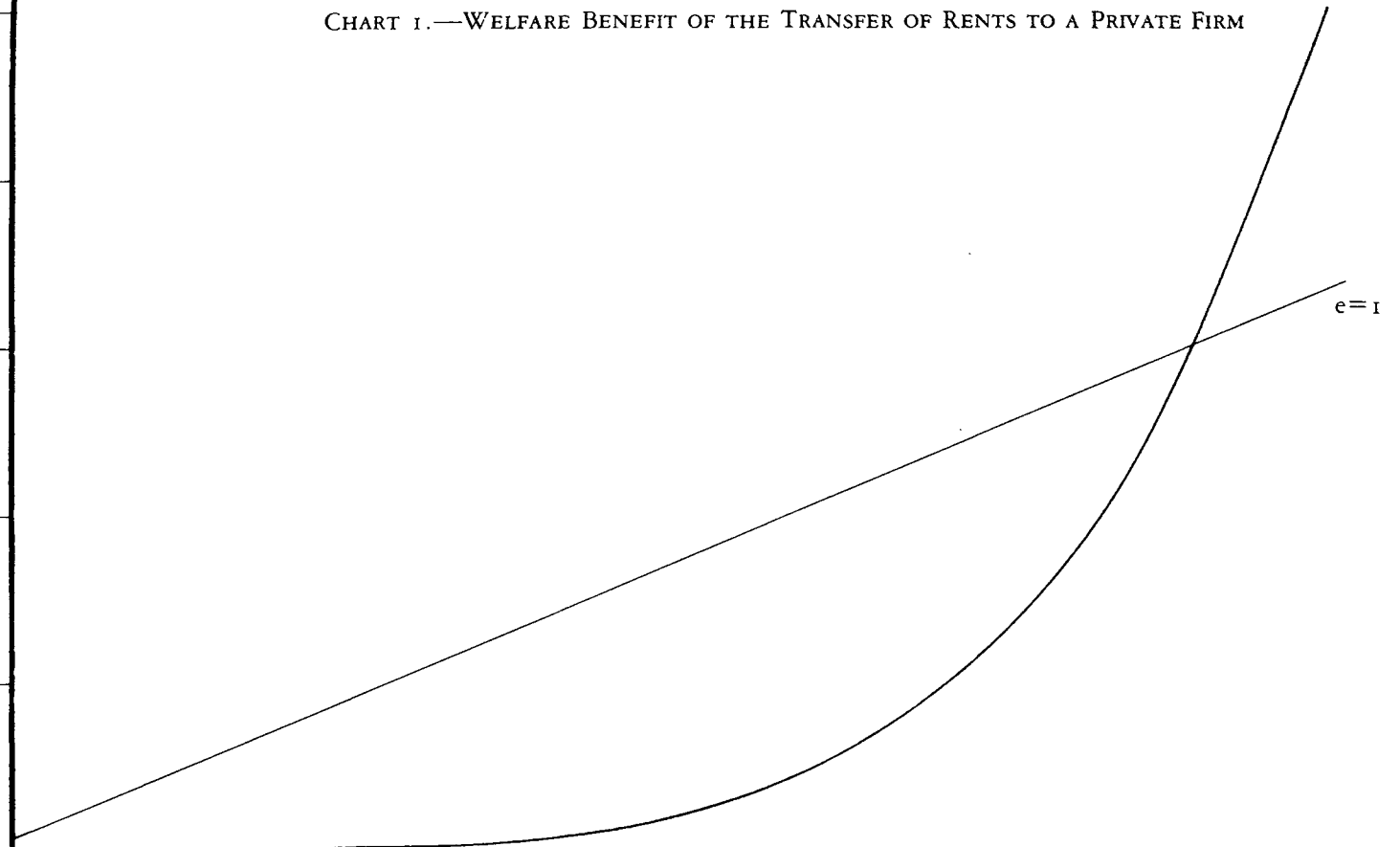
ECONOMIES OF SCALE

175

Note: Welfare benefits computed for a household with income of ₵179 per adult equivalent in 1971.

