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# CAPTURING ECONOMIC RENT FROM GHANAIAN TIMBER

An important policy issue in many developing countries centers on how governments can capture economic rent from natural resources that have already been leased to private firms. In this essay we develop an analytical framework to deal with this issue, and we apply it to timber in Ghana, using original microeconomic survey data. Economic rent is measured as the residual after all costs of production—including normal returns to capital—are subtracted from the value of log output. The level of social benefits from forestry in Ghana depends importantly on the amount and distribution of economic rent generated in exploiting timber. Moreover, a central objective of government policy for timber is to transfer economic rent from private firms to the government by means that do not interfere with the efficiency of timber production.[1] Hence, in this study we contrast current and suggested Ghanaian policies with respect to their effectiveness in achieving that transfer of rent.

The first part of the paper contains a brief history of concession, royalty, and tax policies for timber in Ghana. We next define the concept of economic rent, discuss problems encountered in measuring rent, and present an estimate of the

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[1] This essay is concerned with maximizing the amount of resource-based rents transferred to the central government in a single period. The model of firm behavior presented assumes that the maximum annual yield of any species of timber is set independently of the royalty rate. Such an assumption is reasonable when timber yields are established, as in Ghana, on the basis of maximum sustainable yield, the maximum volume of timber which can be harvested in perpetuity given the regenerative characteristics of the species. Under maximum sustainable yield, the present value of all future royalty payments to the government is maximized by maximizing the royalty payments in each period, since such important economic considerations as the costs of deferring income are ignored. A substantial literature has developed recently questioning the validity of the maximum sustainable yield principle and advocating the use of optimum economic yields in establishing harvesting rates for renewable resources. See, for example, Plourde (6) and Quirk and Smith (7). Clearly, the royalty rate may be used as a policy instrument to achieve variations in harvesting

aggregate amount of rent generated in producing Ghanaian timber. The heart of the analysis focuses on a calculation of appropriate royalty rates, by species, based on estimates of revenues, costs, and economic rent of classes of firms in the Ghanaian timber industry. We then conclude with some policy recommendations. Characteristics of the sample survey, which serves as the data base for the empirical analysis, are discussed in an appendix.

## GOVERNMENT POLICIES FOR TIMBER[2]

Virtually all policies affecting the logging industry have some impact on the amount of economic rent generated, and a wide variety of concession, royalty, and tax policies are available to effect the transfer of rent from private firms to the government. The government can capture rent (among other means) by requiring a lump-sum payment at the time a concession is leased, a royalty payment based on the value of logs produced, or payment of corporate income taxes. If all three policies coexist, their effects will be interrelated and to some extent offsetting; for instance, a high royalty rate (or export tax on exported logs) would decrease amounts paid as income tax and, moreover, would decrease amounts firms would be willing to pay in advance for concession rights. For this reason, concession, royalty, and tax policies must be carefully coordinated if the government is to extract as much rent as possible.

Ghana has very little productive timber land not already under concession. About three-fourths of the 6,941 square miles in the forest reserve areas in Ghana can be considered productive timber land, and about 85 percent of this productive area is under alienation, usually the forest concession. In addition, essentially all of the productive unreserved forest lands are already under concession.[3] The trends in concessions policy are summarized in Table 1. Though the coverage of the table ends with 1970, no important changes have occurred since then.

The length of current concessions ranges from three to 99 years. Some of the existing concessions are beginning to expire, but under current arrangements there will not be a major reversion of concessions to the government during the next few years. Hence, barring a change in existing terms, the government will not have major areas of timber lands to offer for new concession in the near future.

For the most part, existing concessions were obtained by private firms without payment of a "bonus," a lump-sum amount of money that the firm agrees to pay upon receipt of concession rights. Firms generally pay a small concession rent, usually ₵20 per square mile per year, though this amount varies with the size of

intensity over time, and royalty policies designed to transfer maximum rents from producers to the government in a single period may be suboptimal in the context of maximizing the present value of the stream of royalty payments. The simultaneous determination of optimum economic yield by species and of the optimum royalty would require substantially more data on the biological properties of Ghanaian hardwoods than are available. Moreover, such an analysis would contribute very little to the understanding of royalty policy as an efficient means of fiscal transfer in existing concessions which is the central theme of this study.

[2] Details and historical trends of concession, royalty, and tax policies are presented in Pearson (*4*, Appendix B), and a firm-by-firm breakdown of the existing pattern of concessions is contained in Appendix C to that study.

[3] See (*8*, p. 18). The other form of alienation, timber licenses, is unimportant and can be ignored in this discussion.

TABLE 1.—NUMBER, AREA, AND AVERAGE SIZE OF CONCESSIONS ISSUED, 1900-70*

| | Number of concessions | | | Area (*square miles*) | | | Average area of concessions (*square miles/concession*) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | Ghanaian | Non-Ghanaian | Total | Ghanaian | Non-Ghanaian | Total | Ghanaian | Non-Ghanaian |
| 1900-60 | 29 | 10 | 19 | 7,683 | 1,152 | 6,531 | 264.9 | 115.2 | 343.7 |
| 1961-65 | 59 | 57 | 2 | 2,442 | 2,045 | 397 | 41.4 | 35.9 | 198.5 |
| 1966-70 | 43 | 43 | 0 | 698 | 698 | 0 | 16.2 | 16.2 | 0 |
| Totals | 131 | 110 | 21 | 10,823 | 3,895 | 6,928 | 82.6 | 35.4 | 329.0 |

*Data from John M. Page, Jr., "Development Policy and Economic Performance in Some Ghanaian Export Industries: An Analysis of Firm Level Data from Ghana's Timber and Wood Products Sector," unpublished D.Phil. dissertation, Oxford University, Oxford, England, January 1975, p. 68.

concession.[4] In addition, firms holding concessions within the forest reserve pay annual fees of ₵0.75 per acre to the Forestry Division to finance the cost of silvicultural improvement programs.

Royalties under existing policies are specific charges per tree harvested (as distinct from payments for the stumpage, i.e., the right to cut and remove timber).[5] A uniform national schedule of royalties was introduced in 1962 when the government undertook administration of timber lands on behalf of tribal authorities. In 1965 the level of royalties was raised, and specific fees were doubled on most species of timber. The royalty rate varies by species in the ₵6-28 range; for example, the rate for afrormosia is ₵28 per tree harvested, for the most valuable redwoods, ₵16 per tree, and for most secondary species, ₵6 per tree. The complete royalty schedule by species, established in 1971, is presented in Table 2.

Because royalty rates are based on the number of trees harvested rather than the value of the logs produced, the ad valorem (percent of total value) equivalents of the "per tree" rates of royalty have fallen with devaluations of the Ghanaian currency and with rises in the price of logs. Estimates of these changes for selected species, presented in Table 3, show the ad valorem equivalents of recent royalty rates to lie in the range of 3 to 4 percent.

The Ghana Timber Marketing Board (GTMB) levies a marketing board fee of 3 percent ad valorem on the value of log exports. To the extent that the GTMB

[4] The exchange rate between the Ghanaian cedi (₵) and the U.S. dollar ($) has undergone the following changes: from ₵.714/$1 to ₵1.02/$1 in July 1967; from ₵1.02/$1 to ₵1.82/$1 in December 1971; from ₵1.82/$1 to ₵1.28/$1 in February 1972; from ₵/$1.28/$1 to ₵1.15/$1 in February 1973. The exchange rate used in the analysis in this study is ₵1.02/$1 which was in effect during 1970/71.

[5] Stumpage charges are based on an estimated value of the entire stand of timber in a concession tract.

