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APPENDIX B

SHADOW PRICE ESTIMATION

by

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The methodology described in Appendix A requires that outputs, intermediate inputs, and primary factors involved in the production, assembly, processing, and marketing of rice be valued at shadow or social accounting prices. These shadow prices reflect the value placed by society on the opportunities foregone by using scarce resources in the rice sector. As such, they serve as a guide to how resources can be allocated to maximize social welfare.

The next section develops some of the general concepts and outlines the major assumptions used in shadow price estimation. Following this explanation, there is a discussion of the specific procedures used to estimate the shadow prices of outputs, intermediate inputs, and various factor services. The estimates are presented and evaluated with respect to their limitations and biases. Major conclusions are summarized at the end of the paper.

CONCEPTS AND ASSUMPTIONS

Shadow prices may differ from prices observed in the market because of non-competitive behavior, externalities, and distortions introduced by government policy.¹ Policy induced distortions are perhaps the most pervasive, and at the same time the most complex, cause of divergence between market and shadow prices in less developed countries.

There exist in the literature two basic approaches to the social valuation of resources. The first argues that shadow prices should be defined solely with respect to the objective of economic efficiency. Other objectives are recognized, but the use of policies to achieve those objectives is generally perceived as having an economic cost valued at these shadow prices.² An alternative approach is to build into shadow price estimates the weights attached to various national goals.³ Benefits accruing to different income groups, for example, may be assigned different values taking into account the objective of improving income distribution. If this procedure is used, the optimal policy mix maximizes net social benefits expressed in terms of accounting prices which reflect these social weights.

The approach used in the West African rice project has been to define shadow prices solely in terms of economic efficiency. No adjustment is made for the contribution of policies to other objectives though their impact on these objectives may be separately assessed.

If there are historical policy-imposed distortions in the economic system, the estimation of shadow prices will vary depending on whether these distortions are expected to be removed. In calculating "first-best" shadow prices it is assumed that all government imposed distortions will be eliminated except insofar as they contribute to the optimal allocation of resources. "Second-best" shadow prices, on the other hand, are estimated assuming that existing nonoptimal policies will remain in effect during the period of the analysis. This is equivalent to deriving the first-order conditions for welfare maximization with market distortions acting as constraints. This latter approach has been used in the West African rice project.

Given these assumptions, the general procedure used to estimate the shadow price of a given resource is to determine the decline in national income which occurs as the result of withdrawal of the resource from alternative uses. Under conditions where all goods are tradable, government quantitative trade restrictions do not exist, and the country has no monopoly power in international trade, this change in national income should be valued in world prices.⁴ The justification for this valuation, rather than using domestic prices that reflect consumers' marginal preferences, is that consumer prices are invariant with respect to changes in the allocation of resources under these conditions. Welfare depends, then, only on the level of purchasing power over the world's goods and services and can be measured by national income denominated in world prices. Because of the possibility of trade, resources may be allocated so as to maximize production expressed in world prices without directly affecting the pattern of consumption except through alterations in income.

If some goods are nontraded and the number of primary factors equals the number of traded goods, Bhagwati and Srinivasan (4) have recently demonstrated that the shadow prices of the primary factors are uniquely determined by the world prices of the traded goods, and the world price equivalents of nontraded goods then depend only on the technology used in production. In the more general case where the number of primary factors does not equal the number of traded goods, however, shadow prices are not uniquely defined with respect to world prices but depend, in addition, on the pattern of policy distortions and market imperfections, together with the resulting allocation of

resources (2). If government policy takes the form of a quantitative restriction on trade flows, any changes in the allocation of resources will, in general, alter the relative magnitude of the consumer price distortion resulting from this policy, and changes in social welfare will no longer depend uniquely on changes in output valued at world prices (4, p. 9):⁵ Finally, where a country has some monopoly power in the international trade of certain goods, it is in general not sufficient to replace world prices with marginal revenue since this does not allow for changes in the domestic consumption of these goods which occur as resources are reallocated (4, p. 19).⁶

In the literature on shadow price estimation, there is disagreement over some issues. In particular, the general equilibrium implications of partial equilibrium approaches to shadow pricing have only begun to be explored.⁷ Nevertheless, most empirical estimation techniques are essentially partial equilibrium in nature. The methodology used here follows this tradition but also explores some of the indirect effects induced by withdrawing resources from alternative uses and whether these indirect effects require adjustments in the shadow price estimates.

Although some attention has been given to identifying market imperfections resulting from noncompetitive behavior or externalities, the most important distortions appear to be those induced by government policy. The effects of these distortions are shown in the following generalized shadow price equation:⁸

$$\begin{aligned}
 P_h^* = & \frac{1}{r} P_h + \sum_{i=1}^m P_i^w t_i^c \frac{dx_i}{d\lambda_h} + \frac{1}{r} \sum_{k=1}^n P_k^d t_k \frac{dz_k}{d\lambda_h} \\
 & + \sum_{i=1}^m P_i^w t_i^d \frac{\hat{d}x_i}{d\lambda_h} - \sum_{i=1}^m P_i^w t_i^d \frac{\bar{d}x_i}{d\lambda_h}
 \end{aligned}
 \tag{1}$$

where p_h^* is the shadow price of the h^{th} resource expressed in foreign currency;

p_h is the market price of that resource;

r is the official exchange rate;

p_i^w is the world price of the i^{th} tradable good measured in foreign currency;

p_k^d is the producer price of the k^{th} nontradable good;

t_i^c is the tax rate which causes the price paid by consumers for tradables to differ from the border price (subsidy rates are expressed as negative tax rates);

t_i^d is the tax rate which causes the price paid or received by producers for tradables to differ from the border price;

t_k is the tax rate which causes the price paid by consumers for nontradables to differ from the price received by producers;

x_i is final consumption of the i^{th} tradable good;