Base income (cedis / adult equivalent)

25 50 75 100 125 150 175 200



¢47 per adult equivalent at rural prices is near the base income level. Although the arguments are neither precise nor wholly conclusive, they suggest that a reasonable range within which the base income may lie is ¢40 to ¢70 per annum.¹⁸

Estimating the elasticity of the marginal valuation of income presents equally difficult problems. Certainly, the policy statements issued by the Government of Ghana could lead to the conclusion that it values incremental additions to the incomes of the rich less than increments to the incomes of the poor. Literature on the use of welfare weights suggests that the plausible range for the elasticity of the marginal valuation of income is from 1 to 5.¹⁹

Chart 1 traces the effect of variations in the base income level and the elasticity of the marginal valuation of income on the welfare benefit of rents retained by small-scale firms. Income per adult equivalent of households owning small-scale enterprises was estimated by assuming that owners of these firms are drawn at random from households in Ghana's highest three income categories. Such a household had income per adult equivalent of ¢179 in 1970.²⁰ Benefits per cedi transferred range from .21 accounting cedis with base income equal to ¢50 per adult equivalent and an elasticity of the marginal valuation of income of unity to 1.38 accounting cedis if the base income is increased to ¢200 and the elasticity to 5.

The effect of egalitarian government attitudes toward income distribution is shown quite clearly. Raising the elasticity of the marginal valuation of income in the absence of an increase in the base income level reduces the welfare benefit associated with the transfer of income and thus increases the social cost of rents retained by the small enterprise.

Values of the accounting ratio for rents are presented in Table 7. Column (1) refers to general manufacturing activity in Ghana and the estimated accounting ratio for extra capitalists' income is appropriate for the evaluation of rents retained by private firms in general. The parameter values and estimates of f_i in columns (2)-(6) refer to various ownership categories of firms in Ghana's logging industry. The accounting ratios for these firms have been estimated on the basis of the assumption that retained rents are reinvested in the existing enterprise.

The accounting ratio for capitalists saving, f_s , and hence the accounting ratio for rents is very sensitive to the assumed accounting ratio for gross profits, f_p , and

¹⁸ Alternatively, it is possible to follow the suggestion of Little and Mirrlees and take the mid-point between subsistence income and the minimum taxable income (6, ch. 13). Taking ¢40 per year as a subsistence income, the base income level estimated in this way is ¢70 per year. The inability or lack of desire of the government to implement socially profitable projects may provide an indication of the level of the base income. The government frequently acts as an employer of last resort, paying workers minimum wages in excess of the value of their marginal product. The government sector wage of ¢1.25 per day yields an annual income per adult of ¢70 at rural prices. Since the value of the worker's marginal product, although low, is probably positive, the wage may overstate the pure transfer component of public employment. Hence, the base income level may be somewhat less than ¢70 but more than the level assumed.

¹⁹ Stern discusses various methods of estimating the elasticity of the marginal utility of income and justifies a plausible range of 1 to 5 (17).

²⁰ Details concerning the distribution of household incomes in Ghana and the income per adult equivalent by income class of households are taken from Page (7).

TABLE 7.—AN ACCOUNTING RATIO FOR RENTS, 1971*

	General manufacturing (1)	Foreign timber (2)	Expatriate timber (3)	Ghanaian timber		
				Large (4)	Medium (5)	Small (6)
Marginal tax rate, t	.50	.60	.50	.50	.50	.50
Marginal savings rate, s	.50	.25	.40	.50	.50	.40
Marginal share of consumption, c	.50	.75 ^a	.60	.50	.50	.60
Accounting ratio						
Consumption	.75	1.00	.83	.75	.75	.76
Savings	.03	-1.53	-1.51	-1.33	-1.33	-.61
Benefit from income ^b	—	—	—	—	.04	.21
f_r	.39	.37	-.10	-.29	-.33	.00

*Calculated from Equations (3)-(9).

^aConsumption is assumed to contain a remittance component with accounting value of 1.

^bBenefit from extra income is computed with base income equal ₵50 per adult equivalent and the elasticity of the marginal valuation of income equals 1. These accounting ratios apply to net of tax income. The gross of tax equivalent is $f_r = (1-c) f_r$.

the rate of return, r .²¹ The accounting ratio for gross profits, value added at world prices less depreciation and wages at accounting prices to the equivalent at market prices, ranges from more than one for activities receiving negative effective protection to less than zero for some heavily protected import-substitution activities. For this reason the accounting ratio for savings by general manufacturing activities lies substantially above the accounting ratios for all categories of logging firms. The high social returns to timber extraction make private savings which are reinvested in logging enterprises substantially more valuable than uncommitted social income, and this makes the accounting cost of retained rents negative for most logging firms. Only foreign-owned enterprises, which are assumed to have a high component of remittances abroad from their retained earnings, and small-scale firms, which have high production costs and hence lower average rates of return, show accounting ratios for rents above zero. If, on the other hand, retained profits were invested in the manufacturing sector, the social benefit of the transfer of rents to the private sector would reflect the lower social returns to manufacturing investment in general, and the accounting ratio for timber firms would approximately equal that for manufacturing firms.