TABLE 2.—ROYALTY SCHEDULE, 1971*[a]

| Species | Common name | Royalty per tree (₵) |
|---|---|---|
| Class I A | | |
| Chlorophora exelsa | Odum | 16 |
| Entandrophragma angolense | Edinam | 6 |
| Entandrophragma cylindricum | Sapele | 16 |
| Entandrophragma utile | Utile | 12 |
| Khaya anthotheca | African mahogany | 16 |
| Khaya ivorensis | African mahogany | 16 |
| Khaya grandifoliola | African mahogany | 6 |
| Tieghemella heckelii | Makore | 10 |
| Nauclea diderrichii | Kusia | 8 |
| Class I B | | |
| Afrormosia elata | Afrormosia | 28 |
| Lovoa trichioides | African walnut | 8 |
| Terminaila ivorensis | Emeri | 8 |
| Triplochiton scleroxylon | Wawa | 8 |
| Class I C | | |
| Tarrietia utilis | Niangon | 6 |
| Class II A | | |
| Entandrophragma candollei | West African cedar | 16 |
| Guarea Cedrata | Scented guarea | 6 |
| Guarea thompsonii | Guarea | 6 |
| Lophira alata | Ekki | 6 |
| Piptadeniastrum africanum | Dahoma | 6 |
| Class II B | | |
| Antiaris africana | Antiaris | 6 |
| Guibourtia ehie | Guibouria | 6 |
| Mansonia altissima | Mansonia | 6 |
| Mitragyna ciliata | Abura | 6 |
| Mitragyna stipulosa | Abura | 6 |
| Nesogordonia papaverifera | Danta | 6 |
| Turraeanthus africanus | Avodire | 6 |

*Republic of Ghana, Division of Forestry, unpublished data.

[a] For species not listed, the royalty is generally N₵6 per tree.

provides services to the logging firms, this levy should be considered a payment for services rendered (and hence should not be counted as economic rent). Until recently, at least, firms tended to consider the marketing board levy as an export tax, claiming that the GTMB provided services for the government but not for the firms. Moreover, in the budget speech of August 1973, it was announced that log exports were henceforth to be charged export taxes at an ad valorem rate of 10 percent in place of much smaller, specific duties and that sawn timber exports were to be charged an export duty of 5 percent ad valorem.

The other major tax policy affecting logging firms is the corporate income tax that applies to all corporations operating in Ghana. The applicable tax rate is 55 percent of net profits. It is likely that the effective rate of corporate income taxation for the logging industry is somewhat greater than the nominal rate of 55 percent, because the economic life of most buildings and machines in logging is shorter than that prescribed by the legislated schedule of depreciation.[6]

In summary, the current set of government concession, royalty, and tax policies for timber includes no concession bonuses, very low annual rates for concession rents and silvicultural fees, a variegated structure of royalty rates based on the number of trees harvested rather than the value of logs produced, a GTMB charge on log exports of 3 percent ad valorem, an export tax on logs of 10 percent ad valorem, and a corporate income tax the effective rate of which is slightly in excess of the nominal rate of 55 percent. The succeeding part of this essay contains an analysis of the extent to which this set of policies has been successful in transferring economic rent from timber firms to the government.

## AGGREGATE TRANSFER OF ECONOMIC RENT FROM TIMBER FIRMS TO THE GOVERNMENT

An economic activity can contribute to increases in income in a developing country in two principal ways—by generating economic rent directly in its own production process, and by generating rent through a variety of indirect economic relationships.[7] The developmental contribution of the timber industry in Ghana, measured by growth of Ghanaian income, therefore depends on the amount and distribution of economic rent generated directly and indirectly in the production and processing of logs. Discussion here will focus only on the first of these two effects, the direct generation of economic rent in the production of Ghanaian logs.[8]

[6] Legislated depreciation allowances are: buildings—10 percent for the first year and 5 percent per annum thereafter; and machinery—20 percent for the first year and 10 percent per annum thereafter. The effective rate of taxation differs among classes of firms in the logging industry because of differing capital-labor ratios and varying proportions of internal versus external financing.

[7] A detailed discussion of the measurement of contributions of an export activity in a developing economy is contained in chapter one of Pearson and Cownie (5). For a methodological discussion of indirect effects see Pearson (3, pp. 45-50).

[8] For an analysis of indirect effects—linkage effects and externalities—associated with log production in Ghana, see Page in Pearson and Cownie (5, pp. 105-113).

TABLE 3.— AD VALOREM EQUIVALENTS OF TIMBER ROYALTIES OF SELECTED SPECIES, BASED ON EXPORT QUALITY LOGS, AVERAGE UNIT VALUES F.O.B.*

| Species | 1962[a] | 1962[b] | 1965[a] | 1965[b] | 1968[a] | 1968[b] | 1971[a] | 1971[b] |
|---|---|---|---|---|---|---|---|---|
| Afrormosia | 6.0 | 1.2 | 28.0 | 5.7 | 28.0 | 4.9 | 28.0 | 4.0 |
| Utile | 6.0 | 1.9 | 16.0 | 4.7 | 16.0 | 3.1 | 16.0 | 3.1 |
| Mahogany | 8.0 | 1.9 | 16.0 | 3.9 | 16.0 | 3.1 | 16.0 | 3.2 |
| Sapele | 6.0 | 1.7 | 16.0 | 3.6 | 16.0 | 2.7 | 16.0 | 2.6 |
| Wawa | 4.0 | 1.6 | 8.0 | 5.7 | 8.0 | 3.9 | 16.0 | 3.8 |

*Data from John M. Page, Jr., "Development Policy and Economic Performance in Some Ghanaian Export Industries: An Analysis of Firm Level Data from Ghana's Timber and Wood Products Sector," unpublished D.Phil. dissertation, Oxford University, Oxford, England, January 1975, p. 72.

[a] Royalty rate per tree harvested, in cedis.

[b] Ad valorem equivalent in percent, based on export quality logs.

Economic rent is the scarcity value of a factor of production that is in limited supply—for example, a natural resource (such as timber), land, or entrepreneurship. This rent is measured as the residual after the costs of all factors of production have been subtracted from the value of output. Several elements can enter into this residual measure: (a) scarcity rents, reflecting the value of the limited factor—the stand of merchantable trees in the case of the Ghanaian timber industry; (b) location rents, deriving from differential distances to market—for example, more rent is associated with a tree located closer to Takoradi than with an identical tree sited further away from the port; and (c) monopoly rents, arising from the producing firms' use of market power to raise output prices or lower input prices in situations in which competition is imperfect in the local economy or internationally.[9]

Several problems arise in attempting to measure economic rent. First, there is an important distinction between "actual" economic rent, the difference between total revenues and total costs in some past period of time, and "maximum potential" rent, the difference between revenues and costs that would have occurred if the class of most efficient firms had been the sole firms producing during that time period. Because these most efficient firms would have produced with lower costs, in the case of the logging industry it is very likely that these firms would also have produced more logs.[10] Under these circumstances, measuring maximum potential economic rent is an exceedingly difficult task.

In a more general sense, the present net worth of the future stream of economic rents is measured as the present value of a discounted time stream of differences between annual total revenues and total costs. This measure requires estimates of future prices of outputs and inputs and is therefore highly sensitive to assumptions made with respect to future world and domestic market prices and to changes in logging technology. Two of the most uncertain parameters are export prices and the cost of capital, i.e., the rate of interest that will be required to keep logging firms in operation.