\hat{x}_i is intermediate consumption of the i^{th} tradable good;

\bar{x}_i is production of the i^{th} tradable good;

z_k is final consumption of the k^{th} nontradable good;

l_h is the fixed quantity of the h^{th} resource available to the economy at the beginning of the relevant period;

m is the number of tradable goods; and

n is the number of nontradable goods.

Resources include primary factors, stocks of goods left over from the previous period, and foreign exchange. Market prices of resources that are fixed in supply are determined only by their scarcity values and not by the reservation prices attached to them by those who control their supply. Under this assumption, the value of leisure time and of savings, for example, can be ignored. Where quantities of resources are not predetermined, the scarcity value and reservation price should equal one another unless there are policy-induced distortions or other imperfections in the markets for these resources.

Given these assumptions, the estimation of shadow prices requires correction of the relevant market prices facing consumers and producers for distortions caused by government taxes and subsidies on flows of goods and nonfactor services. The first two terms to the right of the market price p_h in equation (1) show that taxes on consumption goods raise the value of those goods to consumers. To the extent that withdrawal of a resource from alternative uses results in a change in consumption of tradables or of nontradables, the effect of distortions in consumer goods prices is taken into account through these terms.

The last two terms in equation (1) correct for distortions faced by producers in the prices of both the inputs they purchase and the products they sell. When the utilization of tradable inputs and the production of tradable outputs are affected by withdrawal of a resource from alternative uses, a weighted average of the distortions in the prices of these inputs and outputs is subtracted from the

market price of the resource. The weights are the amounts by which each of these inputs and outputs is increased or decreased.

In general equilibrium, consumption and production of most goods would normally be expected to change as a result of a withdrawal of a unit of the resource from the rest of the economy. Estimating these changes in a world of many commodities, however, would be a formidable task. One alternative is to work with a limited number of aggregate commodity groups, such as imports, exports, and nontradables. The conditions for aggregation, however, are very stringent and the possibility of estimating parameters for these aggregates are quite limited.

A more practical approach is to investigate the activities from which a resource is likely to be withdrawn in order to make adjustments in the price of the resource based on the distortions existing in the major markets affected by the withdrawal. This procedure requires some knowledge of how relevant product and factor markets operate. To the extent that the government is directly involved in allocating resources, it also requires an understanding of how its decisions are likely to be made.

If there are no direct government controls on consumption and if world prices, the exchange rate, and tax and subsidy rates are fixed, changes in the quantities of tradables and nontradables consumed may be related to changes in the availability of a resource via its price and income effects by the following equations:

$$\frac{dx_i}{d\ell_h} = \sum_{k'=1}^n \frac{\partial x_i}{\partial p_{k'}^c} \frac{dp_{k'}^c}{d\ell_h} + \frac{\partial x_i}{\partial y} \frac{dy}{d\ell_h} \quad (2)$$

$$\frac{dz_k}{d\lambda_h} = \sum_{k'=1}^n \frac{\partial z_k}{\partial p_{k'}^c} \frac{dp_{k'}^c}{d\lambda_h} + \frac{\partial z_k}{\partial y} \frac{dy}{d\lambda_h} \quad (3)$$

Where k' represents any of n nontradable goods including the k^{th} , $p_{k'}^c$ is the consumer price of the k'^{th} nontradable good, y is income, and the other symbols are the same as in equation (1).

While it may be impossible to estimate precisely the magnitude of these consumption effects, it is at least possible to determine the signs of the more important ones. Consider, for example, the withdrawal of one unit of labor from millet production. The first order effect is likely to be a rise in the price of millet, and a consequent decline in consumers' real income ($dp_k^c/d\lambda_h < 0$ and $dy/d\lambda_h > 0$). For goods such as rice (x_1) or cassava (z_k), which are substitutes for millet (z_k), both their cross price and income elasticities are positive ($\partial x_1/\partial p_k^c > 0$ and $\partial x_1/\partial y > 0$ in equation (2), and $\partial z_k/\partial p_k^c > 0$ and $\partial z_k/\partial y > 0$ in equation (3)). As a result, the two terms in the equations tend to offset one another and little change occurs in consumption. Hence, any distortions in the markets for substitutes can reasonably be ignored. If distortions in the market for millet exist ($t_k \neq 0$), the shadow price of labor would still not have to be adjusted as long as the good's own price elasticity and its income elasticity are both negative ($\partial z_k/\partial p_k^c < 0$ and $\partial z_k/\partial y < 0$), since the two terms in equation (3) still tend to offset one another.

Under these conditions, the first and second terms in equation (1) are close to zero and no adjustment to the market price of labor (p_h) is necessary because of changes in the consumption of millet or its substitutes.