EVALUATING SMALL-ENTERPRISE PROMOTION

Table 8 summarizes the main findings of the analysis. Entries in the table are annual social income, expressed in cedis convertible at the official exchange rate, per square mile of forest exploited.²² The impact of economies of scale on social returns to timber extraction is demonstrated by the significant increase in social income per unit area occurring up to the level of minimum-efficient scale.

Several interesting conclusions emerge. Small-scale enterprises are dominated by larger-scale firms at all reasonable combinations of the base level of income and the elasticity of the marginal valuation of income. Even when the base income level is raised to ₵200 per adult equivalent and the elasticity of the marginal valuation of income to 5, the welfare benefits of the transfer of rents to firms producing less than 1,250 tons per annum cannot overcome the social costs incurred by very small-scale production.²³ At the more likely values of Y_b and e of ₵50 and one, respectively, annual social income per square mile for small-scale firms is approximately one-fourth of that for a firm of minimum-efficient scale. The added returns to increases in firm size beyond minimum-efficient scale are quite modest, however, reflecting the flattening out of the long-run average cost curve. The costs of promoting small-scale enterprises in tropical timber production have been substantial, particularly in light of the constraint on the availability of the resource and cannot be offset by reasonable weights assigned to the benefit from additional incomes provided to small-scale entrepreneurs.

²¹ Greater detail on the estimation of the parameters for consumption, savings, and retained earnings may be found in Page (7).

²² Details of the estimation of social revenues per square mile for an "average" concession in Ghana are contained in Page, Pearson, and Leland (10).

²³ A base level of income of ₵200 per adult equivalent equates to a household income of ₵1,000 per annum, which would place the household in the top 0.8 percent of household incomes in the rural sector and the top 7.5 percent of households in the urban sector. It is extremely doubtful that a reasonable case can be made for setting the base level of income this high.

TABLE 8.—ANNUAL SOCIAL INCOME PER SQUARE MILE, 1971*
(thousands of cedis at accounting prices)

Annual volume of output (thousand tons)	Ghanaian public sector	Private Ghanaian ($Y_b=50, e=1$)	Investment ($Y_b=200, e=5$)	Foreign investment	Expatriate investment	Private Ghanaian rents invested in all manufacturing
.63	2.04	2.04	2.04	2.04	2.04	2.04
1.25	11.10	11.10	12.44	10.68	11.24	9.17
2.50	25.01	28.26	28.29	21.39	26.05	21.20
5.00	32.97	37.61	37.61	27.81	34.34	27.54
7.50	35.13	40.41	40.41	29.25	36.81	28.95
15.00	.54	43.95	43.95	32.52	40.26	32.21
30.00	39.25	44.46	44.46	32.39	41.00	32.78
50.00	41.35	46.23	46.23	35.16	43.33	34.84
100.00	42.30	47.34	47.34	35.94	44.16	35.61

*Author's calculations from data in Tables 6 and 7.

Exploitation of the resource by private Ghanaian, as opposed to public, enterprises, increases the social returns to timber extraction. This result arises from two elements of social cost which differ between the public and private sector. First, funds which are diverted from other investments in private manufacturing are assumed to be socially less valuable than uncommitted social income, and to the extent that investments are made at the expense of present consumption rather than diverted from other activities, the costs in terms of the unit of account are further reduced. Second, as long as rents retained by the private sector are reinvested in timber production, the social value of private capitalists' income exceeds the value of uncommitted social income for medium- and large-scale firms and approximately equals its value for small-scale enterprises. If, however, resource-based rents are wholly consumed by private investors or are invested in the manufacturing sector in general, this conclusion is reversed and public exploitation of the resource dominates private investment.

Exploitation of the forest by foreign and expatriate investors appears to offer marginally lower social returns than public or private Ghanaian investments. Although a component of the initial capital cost of the project is provided as foreign exchange by the investor, net-of-tax returns are repatriated and constitute a cost in terms of the unit of account. The engineering estimates of social costs, however, are based upon the assumption of equal levels of technical and managerial efficiency at all levels of output and for all ownership classes of firms. If foreign or expatriate firms exhibit greater technical efficiency on average than Ghanaian firms, the result may be reversed. But the evidence suggests that the policy of "Ghanaianization" by itself may have been an inappropriate method to increase social returns to the resource.