Page has estimated that actual economic rent amounted to 26 percent of the value of log output in 1970-71 (5, pp. 99-105). That estimate of rent, which is summarized in Table 4 as the sum of payments to government, rents to local investors, and rents repatriated by foreign investors, is of course dependent upon a number of assumptions. It is of interest to single out one for special comment. Logging firms operating in Ghana in 1970-71 were assumed to require a 15 percent annual rate of return on their invested capital. Normal costs thus included a 15 percent return to capital, and the estimate of rent retained by logging firms was therefore additional to this normal return to capital. Suppose,

[9] Our concept of economic rent includes excess profits (above the return to capital required to attract and retain the investment) and payments to excluded factors of production, such as "soil rent" to land and some portion of the return to managers. Forestry economists often refer to a distinction between "soil rent," the annual interest charge on the present value of undeveloped land (bare soil), and "rent to standing timber," which we have referred to as the scarcity rent. Economic rent also incorporates any effects of differential "X-efficiency," deriving from varying degrees of motivation and incentives of managers and employees and from other influences; see Liebenstein (1).

[10] For an elaboration of this point, see p. 36.

TABLE 4.—SHARES IN LOGGING OUTPUT AND NET GAIN FROM LOGGING, 1970-71 (Ghana)*

| Input and factor shares | | | Net gain coefficient | |
|---|---|---|---|---|
| Imported intermediates | .0755 | | Value of output | 1.0000 |
| Locally purchased intermediates | .0772 | | Less foreign input costs | -.3633 |
| Fuels | .0700 | | Less foreign factor costs | |
| Payments to foreign contractors | .0435 | | | |
| Payments to local contractors | .1096 | | Labor | -.0053 |
| Road and rail transport | .0814 | | Capital[a] | -.0901 |
| Electricity and water | .0153 | | | |
| Financial services | .0180 | | Less local input costs | -.1292 |
| All intermediates | | .4925 | Less local factor costs | |
| Wages and salaries | | .1343 | Skilled labor | -.0605 |
| Expatriate | .0133 | | Unskilled labor[b] | -.0302 |
| Ghanaian | | | Capital[c] | -.0338 |
| Skilled | .0605 | | | |
| Unskilled | .0605 | | Less rents repatriated by foreign investors | -.0704 |
| Payments to government | | .0970 | | |
| Direct taxes and royalties | .0794 | | Net gain | .2172 |
| Export taxes | .0176 | | | |
| | | | Components of net gain coefficient | |
| Residual (profits, depreciation, rents retained by private sector, etc.) | .2762 | .2762 | | |
| Excess payments to unskilled labor | .0302 | | | |
| | | | Payments to government | .0970 |
| Total output | 1.0000 | 1.0000 | Rents to local investors | .0900 |

*Table from John M. Page, Jr., "The Timber Industry and Ghanaian Development," in Scott R. Pearson and John Cownie et al., *Commodity Exports and African Economic Development*, Lexington Books, Lexington, 1974, p. 100.

[a] Based on an annuity computed for machinery with a life of 10 years at 15 percent and buildings with a life of 20 years at 15 percent. Import costs of capital as well as repatriated normal profits are included.

[b] Based on an estimated overvaluation of 50 percent in the social costs of unskilled labor.

[c] Returns to local investor based on the annuities computed as specified in note a.

however, that some firms were content with a rate of return less than 15 percent; in this instance the true amount of rent would be greater than that estimated. Conversely, if firms actually required a rate of return in excess of 15 percent, the estimate of rent is too high. Clearly, calculations of economic rent are very sensitive to assumptions about what return to capital firms require in order to continue investing in the logging business.

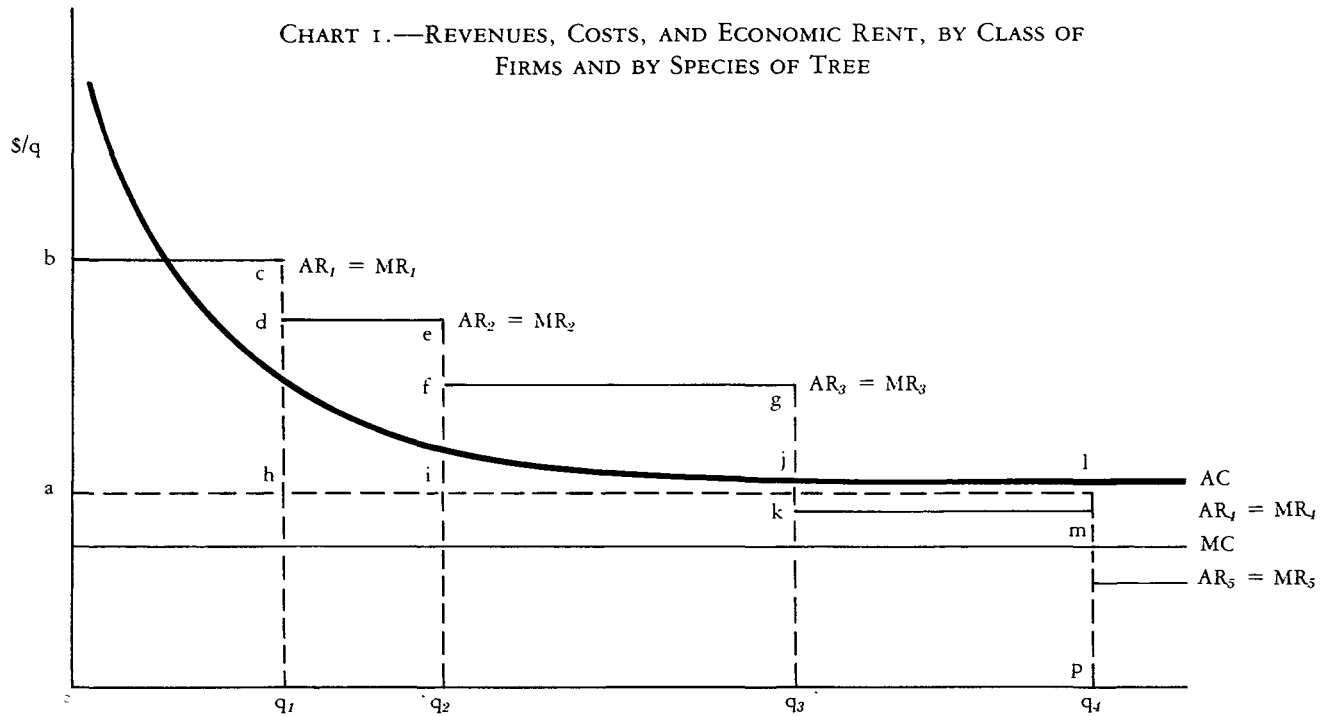
The distribution of rent is of prime importance in the current study. Of the actual rent generated by the logging industry in 1970-71, the Government of Ghana claimed only about 38 percent in the form of royalties and taxes, mostly marketing board levies and corporate income taxes. More than three-fifths of the rent remained in the hands of the logging industry; of this amount 35 percent went to Ghanaian investors and 27 percent to foreign investors. This result, while based only on a single year, calls into question the efficacy of the government's concession, royalty, and tax policies in transferring timber rent from the private sector to the public sector.

The distribution of economic rent among Ghanaian firms, expatriate firms, and the government affects critically the benefits that will accrue from exploitation of timber. Rent retained by foreign firms and remitted abroad clearly makes no contribution to Ghanaian development. If the government could enact policies to capture the remitted rent, this transfer would bring about gains in Ghanaian income—directly by the amount transferred, and indirectly if government expenditure of the rent were to cause further development.

Whether more beneficial developmental effects result from leaving economic rent in the hands of private Ghanaian logging firms or from transferring these rents to the government is, however, a moot question. The economic efficiency of logging could be enhanced if the transfer of rent is maximized because only the most efficient firms could pay the taxes and remain in business. Efficiency considerations aside, the transfer itself causes no direct change in Ghanaian income, and the issue depends on the comparative developmental impacts of the consumption and investment pattern of private firms versus that of the government.[11] In the remainder of this study, the assumption is made that government revenue is a better generator of additional income than private spending by owners of logging firms and hence that the transfer of rent from Ghanaian firms to the government is desirable, but it is recognized that this result may not apply uniformly.