On the other hand, if labor had been withdrawn primarily from fishing, and if fish (z_k) and rice (x_i) are complements ($\partial x_i / \partial p_k^c < 0$), both terms in equation (2) would be positive. Therefore, the market wage rate in equation (1) should be adjusted upwards if rice is taxed and downwards if rice is subsidized. The same result holds for equation (3) in the case of nontraded complements.

The third term in equation (1), showing the effects of changes in consumption of intermediate goods, is also influenced by changes in the production of both tradables and nontradables. With fixed input-output coefficients, the impact on intermediate consumption, $x_{i'}$, is straightforward, as shown in equation (5):

$$\frac{dx_i}{d\lambda_h} = \sum_{i'=1}^m a_{ii'} \frac{dx_{i'}}{d\lambda_h} + \sum_{k=1}^n a_{ik} \frac{dz_k}{d\lambda_h} \quad (5)$$

where i' represents any of the m tradables being produced including the i^{th} ,

$a_{ii'}$ is the physical input-output coefficient for the i'^{th} tradable good,

a_{ik} is the physical input-output coefficient for the k^{th} nontradable good,

\bar{z}_k is the production of the k^{th} nontradable good.

The rest of the notation is the same as for equation (1). To illustrate, a shift of labor from millet to rice production causes rice output to rise and millet output to fall ($dx_{i'}/d\lambda_h > 0$ and $d\bar{z}_k/d\lambda_h < 0$). If rice is fertilized ($a_{ii'} > 0$) but millet is not ($a_{ik} = 0$), consumption of fertilizer will rise. If the market price of fertilizer is subsidized ($t_1^d < 0$), as it usually is in West Africa, the third term in equation (7) would be negative. As a result, other things equal, the shadow price for labor would be less than the market price.

Similarly, the change in the quantity produced of each tradable good as the result of the reallocation of a scarce resource can be expressed by:

$$\frac{d\bar{x}_i}{d\lambda_h} + \frac{\partial \bar{x}_i}{\partial \lambda_{hi}} \frac{d\lambda_{hi}}{d\lambda_h} \quad (6)$$

This change thus equals the marginal product of the resource (λ_h) in the production of the i^{th} tradable good multiplied by the proportion of this resource withdrawn from that industry. This proportion may depend on the operation of resource markets, on government quantitative controls, and on factors specific to the activity toward which the resource is being diverted. The introduction of a new cash crop, for example, is likely to draw labor from both the local labor market and farmers' other activities. If an important proportion of a resource is withdrawn from sectors which are heavily taxed or subsidized, an adjustment to the market price of the resource should be made. Thus the value of the marginal product of labor withdrawn from the coffee sector in the Ivory Coast is greater than the market wage rate because exports of that sector are taxed. In other words, the fourth term in equation (1) is positive.

SHADOW PRICE ESTIMATES

In this section, shadow price estimates are presented for rice output, intermediate inputs, and primary factors. In addition, the section discusses the specific procedures involved in deriving those estimates, which involve two phases. The first is an estimation of the market price of each resource and an assessment of the extent to

which this price is distorted by imperfections in the markets for primary factors. The second phase makes the adjustments, if required, indicated by equation (1). Finally, the relationship between this approach and one requiring estimation of the shadow price of foreign exchange is examined.

Rice Output

The accounting price of rice output is the world price for the relevant quality at the assumed point of consumption. This consumption point is typically a port or capital city, but in some instances estimates were made for delivery to other markets. A basic reference price for Thai 5 percent broken, f.o.b. Bangkok, was established at \$350 per metric ton (mt) in 1975 US\$, which is reasonably consistent with both past prices and future projections (17). This price is based on the long-term trend, which is more important for this analysis than short-term inter-annual variations. It is also fairly representative of 1975-76, the latest agricultural year for which complete data are available. To this export price, \$50¹² per mt was added to cover insurance and freight. The resulting c.i.f. reference price was then adjusted to account for observed quality differences between the rice actually imported and Thai 5 percent broken.

The adjustment for quality differences varies by country. The discount for 25-35 percent broken rice is based on historical differences between its price and the reference price for Thai 5¹³ percent broken rice. This discount averages about 30 percent.

The resulting c.i.f. price is reasonably consistent with the price of rice imported into the Ivory Coast and can also be used for Sierra Leone and Mali.¹⁴ Liberia imports rice, mostly from the United States, which is of higher quality than Thai 5 percent broken. Hence, a premium rather than a discount was applied to the price of Thai 5s. Retail price comparisons, however, indicate that imports are of better quality than domestically produced rice, so a \$30/mt discount was then subtracted from the price of imported rice to arrive at an equivalent c.i.f. price for domestic rice. Senegal, on the other hand, imports two major qualities of rice -- 100 percent broken for the mass market and 100 percent wholegrains for a small, upper-income market. Since the rice produced in Senegal is of a quality intermediate between the two, the equivalent c.i.f. price of this local rice was estimated as the weighted average of the prices of the two qualities of imported rice, where the weights are the proportions of broken and wholegrains found in domestically produced rice.¹⁵

For imported rice that is transported from the coastal ports of Africa to the interior countries, the cost of transport and handling has been added to the c.i.f. price at the port to obtain a c.i.f. price at the interior border. On the other hand, for a country that is a potential exporter within the region, the cost of transport and handling between the frontier of the exporting country and the consumption center of the importing country has been subtracted from the price to wholesalers in that consumption center to yield a f.o.b. price at the frontier of the exporter. For example, the relevant

shadow price of rice exported from Mali to Bouaké in the center of the Ivory Coast was calculated by first adding the cost of transport from Abidjan to Bouaké to the c.i.f. price, Abidjan, in order to obtain a price for imported rice in Bouaké. From this was subtracted the cost of shipping rice from the Malian frontier to Bouaké, which gives an f.o.b. price at the frontier. This price is the one that would make Malian rice competitive with Ivorian imports from other sources.