CONCLUDING REMARKS

This study evaluated the efficacy of a program of small-enterprise promotion in Ghana. The need for optimum allocation of forest lands gave rise to the criterion that public authorities faced with a constraint on the availability of the timber resource should seek to maximize social income per unit of area. Engineering estimates of market and social costs strongly supported the conclusion that tropical timber production was subject to significant economies of scale and to high cost penalties at very low levels of output. The Government of Ghana's creation and support of a significant number of small-scale logging enterprises was therefore a matter of trade-offs between economic costs and the welfare benefit assigned to incomes of small-scale entrepreneurs. The social value of rents per unit of forest area was estimated using a simple model to measure the benefit from a transfer of rents between the public sector and small-scale enterprises. The results indicated that the high costs of small-scale production could not be offset by any reasonable welfare gain assigned to the extra incomes of small capitalists.

The program of small-enterprise promotion in logging has had high economic costs for Ghana. Twenty percent of total log production in 1971 was by firms operating at levels of output less than or equal to 5,000 tons per annum. The annual social incomes of such enterprises even under highly optimistic evaluations of the welfare gain from retained rents are less than 85 percent of those for a firm of minimum-efficient scale and fall rapidly toward zero at small volumes of output.

Public sector programs of industrial licensing and subsidies for the purpose of promoting small enterprises must recognize and evaluate the extent to which production technologies limit social returns. The methodology employed in this essay provides one mechanism for assessing the trade-offs between scale economies and more equitable distribution of income.

CITATIONS

1 R. A. Berry, "The Relevance and Prospects of Small Scale Enterprises in Colombia," Economic Growth Center, Yale University, Discussion Paper No. 142, New Haven, 1972.

2 J. Haldi and D. Whitcomb, "Economies of Scale in Industrial Plants," *Journal of Political Economy*, 75, 1967.

3 Laurence J. Lau and S. Tamura, "Economies of Scale, Technical Progress, and the Non-Homothetic Leontief Production Function: An Application to the Japanese Petrochemical Processing Industry," *Journal of Political Economy*, 80, November/December 1972.

4 Ian M. D. Little and J. A. Mirrlees, *Project Appraisal and Planning for Developing Countries*, Basic Books, New York, 1974.

5 David M. G. Newbery, "The Social Value of Private Investment in Kenya," in I. M. D. Little and M. F. G. Scott, Editors, *Using Shadow Prices*, Heineman Educational Books, London, 1976.

6 John M. Page, Jr., "The Timber Industry and Ghanaian Development," in Scott R. Pearson and John Cownie, Editors, *Commodity Exports and African Economic Development*, Lexington Books, D.C. Heath and Company, Lexington, Massachusetts, 1974.

7 ———, "Development Policy and Economic Performance in Some Ghanaian Export Industries: An Analysis of Firm Level Data from Ghana's Timber and Wood Products Sector," D.Phil. Dissertation, Oxford University, Oxford, England, 1975.

8 ———, "The Social Efficiency of the Timber Industries in Ghana," in I. M. D. Little and M. F. G. Scott, Editors, *Using Shadow Prices*, Heineman Educational Books, London, 1976.

9 ———, "Economies of Scale, Income Distribution, and Small Enterprise Promotion: A Ghanaian Case," Food Research Institute, Stanford University, July 1978.

10 John M. Page, Jr., Scott R. Pearson, and Hayne E. Leland, "Capturing Economic Rent from Ghanaian Timber," *Food Research Institute Studies*, XV, 1, 1976.

11 C. F. Pratten, *Economies of Scale in Manufacturing Industry*, University of Cambridge, Department of Applied Economics, Occasional Papers, 28, Cambridge University Press, Cambridge, 1971.

12 Blair E. Rourke and F. A. Obeng, "Seasonality in the Employment of Casual Labor in Ghana," Institute of Statistical, Social, and Economic Research, University of Ghana, Legon, 1972.

13 M. F. G. Scott, J. MacArthur, and D. M. G. Newbery, *Project Appraisal in Practice*, Heineman Educational Books, London, 1975.

- 14 A. Silberson, "Economies of Scale in Theory and Practice," *Economic Journal*, Special Issue, March 1972.
- 15 L. Squire and H. G. van der Tak, *Economic Analysis of Projects*, Johns Hopkins University Press, Baltimore, 1975.
- 16 William F. Steel, *Small Scale Employment and Production in Developing Countries: Evidence From Ghana*, Praeger, New York, 1977.
- 17 N. G. Stern, "Welfare Weights and the Elasticity of the Marginal Valuation of Income," St. Catherine's College, Oxford, 1973.
- 18 Swan Wooster Engineering Company, Ltd., "Ghana Forest Products Transport Study," Report Prepared for the Canadian International Development Agency, Vancouver, B.C., Canada, November 1972.
- 19 World Bank, *Employment and Development of Small Enterprises: Second Policy Paper*, Washington, D.C., February 1978.