[11] This issue has also been a source of considerable controversy in discussions of development policy, especially relating to agricultural development. In essence, it boils down to a comparison of the final demand linkages associated with private consumption and investment versus the fiscal linkages associated with government capital and recurrent expenditures; see Pearson (3, pp. 45-50) for definitions of these concepts.

CHART 1.—REVENUES, COSTS, AND ECONOMIC RENT, BY CLASS OF FIRMS AND BY SPECIES OF TREE




q = quantity of timber harvested, in tons
AC = average cost of logging
MC = marginal cost of logging
$AR_i$ = average revenue from species i, i = 1 ... 5
$MR_i$ = marginal revenue from species i, i = 1 ... 5

$q_1$ = maximum quantity of most valuable species, in tons
$q_2 - q_1$ = maximum quantity of second most valuable species, etc.

## ESTIMATES OF REVENUES, COSTS, AND ECONOMIC RENT, BY CLASS OF FIRMS AND BY SPECIES OF TREE: THEORY

In the preceding section, we have argued that current policies have been very ineffective in capturing actual economic rent. Moreover, detailed analysis of the engineering, cost, and output mix data for individual firms and for classes of firms indicates that a great deal of potential economic rent is not realized because of inefficient logging operations. Many, especially small-scale, firms have high production costs, harvest only the higher valued species of trees in their concessions, and take only one or two logs per tree, rather than the three usually available.[12] As a result, under current policies, the rent generated has been significantly smaller than it potentially could be, and the government has been receiving something less than two-fifths of this reduced amount of rent.

To augment the total rent generated and to increase its share of this larger amount, the Government of Ghana could introduce a new structure of royalty rates for the various species of merchantable timber.[13] The current system of royalties, it will be recalled, is a straightforward schedule of payments per tree harvested, differentiated by species. If a revised structure of royalties is to be used to capture economic rent that has been retained by firms, the design of this structure must be considerably more complex than that of the current one.

Chart 1 contains a simplified, diagrammatic representation of the economics of a logging firm or a class of similar logging firms operating in Ghana. As drawn, the firm (or class of firms) will harvest species 1 through 4 since marginal cost ($MC$) is less than marginal revenue ($MR$) (but not species 5 since $MR_5$ is less than ($MC$) provided that total revenue exceeds total variable costs. The firm thus produces the quantity of timber represented by *op* and receives total revenues of *obcdefgkmp*. Its total costs are *oalp*. Assuming that the cost curves incorporate a normal return to capital, actual economic rent equals the excess of total revenue over total costs, or *abcdefgj* less *jklm*.

The first question concerns the amount of rent generated. Potential economic rent is equal to actual economic rent if the class of firms portrayed is the most efficient in the industry. Less efficient firms have cost curves positioned at points further above the x-axis than the most efficient class of firms and thus generate less economic rent because they harvest fewer species with higher costs.

The second question involves the distribution of the rent generated. Suppose

[12] See Page (2) and other references cited therein.

[13] See Pearson (4), especially pp. 18-34, for a discussion of the likely success of alternative policies in achieving various government objectives. Six policies—retaining the existing set of policies, rescinding and reselling all concessions, introducing a new structure of royalty rates, changing the corporate income tax, introducing an excessive profits tax, and increasing the amount of government participation—were studied in relation to their effects on four objectives—capturing economic rent, encouraging efficient harvesting of the timber resource, reducing risk to firms, and increasing the amount of Ghanaian participation. The policy under consideration here, introducing a new structure of royalty rates, was singled out as the most likely to be effective in achieving the largest number of government objectives.

the government desires to capture a maximal amount of rent. Assume, moreover, that the government wants to extract the rent by means of a royalty, having already leased its timber concessions. The government could set the royalty rate on species 1 equal to *ab*, on species 2 equal to *hd*, and on species 3 to *if*. If the firm is to have non-negative profits, the royalty rate on species 4 should be negative *kj*, i.e., a subsidy, and on species 5, the rate should be zero. Of course, if these royalty rates are set with respect to the cost curves of the most efficient class of firms, all other firms are likely to harvest less intensively, and some will go out of business. A crucial policy decision, therefore, is whether to set the royalty rates with respect to the most efficient, least efficient, or some other class of firms.

Because log prices may change abruptly and by large amounts (thereby shifting the *AR* and *MR* curves in Chart 1), the royalty rate for each merchantable species should be set on a sliding scale. The following formula could be employed for this purpose:

$$r_s = t[p_s - (p^0 + cd)]$$

where $r_s$ = royalty rate, per ton, by species $s$
$t$ = tax rate parameter, $0 < t < 1$
$p_s$ = current price, per ton, of species $s$
$p^0$ = price parameter, set approximately equal to average cost at full output of reference class of firms

With reference to Chart 1, if the current price of the most valuable species rises, shifting the curve $AR_1 = MR_1$ upward, then additional economic rent is generated (provided that costs do not increase commensurately).[14] The sliding scale royalty is designed to capture that additional rent. If $(p^0 + cd)$ is chosen to approximate the average cost (at $q^4$) and if the tax rate parameter, $t$, is set equal to one, the sliding scale royalty will act as a 100 percent excess profits tax and transfer all rent to the government.[15]

The parameters $c$ and $d$ are included in the formula in an attempt to allow the government to capture location rents, associated with differential distances from market. In practice, it may well prove unwieldy to include these parameters, and hence $p^0$ would then be chosen to approximate the average cost at full output of a reference firm or class of firms. If the reference class of firms is the most efficient, all other firms would be forced out of business.[16] If some less efficient class of firms is chosen to be the reference, then all more efficient firms would retain a portion of rent unless a complementary policy were instituted. Royalty policy can

[14] The formula for the royalty rate, as stated, provides for a specified payment per ton of logs produced. The ad valorem royalty rate can be found by dividing both sides of the formula by the current price:

$$r/p = t\left[1 - \frac{(p^0 + cd)}{p}\right]$$

[15] If $(p^0 + cd) = AC$ (average costs), then $r = t[p - AC]$. Multiplying by $q_1$, the quantity of species 1 produced, the total tax, $r \cdot q_1 = t\,[p \cdot q_1 - AC \cdot q_1] = [TR - TC]$, since $p \cdot q_1$ is total revenue and $AC \cdot q$ is total costs (which include a normal return to capital). If $t = 1$, the royalty transfers all rent to the government just as an excess profits tax would do for the firm or class of firms under analysis.

[16] Concession rights could then either be transferred privately in secondary markets or revert to the government to be auctioned competitively to efficient firms.

thus be used to improve efficiency by altering the structure of the logging industry. Finally, the tax parameter, $t$, should not be set equal to one in a world of uncertainty. If the government sets $t$ too high, it could force many economically efficient firms into bankruptcy; if it sets $t$ too low, it would fail to capture some rent. This escaping rent could be captured, at least in part, by other taxes, and hence it is preferable to err on the low side in setting the tax parameter.

Assuming that this sliding scale royalty policy were introduced, it is of interest to examine its effectiveness in achieving alternative government objectives related to the generation and transfer of economic rent. This royalty policy would capture rent very effectively if the parameter, $p^0$, were chosen to approximate the average costs of the most efficient firm (or class of firms), and if the parameter, $t$, were chosen to be close to one. The royalty policy requires that government policy makers rather than the firms' managers have to estimate costs over time in order to choose $p^0$. But the royalty has the offsetting advantage that it permits the government to share some risk with the firms, which will lead to greater rent if the government discounts at a lower rate than the firms.