Within countries, various consumption points have been used to analyze the role played by transportation costs in providing natural protection against imports or in depressing the market for locally produced rice. The relevant shadow price is estimated by adding to the c.i.f. price the tradable component of the cost of transport and handling from the port or frontier to the internal consumption point. The value of primary domestic factors used in the internal distribution of these imports is, in turn, subtracted from the cost of distributing the domestic rice which replaces these imports since these factors are saved by import substitution.

The results of these adjustments are shown in Table 1, which gives the central values of the shadow price of rice of several different qualities in selected West African locations. The individual country studies examine the sensitivity of results to changes in these prices arising from variation in the world reference price.

Table 1.--Shadow Prices of Rice in
Selected West African Locations
(1975 U.S.\$/mt)

Location	Quality		
	Wholegrains	25-35percent brokens	100 percent brokens
Ivory Coast^a			
Abidjan (c.i.f.)		308	
Abidjan (wholesale buying)		305	
Bouaké (wholesale buying)		329	
Forest farmers (consumer cost) ^b		385	
Savannah farmers (consumer cost)		392	
Liberia			
Monrovia (c.i.f.)	344	314	
Mali^c			
Bamako (wholesale buying)		364	
Ségou (wholesale buying)		369	
Mopti (wholesale buying)		378	
Mopti (consumer cost)		398	
Gao (wholesale buying)		393	
Sikasso (consumer cost) ^b		361	
Senegal^a			
Dakar (c.i.f.)	400		250
Dakar (wholesale buying)	407		257
Saint Louis (wholesale buying)	445		295
Ziguinchor (wholesale buying)	452		302
Nianga (consumer cost) ^b		346	
Matam (consumer cost) ^b		346	
Lower Casamance (consumer cost) ^b		346	
Sierra Leone^d			
Freetown (c.i.f.)		300	
Freetown (wholesale buying)		309	

^aThe exchange rate is 250 CFA francs per U.S.\$.

^bConsumer cost equals the cost to farmers of the imported rice which they must purchase at a market and transport to their homes if they were to replace rice that they produce and hand-pound themselves.

^cThe exchange rate is 500 Malian francs per U.S.\$.

^dThe exchange rate is 1.0 Leones per U.S.\$.

Intermediate Inputs

The social accounting prices of intermediate inputs are equal to their border prices adjusted for the cost of internal transport and handling. If the input is tradable and likely to be imported, the cost of moving it from the frontier to where it is used has been added to its c.i.f. price. If the input is an exportable, the saving in transport and handling costs resulting from local use of the input has been subtracted from the f.o.b. price. The costs of internal transport and handling are treated like any other intermediate inputs, i.e., they are broken down into their indirect tradable and primary factor components, all valued at appropriate shadow prices. Customs duties and other indirect taxes and subsidies are excluded from the shadow price estimates because they are transfers among economic sectors, not real resource costs.

Some intermediate inputs, such as composite fertilizers, selected seeds, and traditional tools, are not tradable but are manufactured locally. The social costs of these domestically produced intermediate inputs are calculated by disaggregating their production costs into indirect tradable and primary factor components, all of which are valued at appropriate shadow prices.

Unskilled Labor

The first step in estimating the shadow price of unskilled labor is to obtain data on market wage rates. The information from each of the countries included in the study reveals both the high degree of integration of the West African labor market and its complexity. Observed and estimated market wages vary systematically according to region. They are highest along the coast, especially in the Ivory Coast, and lowest in the more arid, interior areas. Within regions, the labor costs estimated on a per day basis are higher for males than females and higher for adults than children. Wage rates also depend on the labor task (e.g., land preparation and transplanting cost more than other rice tasks), the method of payment (e.g., piecemeal, per day, per month), and the inclusion of in-kind benefits such as meals. Other factors influencing wages include the length of the day, the extent of supervision required, and the magnitude and incidence of search costs.

On the other hand, there appears to be little, if any, seasonal variation in wage rates. Despite the impossibility of double cropping in most of the region, opportunities for useful employment, as well as non-market activities and leisure, throughout the year are apparently sufficient to cause wages to remain relatively constant.

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A base wage was established in each region and then adjusted as necessary to account for some of the complexities involved in the determination of market wages. Where possible this estimated market wage was compared with the per unit labor cost found by dividing commercial contract rates by the number of days required to perform

the relevant operation or with the returns per man-day earned by farmers engaged in subsistence food production. For example, the wage paid in irrigated rice in the forest zone of the Ivory Coast was estimated by adding to the nominal daily wage of 330 CFA francs the following items: 75 CFA francs for a meal provided by the employer, 25 CFA francs for travel costs paid by the employer, and 20 CFA francs for the implicit cost of supervision by the farmer. These costs total 450 CFA francs, an amount consistent with rates paid for contract labor. In the savannah zone to the north, nominal wages average about 275 CFA francs, and the only additional adjustment is for meals provided by the employer, yielding a total wage of about 350 CFA francs. A wage of this amount is similar to the return per man-day that can be earned in subsistence food production in that region.