Any royalty policy has the detrimental effect of introducing a wedge between the firm's marginal costs and marginal revenue, thereby causing the firm to produce less output than would be socially desirable. An advantage of the sliding scale royalty, differentiated by species, is that this interference is likely to be minimized.[17] Hence, this royalty would cause some reduction in output, but the loss would generally not be too great. In addition, over time, the royalty rate policy would tend to provide an incentive for firms to invest in more efficient, cost-reducing technology since they would be encountering somewhat less uncertainty. But because the rent would be transferred to government effectively, firms could not count on retaining a "cushion" against unexpected adverse market changes. Finally, the royalty policy could lead to greater Ghanaian participation in logging if the government chose to restrict foreign entry and to set the parameters in the rate structure so as to permit inefficient local firms to continue to produce. This choice would, of course, involve the sacrifice of some government rent; the amount would depend on the relative degree of inefficiency of the subsidized firms.

## ESTIMATES OF REVENUES, COSTS, AND ECONOMIC RENT, BY CLASS OF FIRMS AND BY SPECIES OF TREE: APPLICATION

In this section we estimate marginal and average revenues and costs per square mile of forest for four size categories of firms, using price and expenditure data gathered in a sample survey of timber firms.[18] We then combine these results to estimate resource-based rents by species of trees and by class of firms. Finally, we derive a schedule of royalties that would allow the government to capture the estimated timber rents.

[17] This result holds when firms' marginal costs (a) are constant or decreasing and (b) are less than the difference between the price and the royalty of each species.

[18] Characteristics of the survey are summarized in the appendix.

TABLE 5.—PRICES OF SELECTED SPECIES OF GHANAIAN TIMBER, 1970-71*
*(cedis per cubic foot hoppus measure)*

| Species | Price |
|---|---|
| Logs of export quality | |
| Afrormosia | 3.35 |
| Sapele | 1.94 |
| Mansonia | 1.87 |
| Dahoma | 1.78 |
| Utile | 1.64 |
| Makore | 1.45 |
| Mahogany | 1.44 |
| African walnut | 1.24 |
| Edinam | 1.21 |
| Odum | 1.15 |
| Miscellaneous redwoods | 1.20 |
| Wawa | 0.64 |
| Logs of local sales grade quality | |
| Plymill grade | 0.60 |
| Redwoods primary species | 0.50 |
| Other redwoods | 0.40 |
| Wawa | 0.32 |

*1970-71 prices for export logs are from Republic of Ghana, *External Trade Statistics*, December 1970; 1970-71 local log prices are from the authors' survey of logging and sawmilling firms.

*Marginal and Average Revenues of a Typical Concession*

The "marginal revenue of the concession curve," as drawn in Chart 1, is a step function defined by the stocking of a given forest concession and by the prices of individual types of timber. In this section we provide an empirical estimate of the marginal revenue curve, using price data from 1970-71 and estimates of the stocking of an "average" forest concession.[19] Throughout the analysis we assume

[19] While export price data are available through accounting year 1974/75, more recent cost and local price data are not. Consequently, costs and prices for 1970/71 have been used in the empirical analysis to ensure comparability. Between 1970/71 and 1974/75 export prices for African hardwoods, denominated in foreign currency (West German marks per cubic meter), increased on average by 47 percent. Relative prices among species, however, remained virtually constant. During the same period, the Ghanaian logging industry also experienced increases in input costs, including wages for skilled and unskilled labor and prices of imported capital goods, adjusted for currency fluctuations. Since reliable estimates of these input cost rises are not available, we cannot determine whether the amount of economic rent in Ghanaian logging increased or decreased during the recent period of rising output prices. Crude estimates indicate that revenues probably increased somewhat more than costs.

TABLE 6.—ESTIMATED STOCKING OF TIMBER PER SQUARE MILE OF FOREST RESERVE*
*(thousands of cubic feet hoppus measure)*

| Species | Quantity | Cumulative total |
|---|---|---|
| Export quality logs | | |
| Afrormosia | .830 | .830 |
| Sapele | 3.230 | 4.060 |
| Mansonia | .754 | 4.814 |
| Dahoma | .320 | 5.134 |
| Utile | 5.030 | 10.164 |
| Makore | 2.080 | 12.244 |
| Mahogany | 2.790 | 15.034 |
| African walnut | .072 | 15.106 |
| Edinam | 1.190 | 16.296 |
| Odum | .025 | 16.321 |
| Miscellaneous redwoods | 1.550 | 17.871 |
| Wawa | 18.140 | 36.011 |
| Local sale grades | | |
| Plymill grade | 4.500 | 40.511 |
| Redwoods primary species | 13.460 | 53.971 |
| Other redwoods | 17.960 | 71.931 |
| Wawa | 23.510 | 95.441 |

*Swan Wooster Engineering Co., Ltd., "Ghana Forest Products Transport Study," report prepared for the Canadian International Development Agency, Vancouver, B C , Canada, November 1972, pp. 211-21.

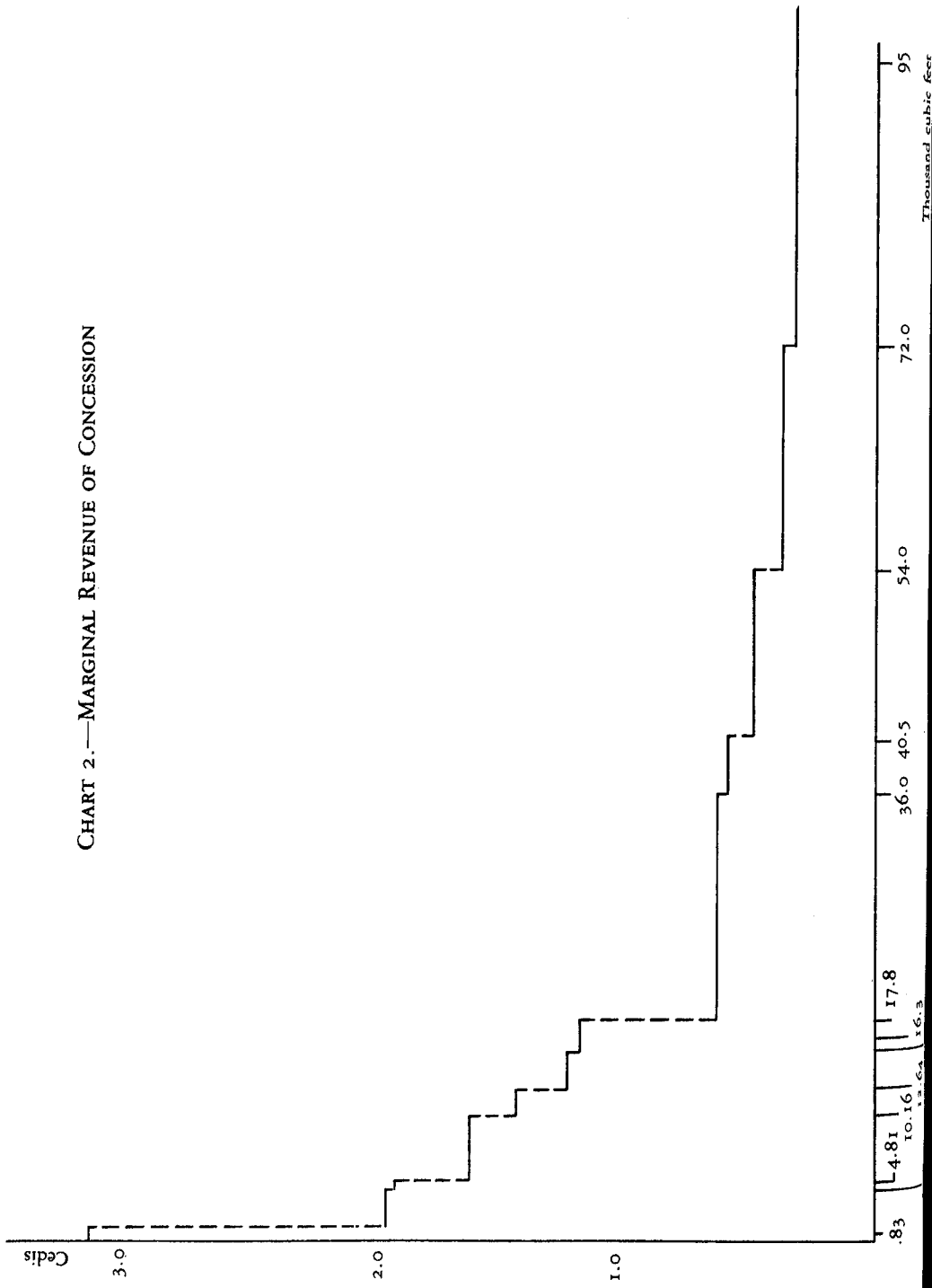
that production decisions do not affect the market price received. This assumption is clearly true for exported logs.[20] Logs sold locally find their eventual use as inputs into traded goods production (as sawn timber or plywood). Given the large numbers of buyers and sellers in the market for sawmill grade logs—more than 60 purchasers and 300 sellers—it is reasonable to assume that these logs also receive the value of their marginal product in traded goods production.

In Table 5 we summarize price information for 16 separate types of Ghanaian timber. The prices, which are for 1970-71, are unit values taken directly from the international trade statistics for exported logs and from the authors' sample survey for logs sold locally.

Estimates of average stocking of timber on one square mile of timber land are presented in Table 6. Quantities are expressed in thousands of cubic feet hoppus measure and are drawn from estimates of projected output on a hypothetical

[20] For discussion of the "small country assumption" as it relates to Ghana's timber output, see Page in Pearson and Cownie (5, pp. 99-105).

CHART 2.—MARGINAL REVENUE OF CONCESSION



concession representing the average composition of all timber lands in forest reserves. In practice the stocking of any individual concession will vary in both the number and composition of species. If concessions are not distributed at random—for example, if certain classes of firms tend to obtain better quality concessions—observed rents will tend to diverge systematically from the hypothetical values presented here. By focusing on an average concession, however, we are able to avoid the effects of concession composition and concentrate on differences in rents arising from differences in unit costs and resource utilization.

Marginal revenue of the concession curves are presented in Chart 2. Marginal revenues fall off quite steeply above 17,800 cubic feet per square mile as exploitable timber changes from export-grade redwoods to export-grade Wawa and local sales-grade logs.

*Marginal and Average Costs of Production*

Cost data gathered in the authors' survey permit estimates of the marginal and average costs of production of several categories of logging firms. Firms are stratified according to volume of output in cubic feet per annum. Elsewhere both engineering data and econometric analysis of the sample survey data have been used to establish that economies of scale exist in logging production up to the levels of output encountered in the largest of Ghana's logging enterprises (2, pp. 127-69). Penalties in terms of increased costs at levels of output below minimum efficient scale were found to be moderate until quite low levels of output were reached at which point costs began to rise steeply. For this reason we have defined four categories of firms differentiated by volume of output (in million cubic feet per annum): large-scale firms (more than 1.5); medium-scale firms (between .4 and 1.5); small-scale firms (between .1 and .4); and very small-scale firms (less than .1). The last category corresponds to firms on the steeply rising portion of the average cost curve which would be expected to encounter significantly higher unit costs.

In Table 7 we present estimates of the marginal and average cost of production for each category of firms. All costs are cell means for firms drawn from the sample survey in each category. Marginal costs were assumed to include all current input and labor costs and the portion of overheads not directly linked to the maintenance of the capital stock.[21] Average costs of production included cost items for depreciation and imputed "normal" rates of return before tax of 10 and, alternatively, of 15 percent. Concession rents, royalties, export taxes, and miscellaneous fees paid to the central government have been excluded. Hence, the estimates of rents derived from these cost figures include both rents captured by the government and those retained by the private sector.

Depreciation costs for capital were charged according to the straight line method assuming an average life of five years for vehicles, ten years for machinery and heavy equipment, and 30 years for buildings. Tests of the sensitivity of the cost estimates to changes in the assumed economic life of the capital stock indicated that the results were little affected by reasonable changes in the assumption regarding depreciation.

[21] For example, the component of overheads resulting from insurance on capital stock is not charged to marginal costs.

The estimated unit costs of production in Table 7 are for all species of timber taken together. Greater precision in the estimates could have been achieved if it had been possible to compute costs per cubic foot separately for Wawa and for other timbers. Unit costs for Wawa—on a cubic foot basis—lie below those for other species due to Wawa's higher cubic content per ton and to the physical characteristics of the wood which tend to lower felling and cross cutting costs per tree harvested. The difference does not appear to be greater than 20 percent of average unit cost for all species, and the likely unit cost of Wawa production probably lies in the range of .30 to .70 cedis per cubic foot. Accordingly, our estimates of rents accruing from the production of Wawa tend to understate actual rents while our calculations of rents for redwoods are slight overestimates.

Divergences between potential and actual rents may arise from differences in the unit costs of production for varying categories of firms. The cost data presented in Table 7 suggest that apparent differences exist in average production costs among size categories of firms. We conducted tests using the Scheffe multiple comparison approach to the analysis of variance to determine if there were statistically significant differences in mean marginal and average costs between types of firms.[22] The results are as follows:

| *Cost item* | *Maintained hypothesis* | *F value* | *Remarks* |
|---|---|---|---|
| Marginal cost | Equity of means | 1.238 | Accept maintained hypothesis |
| Average cost 10 percent return | Equality of means | 7.396* | Reject maintained hypothesis |
| Average cost 15 percent return | Equality of means | 8.215* | Reject maintained hypothesis |

*Significance at one percent level.

On the basis of these results, it is not possible to reject the hypothesis of equality of all mean values of marginal costs. Hence, essentially constant marginal costs prevail at all levels of output observed. Average costs, however, are not constant for all categories of firms.

The results of pair-wise tests, reported in Table 8, reveal significant differences in average production costs between all categories of firm size. The least significant differences occur between unit costs for large- and medium-scale firms and between medium- and small-scale firms. Very small-scale firms have highly significant differences in production costs with average costs exceeding twice those of the largest class of firms. The cost data from the sample survey therefore indicate the presence of increasing returns to scale in logging production.

The analysis of variance was also applied to test for differences in the mean productivity per square mile of forest of firms of different size. Here again

[22] For a succinct statement of the assumptions and methods of the multiple comparison approach to the analysis of variance, see Yamane (9).

TABLE 7.—MARGINAL AND AVERAGE COSTS OF PRODUCTION, 1970-71*
*(cedis per cubic foot or as indicated)*

| | Marginal cost | Average cost | | Productivity (*thousands of cubic feet/square mile*) | Number of firms observed |
|---|---|---|---|---|---|
| | | 10 percent return | 15 percent return | | |
| Large-scale firms (output exceeding 1,500 cubic feet) | .315 | .385 | .404 | 103.2 | 5 |
| Medium-scale firms (output between 400-1,500 thousand cubic feet) | .386 | .517 | .549 | 80.4 | 8 |
| Small-scale firms (output 100-400 thousand cubic feet) | .406 | .572 | .639 | 51.9 | 7 |
| Very small-scale firms (output less than 100 thousand cubic feet) | .393 | .779 | .838 | 35.2 | 8 |
| All firms | .383 | .587 | .636 | 63.1 | 28 |

*Authors' survey of logging firms.

significant differences between pairs of firms existed because large-scale firms exploited the forest with significantly greater intensity.