The difference in wage rates between the forest and savannah zones of the Ivory Coast conforms to the difference in the relative favorability of ecological conditions in the two zones and to the pattern of north-to-south migration characteristic of this part of West Africa. Similar relationships exist, in fact, throughout the West African region, as suggested by Table 2, which gives estimated average daily wage rates for adult males engaged in rice cultivation in several countries. The highest wages are paid in the forest zone of the Ivory Coast, which not only has ecological conditions favorable for cash crop agriculture but also has considerably exploited those conditions in recent years. The agricultural sectors in the other countries with coastal forest zones -- Liberia and

Table 2.-- Daily Agricultural Wage Rates for Adult
Males in Selected West African Locations,

1975-76

(U.S.\$/man-day)^a

Location	Daily wage rate
<hr/>	
Ivory Coast	
Forest	1.80
Savannah	1.40
Liberia	1.25
Mali	
Segou, Mopti	.80-1.00
Office du Niger, Sikasso	1.20-1.40
Senegal	
Fleuve	1.00
Casamance	1.20
Sierra Leone	
South	.70-.80
North	.52-.80

^a These wages have been converted from local currency at the rates of 250 CFA francs = 1U.S.\$, 500 Malian francs = 1 U.S.\$, 1 Liberian \$ = 1U.S.\$, and 1 Leone = 1U.S.\$.

Sierra Leone -- have grown less rapidly than in the Ivory Coast, which is reflected in their lower wages. In addition, there has been net emigration from these countries, especially from Sierra Leone.

The major migration which occurs, however, is from north to south. This pattern is indicated by the progressive increase in wage rates from the region around Mopti in Mali, one of the least favored ecological areas, through Sikasso in southern Mali and the savannah zone of the Ivory Coast, to the Ivorian forest zone. The only exceptions are Segou, with its more favorable climate but higher population density than Mopti, and the Office du Niger, which has a large demand for outside labor because it is a large-scale irrigation scheme in a region with a low level of population. Senegal, though not closely linked to the other countries by migration flows, nonetheless also has a structure of wage rates related to ecological conditions and to the cost of traveling to Dakar and other labor markets.

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Wage rates paid to men, women, and children often differ. This distinction is useful, however, only if agricultural tasks are done specifically by one or another of these labor groups. In the Ivory Coast and Sierra Leone, women are generally paid about three quarters of the male wage rate, except for tasks such as transplanting. The wage rate for children in Sierra Leone is about one half that of men.

In the empirical calculations of this study, the only instance in which a distinction between age and sex categories has consistently been made is for bird watching, where the estimated shadow wage equals one half of the male wage rate.¹⁸ In addition, most operations -- except transplanting -- traditionally performed by women in the Ivory Coast have been valued at a rate about three quarters of the value for men.

The next step is to investigate the extent to which market wage rates are distorted by imperfections in the labor market. One distortion is an official minimum wage which maintains wage rates above their market clearing levels. Official agricultural wages have been decreed in all the countries but do not generally appear to inflate wage rates actually paid by farmers. In the Ivory Coast, on the contrary, actual wages paid in the rural sector are greater than the officially established minimum. In other countries the reverse is often true, although the official wage is usually paid by public agencies.¹⁹

The analysis thus far indicates that the market wage rate approximates the shadow price of unskilled labor reasonably well if corrected for the kinds of product market distortions shown in equation (1). Most of the evidence accumulated throughout the region suggests that both family and hired labor used for rice production are withdrawn from the cultivation of traditional food crops, such as cassava, yams, millet, and sorghum. Even labor initially taken from cash crops such as coffee and cocoa is likely to be replaced by workers coming out of the subsistence sector, who often

travel long distances to find wage employment. Since these nontradable foods are neither taxed nor subsidized, no adjustment is necessary for distortions in their markets. On the other hand, a decline in their consumption resulting from labor being withdrawn from their production could lead to an increase in the consumption of rice -- a food which is taxed in most countries. As noted earlier, however, the income and price effects move in opposite directions and thus tend to offset one another. Finally, the effect on the consumption of other goods and services of a decline in subsistence food production is not likely to be very important. The farmer simply replaces this food with part of the rice he produces in the new activity under consideration. Consequently, little or no adjustment seems necessary for distortions in the consumer markets.

There are, however, two situations in which the market wage may fail to approximate the shadow wage reliably. In both instances, the shadow rate may be overvalued. The first situation arises when family instead of hired labor is used, and the second occurs when hired labor has immigrated from abroad.

Since the market wage equals the supply price of the marginal man-day withdrawn from other employment, it indicates not only the value to the worker of his marginal product in that employment but also the transfer price necessary to induce him to move to a new job. When the change in output is brought about by shifting labor within the family farm, the cost of reallocating labor is less and requires a smaller return than the market wage to induce the shift. The problem

may not be very great if agriculture is highly commercialized and the rural labor market well developed. It is more severe in traditional, small-holder agriculture which is incompletely linked to the cash economy. This makes comparisons between modern and traditional techniques difficult unless the results are relatively insensitive to changes in wage costs.