Given the apparent equality of marginal costs for all classes of firms, variations in harvesting intensity may appear to be inconsistent with the model of firm behavior presented earlier. The observed phenomenon arises from the failure of very small-scale firms to earn total revenues greater than total costs at the level of output dictated by marginal cost. The observations in the sample correspond to several points along the industry's long-run average cost curve. It is likely that each class of firms is operating at the minimum of its average cost curve and that further increases in output would lead to rising average costs. This tendency is accentuated by the fact that small firms pay lower wages for casual labor, being outside the minimum size for union organization, and economize on current inputs for machinery maintenance by maintaining a proportionately larger capital stock. In a competitive environment smaller firms would either leave the industry or increase their size. This result does not occur in Ghana because concession policies both subsidize and limit the expansion of small firms.

### *Unit and Total Rents by Class of Firms*

In Table 9 we present estimates of the unit value of resource-based rents by species of timber and class of firms. Rents are taken as equal to the differences between average revenue and average costs for each of the size categories of firms discussed above. Unit rents are positive for all exportable redwoods but are negative for some of the lower valued species, especially among the smaller size

TABLE 8.—PAIR WISE TESTS FOR DIFFERENCES IN MEAN AVERAGE COSTS BETWEEN CATEGORIES OF FIRM SIZE*

| | Large-scale firms | Medium-scale firms | Small-scale firms | Very small-scale firms |
|---|---|---|---|---|
| 10 percent return | | | | |
| Large | — | | | |
| Medium | .132[a] | — | | |
| Small | .187[b] | .055 | — | |
| Very small | .395[c] | .262[c] | .208[c] | — |
| 15 percent return | | | | |
| Large | — | | | |
| Medium | .146[a] | — | | |
| Small | .235[c] | .090 | — | |
| Very small | .435[c] | .289[c] | .199[c] | — |

* Calculated from data in Table 7.
[a] Significant difference at 10 percent level.
[b] Significant difference at 5 percent level.
[c] Significant difference at 1 percent level.

classes of firms. As expected, unit rents are positively correlated with firm size.

Total rents for a square mile of concession for each size class of firms are presented in Table 10. Total rents were estimated by subtracting total costs, based on the average cost estimates presented in Table 7 and the estimated values of output per square mile, from total revenues accruing from the level of output per square mile. The total rent figures present some interesting insights into the potential rents foregone as a result of leasing policies which have encouraged the growth of very small-scale firms. At the estimated rate of return of 15 percent, total rents per square mile of very small-scale firms are less than 50 percent of those for large-scale enterprises. Total rents for medium- and small-scale firms are about 63 percent of those for large-scale firms. Differences in total rents arise from two sources, the higher unit costs of very small-scale firms and their correspondingly lower levels of resource exploitation.

In order to test the sensitivity of the results to the assumed rate of return we also computed total rents on the basis of a rate of return of 10 percent. Total rents for all firms taken together increased by 21 percent. Within individual size categories of firms the reduction in the assumed rate of return had the greatest impact on the total rents accruing to small- and very small-scale firms for which capital costs comprise a relatively higher proportion of total costs.

*Ad Valorem Royalty Rates*

In Table 11 we present estimates of the ad valorem equivalent of the rents per cubic foot given in Table 9. These rates represent the maximum potential royalty rate which could be charged against each class of firms and species of timber if the

TABLE 9.—RENTS PER CUBIC FOOT BY SPECIES AND CLASS OF FIRMS, 1970-71*

| | Large-scale firms | Medium-scale firms | Small-scale firms | Very small-scale firms |
|---|---|---|---|---|
| Export quality logs | | | | |
| Afrormosia | 2.94 | 2.80 | 2.71 | 2.50 |
| Sapele | 1.54 | 1.39 | 1.30 | 1.10 |
| Mansonia | 1.47 | 1.32 | 1.23 | 1.03 |
| Dahoma | 1.38 | 1.23 | 1.14 | .94 |
| Utile | 1.24 | 1.09 | 1.00 | .80 |
| Makore | 1.05 | .90 | .81 | .61 |
| Mahogany | 1.04 | .89 | .80 | .60 |
| African walnut | .84 | .69 | .60 | .40 |
| Edinam | .81 | .66 | .57 | .37 |
| Odum | .75 | .60 | .51 | .31 |
| Miscellaneous redwoods | .80 | 65 | .56 | .36 |
| Wawa | .24 | .09 | .00 | -.20 |
| Plymill grade logs | .20 | .05 | -.04 | -.24 |
| Sawmill grade logs | | | | |
| Primary species redwoods | .10 | -.05 | -.14 | -.34 |
| Other redwoods | .00 | -.15 | -.24 | -.44 |
| Wawa | -.08 | -.23 | -.32 | -.52 |

* Calculated from data in Tables 5 and 7.

tax parameter in the formula for sliding-scale royalties (see p. 36) were set at 1.0 and incremental transport costs for all firms were equal.

The rates presented in Table 11 quite clearly demonstrate the importance of the level of the royalty to the profitability of firms. If the ad valorem rate were set at the levels which would remove 100 percent of the resource-based rents from large firms, all other classes of firms would experience subnormal profits or losses. Alternatively, if the criterion for establishing the royalty were based on assuring the continued normal profitability of very small-scale logging enterprises, other classes of firms would make supernormal profits.

The ad valorem rates also provide evidence of the extent to which the Ghanaian Government failed to capture economic rents, especially those associated with export quality logs. For example, the royalty on afrormosia, the highest valued species, required to transfer all economic rent to the government was at least 75 percent in 1970-71, even if the very small-scale firms are used as the reference class. By comparison, the actual specific royalty, supplemented by a small specific export tax, amounted to less than 10 percent ad valorem in that year. While the corporate income tax may have captured perhaps half of the residual (which was at

TABLE 10.—TOTAL RENTS PER SQUARE MILE OF CONCESSION, BY CLASS OF FIRMS, 1970-71*
*(thousands of cedis)*

| | Total rent | |
|---|---|---|
| | 10 percent return | 15 percent return |
| Large firms | 28.3 | 26.3 |
| Medium firms | 19.1 | 16.5 |
| Small firms | 20.1 | 16.6 |
| Very small firms | 13.9 | 11.8 |
| All firms | 17.8 | 14.7 |

*Calculated from data in Tables 6 and 9.

TABLE 11.—AD VALOREM EQUIVALENTS OF RENTS, BY SPECIES AND CLASS OF FIRMS, 1970-71*

| | Large-scale firms | Medium-scale firms | Small-scale firms | Very small-scale firms |
|---|---|---|---|---|
| Export quality logs | | | | |
| Afrormosia | 87.8 | 83.6 | 80.9 | 74.6 |
| Sapele | 79.4 | 71.6 | 67.0 | 56.7 |
| Mansonia | 78.6 | 70.6 | 65.8 | 55.1 |
| Dahoma | 77.5 | 69.1 | 64.0 | 52.8 |
| Utile | 75.6 | 66.5 | 60.9 | 48.3 |
| Makore | 72.4 | 62.1 | 55.9 | 42.1 |
| Mahogany | 72.2 | 61.8 | 55.6 | 41.7 |
| African walnut | 67.7 | 55.6 | 48.4 | 32.3 |
| Edinam | 66.9 | 54.5 | 47.1 | 30.6 |
| Odum | 65.2 | 52.2 | 44.3 | 26.9 |
| Miscellaneous redwoods | 66.6 | 54.2 | 46.7 | 30.0 |
| Wawa | 37.5 | 14.0 | 00.0 | -31.3 |
| Plymill grade logs | 33.3 | 8.3 | -6.7 | -40.0 |
| Sawmill grade logs | | | | |
| Primary redwoods | 20.0 | -10.0 | -28.0 | -68.0 |
| Other redwoods | 00.0 | -37.5 | -60.0 | -110.0 |
| Wawa | -25.0 | -71.8 | -100.0 | -162.5 |

*Calculated from data in Tables 5 and 9.

least 65 percent of the value of the afrormosia produced), rents amounting to one-third or more of the value of afrormosia output were not appropriated by the government in 1970-71. If this same comparison were made for other species, similar results would be found, although the amount of residual rent would decrease as one moved from the higher valued to the lower valued species, and it would eventually turn negative. This conclusion underscores the desirability of differentiating the schedule of royalty rates by species according to the formula suggested in this paper.