The second cause of possible overvaluation is illustrated by the Ivory Coast, where an important part of the labor force comes from other countries, particularly those to the north. Most of the wages paid to these workers, whether spent on consumption or sent home as remittances, is a claim on Ivorian goods and services and thus a real social cost. But part of the expenditures of foreign workers and their families are taxes on these products which result in a transfer from the foreign workers to the local economy. The shadow wage for these workers is therefore less than the market wage. The empirical importance of this discrepancy, however, is not great. It is estimated that taxes comprise about 10 percent of the expenditures of foreign workers. Since these laborers amount to less than 25 percent of the total rural work force, the adjustment would be no more than 2.5 percent -- well within the margin of error generally accepted in the calculations.²⁰

The market wages shown in Table 2 have thus been used as estimates of the shadow price of labor in each of the country studies. Comparative advantage in rice production depends, however, not only on current shadow prices but also on expectations concerning the future. Cash crop agriculture in West Africa has always drawn upon

the traditional foodcrop sector for its labor supply. Although population in rural areas is still growing, the demand for labor may eventually begin to outstrip its supply and put upward pressure on real wage rates. This eventuality is particularly acute in the Ivory Coast, where past economic expansion has been based to a considerable extent on immigration of foreign labor. Although there is no strong evidence that rural money wages in the Ivory Coast have risen faster than the cost of living, working conditions seem to have improved and nonpecuniary benefits have been increased. Search and travel costs may also have been shifted from workers to employers. Any upward pressure on wage rates in the Ivory Coast should have implications for relative wages over much of West Africa because of the extent to which labor markets in different countries are linked. Hence, it is particularly important to analyze the sensitivity of the empirical calculations to future increases in the labor costs.

Skilled Labor

The cost of skilled labor is more likely to be influenced by government policy than that of unskilled labor because direct government intervention affects a larger proportion of the skilled labor force. Most West African countries have established wage rate schedules according to skill categories which set minimum salaries for hiring by both the formal private sector and the government. The diversity of skill categories and lack of empirical evidence make it virtually impossible, however, to establish a single ratio which could take account of distortions induced by the government

and adjust market wages of skilled labor to shadow price equivalents. If any distortion does exist, it seems more likely that the market wage exceeds the shadow wage, especially in lower skill categories, causing an overestimation of social costs.

Correction for distortions in product markets is made difficult by not knowing from which sectors skilled labor is withdrawn. Some would be withdrawn from public service, the output of which is not subject to taxation. A large part of the rest would probably come from the tertiary sector, including formal and informal commerce, transportation, and construction. These activities are not tradable, but their imported inputs and their outputs are sometimes taxed. Finally, some skilled labor may be withdrawn from the import substitution sector for which the border prices of output generally are less than corresponding domestic prices. On balance the deviation due to product price distortions of the shadow price of skilled labor from the market wage depends on the relative magnitude of offsetting terms in equation (1). In any case, the effect on the empirical results is minimal because skilled labor is a very minor component of total costs.

Capital

Capital inputs consist of investments with economic lives exceeding a single accounting period and working capital to finance current operations. Determining the social cost of both involves selecting a social rate of discount at which to value the services of capital goods or the opportunity cost of the working capital. In addition, the market prices of the capital goods must be corrected for distortions in product markets.

In principle, the shadow rate of interest equals the rate of return on marginal public sector investments. In a perfectly functioning capital market, this marginal rate of transformation of present into future income equals the marginal rate of substitution of present for future consumption in both the public and private sectors. In such situations, the market rate of interest is an adequate guide to the social opportunity cost of capital services.

In contrast to the well-functioning rural labor market, the market for capital in agriculture appears to be highly segmented. Such segmentation, moreover, represents a fundamental imperfection in the capital market which is likely to persist. It is not sufficient, therefore, to calculate a single shadow rate of interest that would be expected to prevail in a perfect and undistorted capital market. A more complex approach is required, based on the reasons for this segmentation.

The market for agricultural credit is segmented for three main reasons. First, major agricultural investments are generally undertaken by the public sector, usually with a large share of foreign funds obtained on concessional terms. These funds are almost always tied to specific projects, which, because the aid is concessional, may not be required to have the highest marginal rates of return. In addition, it is unlikely that the supply of foreign funds, especially concessional aid, is infinitely elastic. Furthermore, foreign aid is limited by the capacity of these countries to absorb public investment projects. Because concessional aid is limited and

rationed to certain projects, there is a divergence in the cost of capital between projects financed with foreign aid and those funded out of government revenues or foreign borrowing at commercial rates. Since the sources and terms of foreign aid vary greatly, effective rates of interest vary as well.

Second, there is a divergence in interest rates between formal and informal sector activities. Interest rates for private borrowers in public development projects, for example, are lower than for those obtaining funds from the informal credit market. This divergence results primarily from reductions in the transactions costs of the capital market. Such reductions occur because the administrative structure of the projects makes it easier to monitor loans, to enforce repayment, and otherwise to reduce the risks and costs of lending. In addition, project credit is usually restricted to certain types of purchases, such as animal traction equipment and modern intermediate inputs. There may also be some wealthier farmers who have access to commercial credit through the modern banking sector on terms that are similar to those offered by the public projects for much the same reasons.

Finally, there may be a divergence in interest rates in the informal credit market because the buying price of capital exceeds its selling price. This divergence should be especially marked between implicit interest rates on self-financed investments and the higher rates paid on short-term loans borrowed from local money lenders. The divergence probably arises less because of monopolistic lending than because of high transactions costs, including defaults, in the traditional market where loans are small and numerous, information

is costly, and sanctions are difficult. The situation is analogous to the difference in wage rates for family and hired labor.²¹

Segmentation of capital markets creates an array of nominal market rates of interest shown in Table 3. At the top end of the scale, credit is available to some governments from the Eurodollar market on commercial terms. Somewhat below this is credit received from the international development banks. Most public investment, however, has been financed with concessionary foreign aid. In the Ivory Coast rice sector, the average rate of interest paid on past loans has been 3.7 percent, which is substantially below the average rate now generally available to that country. Senegal, on the other hand, as one of the poor Sahelian countries, has paid a relatively low average interest rate of about 3.2 percent and can probably expect to continue to do so. The data thus indicate a plausible range for nominal interest rates on projects financed from these sources of 3 to 13 percent.

The second market rate of interest applies to farmers borrowing from the banking system or participating in public development projects and equals the rate charged on loans by commercial or public development banks. Actual rates paid by farmers may differ from this, however, because most public projects have subsidized purchase prices of capital goods, low rates of interest, and special repayment periods.

Other capital costs are for investments made in traditional agriculture or for the kinds of inputs not furnished by projects. Even though participating fully in a development project, farmers usually must finance all the working capital required for family and

Table 3.--Nominal Rates of interest for Public and
Private Borrowers of Various Sources of Capital
(Percent)

Source	Interest rate	
	Public	Private
Ivory Coast		
Development Bank		
financing for crop purchases	7.0	--
other uses	10.0	13.0
Commercial banks	--	13.0
Concessional foreign aid	3.7 ^a	--
Private foreign ^b	13.0	13.0
Traditional		
borrowing	--	30.0
lending	--	20.0
Liberia		
Development bank	--	12.0
Commercial banks	--	12.0
Private foreign ^b	13.0	13.0
Mali		
Development bank	7.5	13.0
Commercial banks	--	13.0
Private foreign ^b	--	13.0
Traditional	--	25.0
Senegal		
Development bank	7.5	13.0
Public marketing agency	--	13.0
Commercial banks	--	13.0
Concessional foreign aid	3.2	--
Private foreign ^b	13.0	13.0
Traditional	--	25.0
Sierra Leone		
Trading company (medium term)	--	43.3
Commercial banks	--	12.0
Private foreign ^b	--	13.0

^a This rate is based on a weighted average of concessional lending to the Ivory Coast for rice projects during 1963-76.

^b The interest rate on foreign lending is for funds denominated in U.S. dollars.

hired labor. The only sources are family savings, borrowings from friends and relatives, and loans from the traditional credit market. Interest rates observed in the traditional credit market are very high, sometimes in excess of 100 percent per annum.²² Part of this high rate is a premium to compensate for default and delayed payment on some of the loans. Part of it may also be due to monopoly elements, but the scanty evidence which exists indicates that these are not very important in West Africa.²³ Perhaps the most important element in these high interest rates, however, is the high unit costs associated with gathering information and transacting loans, each of which is small in magnitude. These transaction costs have the effect of raising the real cost of capital in the traditional sector well above its cost in formal capital markets. The empirical evidence on traditional interest rates in West Africa is very slim, but estimates of effective market rates have been made by adjusting observed rates for default and delayed payment.²⁴

The fundamental nature of this segmentation implies that social discount rates will also vary among markets. The shadow rates of interest used in the empirical calculations are given in Table 4. These rates have been adjusted for expectations concerning inflation. The adjustment does not equal the current rate of inflation, which is quite high, but reflects the longer term historical rate up until 1972 plus an additional adjustment of 2.5 percentage points to account for the general upward shift in interest rates all over the world after that date.

Table 4.--Real Shadow Rates of Interest
for Different Types of Capital
(percent)

Country	Shadow interest rates			
	General	Publicly financed	Traditional	Commercial
Ivory Coast	--	5	15-25 ^a	8
Liberia	15	--	--	--
Mali	--	2.5	20	8
Senegal	--	2.5	20	8
Sierra Leone	--	3.5	20-40 ^b	8

^a The first rate is the selling price of capital and the second is the buying price.

^b The first rate applies to 3-5 year investments in rice mills financed by traders in larger towns; the second pertains to investment in farm tools and working capital.

In estimating the shadow price of public capital, the relative importance of future sources of credit is crucial. For the Ivory Coast it seems likely that relatively little foreign aid will be available on terms as concessionary as in the past. On the other hand, the country will probably not have to depend solely on commercial loans for its credit. A moderate discount on the Eurodollar rate might yield 10 percent as a central nominal value. This is consistent with the interest rate on credit now available from the agricultural development bank. The Sahelian countries, on the other hand, can probably anticipate concessional financing for many years. As more investment goes into larger infrastructure projects, however, terms will probably harden somewhat. A shadow price of public capital for Mali and Senegal of 7.5 percent as a central nominal value therefore seems reasonable. ²⁵ Estimates for the other countries should probably fall within the 7.5-10 percent range.

The shadow rate of interest for formal sector credit to private farmers depends on its source. Most farmers who participate in public projects buy their inputs on credit, and the government supplies the capital used to finance the purchase of these inputs. Since most of these credit programs are financed from the same sources as are the public investments which accompany them, the shadow price of capital should be the same. If loans are obtained from commercial banks, on the other hand, commercial shadow rates of interest should apply.