## CONCLUDING REMARKS

We have presented a conceptual framework for use by governments of developing countries to capture economic rents associated with natural resources that have been leased to private firms. Application of the framework to the timber industry in Ghana has strengthened our case that a sliding-scale royalty is a potentially effective policy to bring about the transfer of resource-based rents in these circumstances. If our recommended approach is to be applied, however, we should reiterate two critical caveats. First, the approach requires a careful, detailed analysis of costs and revenues so that levels of rent can be measured with accuracy. Second, in setting the parameters of the royalty formula, it is preferable to err on the low side because some of the escaping rent will be recaptured by other tax policies, notably the corporate income tax, and because the social costs of driving an economically efficient firm out of business with an overly stringent royalty policy are generally greater than those associated with leaving some rent in the hands of private firms.

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TABLE A-1.—CHARACTERISTICS OF LOGGING SAMPLE

| | Number of firms | | Percentage output by volume, 1970 | | Percentage of concession area, 1971 | |
|---|---|---|---|---|---|---|
| | Industry | Sample | Industry | Sample | Industry | Sample |
| Large firms, output more than 1.5 million cu.ft. | 5 | 5 | 42.2 | 78.4 | 45.0 | 76.2 |
| Medium firms, output 400-1,500 thousand cu.ft. | 20 | 8 | 20.9 | 15.8 | 28.4 | 17.6 |
| Small firms, output 100-400 thousand cu.ft. | 71 | 7 | 16.9 | 4.2 | 19.8 | 4.2 |
| Very small firms, output less than 100 thousand cu.ft. | 265 | 8 | 20.0 | 1.6 | 6.8 | 2.0 |
| Totals | 361 | 28 | 100.0 | 100.0 | 100.0 | 100.0 |

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## APPENDIX

*Characteristics of the Sample Survey*

A sample survey of timber and wood-processing firms was conducted during the 5-month period from May through September 1972 and in follow-up interviews during March and April 1973. Firms engaged in logging and in integrated logging and wood products manufacturing were interviewed. Data collected were for a 12-month financial year occurring in the period between April 1970 and December 1971. Sixty percent of all returns were for 12-month financial years occurring in the shorter period from April 1970 to July 1971.

Firms for interview were selected according to two methods. For firms engaged in logging only, a simple random sample of 60 firms was drawn from a list of 300 logging contractors provided by the Office of the Chief Conservator of Forests. Thirty-six firms were located and subsequently interviewed by the authors or by an Akan-speaking enumerator. Fifteen of the firms selected in this manner indicated that they maintained regular accounts, although only five eventually produced consistent responses. The remaining 21 firms indicated that audited accounts were not kept and were therefore interviewed using a questionnaire specifically designed for such enterprises.

Interviews were attempted with all integrated logging and processing firms covered by the Forestry Division log and processed timber returns or by the Central Bureau of Statistics industrial survey as of the first quarter of 1970. These sources when combined yielded a population of six plywood and veneer mills and 23 sawmills, owned by a total of 27 registered enterprises. Of this population, 18 firms were finally interviewed.

Two types of questionnaires were developed to be used in conducting the interviews with the choice of questionnaire finally employed depending on the sophistication of the firm's accounting system. For firms which kept regular accounts a questionnaire was employed which was similar to that used in the Industrial Survey, but which elicited responses in greater detail concerning composition of output, capital stock, labor inputs, and composition of material inputs. Additionally for firms which were vertically integrated the questionnaire was designed to allow costing of individual activities, e.g., logging as distinct from processing. Fortunately, most firms encountered little difficulty in allocating costs among the various activities.

The second type of questionnaire was designed for use in interviewing very small-scale logging firms, many of whose accounting procedures are irregular. In this questionnaire emphasis was placed on obtaining physical estimates of the volume of inputs and outputs. In general, firms had good data on the volume and

value of output, number and annual earnings of employees, and the composition and age of their capital stock. Major problems were encountered in providing estimates for either the initial purchase value or replacement cost of capital inputs and for the annual value of spare parts and materials consumed in production.

Use of a particular sample and reference period raises the possibility that they may not be representative of the general structure and performance of the timber and wood-processing industries in the long run. For this reason we examine in some detail the characteristics and biases of the sample period and of the sample.

The period 1970 to 1971 does not appear to have been exceptional in terms of industry output or exports. Log exports continued to reflect the rising trend following the 1967 devaluation. Declines in log output in the second half of 1970 due to inclimate weather were consistent with the general pattern of log production in Ghana. Production of logs increased significantly in the first half of 1971, and industry output during the reference period was very similar to the levels exhibited since 1966. Available price data through accounting year 1974/75 indicate that in the four-year period following the reference year export prices for all West African hardwoods increased on average by 47 percent although relative prices among species remained virtually constant. For this reason profits of logging firms at present may be higher than the levels estimated for the 1970/71 accounting year.

The reference period was somewhat abnormal with respect to trade policy in Ghana. Between 1969 and 1971, the government replaced a large number of quantitative import restrictions with import surcharges and progressively placed about three-fourths of total imports by value on "open general license." Liberalization of the restrictions on importation of spare parts and raw materials relieved to some extent the supply constraints on capacity utilization in the industry. The restrictive effect of import licensing on production may have been less in 1970 and 1971 than in prior or subsequent years. Nevertheless, many of the firms interviewed in the 1972 survey cited lack of machinery spare parts as the major constraint on production during the reference period. As a result, estimates of capacity utilization and social costs of production from this study may imply a slightly better performance of firms in the industry than the actual levels prevailing since 1966, but the differences between the sample year and the period since 1966 as a whole are likely to be rather small.

Table A-1 contains an analysis of the distribution of the logging sample by output and area of concession holdings as compared with the distribution of all registered firms in the industry. The sample covers 28 of 329 logging operations. Firms contained in the sample produced 54 percent of total logging output and held 59 percent of registered concessions in 1971. Analysis of the industry and the sample by firm size and ownership indicates that the sample is quite strongly biased toward large-scale firms which are vertically integrated. Firms engaged in logging only are the most unrepresented in the sample; the sample firms in this category produced less than 2 percent of the output of all firms in the group in 1971. The logging sample is also biased somewhat toward foreign- and jointly-owned firms. In large measure this bias reflects the availability of consistent

accounting data. It is clear that the logging firms studied cannot be viewed as a representative sample of all firms in the sector.

The extent to which the sample biases affect our general conclusions regarding the efficiency of firms in logging production depends on the extent to which the biases are related to industrial efficiency. Large- and medium-scale firms which are overrepresented tend to be relatively more efficient. Among these categories of firms, ownership does not appear to be a significant explanatory variable for differences in production costs. Hence, the bias of the sample toward foreign- and joint-ownership does not appear significantly to affect our conclusions. The underrepresentation of small-scale firms probably biases the sample away from relatively less efficient firms. If ability to keep accounts adequately is a reasonable indicator of economic efficiency, the ten small-scale firms finally included from the random sample may in fact represent the upper 17 percent of small firms in terms of efficiency. The conclusions drawn regarding the social costs of promoting small-scale loggers would then be reinforced.