Shadow rates of interest for traditional credit are based on market rates adjusted for expectations concerning inflation. In most countries these market rates have rather conservatively been

estimated at 25 percent, with a spread of 10 percentage points between implicit borrowing and lending rates when this appears to be relevant. In the Ivory Coast, where a substantial amount of capital in the traditional sector is invested in coffee and cocoa production, interest rates could be adjusted upward because of the export tax on these crops. Given the great uncertainty of the original estimates and the relatively small magnitude of the adjustment (2-3 percentage points), however, such fine-tuning appears inappropriate. Since most marginal additions of capital outside the traditional sector come ultimately from foreign sources, no other adjustments have been made for distortions in the product markets.

There is some arbitrariness in these estimates, but they at least approximate the reality of a highly segmented capital market. In Liberia, however, the capital market is very poorly developed, and in the absence of better data, a real rate of interest of 15 percent was chosen as the shadow price of capital. Although this is substantially greater than the average cost of capital in most of the other countries, it is not inconsistent with Liberia's heavy dependence upon the traditional credit market.

Land

The shadow price of land used for rice production is defined as its return, expressed in equivalent world prices, from its best alternative use outside of rice cultivation. This definition allows different techniques of producing rice to be compared without the cost of one technique being dependent on the cost of others. In contrast to the other primary factors, the shadow price of land is not estimated using its market price as a reference because the market for land is very poorly developed in most areas. Instead, the return to land is

calculated as a residual rent after deducting the costs of intermediate inputs and all other primary factors.

The value of this rent depends on three things. The first is whether land of the type required for a given technique of rice cultivation is scarce.²⁷ In general, much of West Africa is sparsely populated and land appears to be in abundant supply. Of the countries studied, only Sierra Leone has a population density above 25 persons per square kilometer. The traditional, extensive techniques of crop production employed in the region, however, require large areas of fallow to reconstitute soil fertility. Although the shortage of cultivable land is not yet pressing in most of the areas studied, population is growing rapidly in some of the countries such as the Ivory Coast. Thus even if a shadow price of land is estimated at zero under existing conditions, relative profitability may change in the future with increasing land pressure.

Even if land is not used for crop cultivation, it may still have economic value. Forests can be cut for timber and wooded land of any sort may be useful for firewood and charcoal. In addition, palms growing in swampland produce palm wine and building materials, and savannah land produces forage for livestock. Calculations for the Ivory Coast, however, indicate that virtually all the revenue earned by collecting, processing, and distributing these commodities, with the exception of commercial forestry, accrues to labor and intermediate inputs, leaving nothing left over for land rent.²⁸

Land scarcity could also arise in the Office du Niger in Mali. There it is not the land per se which is scarce but rather the land located near the major irrigation canals built 40 years ago which are treated as sunk investments. Much of this land is not currently in use, primarily because the additional irrigation infrastructure necessary for its cultivation has not yet been constructed. The land which can be irrigated, however, probably does have a substantial scarcity value and not necessarily just in rice production. It may well be that the land could be used most profitably for the cultivation of long-staple cotton.²⁹ Sugarcane might also be a possibility. Unfortunately, data are not available with which to calculate the residual return to land in these alternative uses.

In addition to physical scarcity, land may also acquire an economic rent because of site value. Even though land might generally be available throughout a region, it may be relatively scarce in the vicinity of large towns and major transportation routes. In this study, site value within a given producing region is ignored, though the location of each region in relation to consumption centers and the major ports is an important determinant of the cost of transporting rice and the inputs used in its production.

Finally, the shadow price of land may be affected by the way in which it is treated as a natural resource. If it is considered to be a renewable resource, extensive methods of production that lead to permanent degradation, acidification, and erosion of the soil have a greater social cost than those which do not. The bias that results from not taking these externalities into account may not be great, however, if land is currently abundant since the discounted social cost of this resource depletion depends on the social rate of discount and on the length of time before scarcity occurs.

Water

Water is clearly an important factor of agricultural production, but its shadow price depends on both the ability to allocate or control it and its scarcity. Without some form of control, water has no shadow price regardless of its scarcity because it cannot be varied in response to its marginal social value. The land which receives the water may have an accounting price, but the water does not.

Therefore, most of water's economic value in West African rice production is created through capital investments in control systems for allocating available water supplies. Pumping, for example, brings otherwise valueless river water to the fields where it has value. If this water is being optimally allocated, that value equals the cost of constructing and operating the pumps and therefore is a return to these inputs rather than to the water itself. Hence, even when water control is provided by new irrigation investments, water still has no shadow price. Only in the case of existing investments, the capital costs of which may be considered sunk, might a shadow price be assigned to water alone if the amount which can be delivered to the fields is limited in relation to cultivation needs.

Water should also be shadow priced if the growth of irrigation demands on a river or other natural water system reaches the point at which water taken from that system becomes scarce. At present, this situation does not appear to exist, except possibly during the dry season in the Senegal River Valley in some years when water being taken from the river upstream causes greater salt incursion downstream.

The data are not yet available to estimate this cost, but sensitivity analysis can be used to show the economic effects of increased water scarcity.

Foreign Exchange

The approach used in this study to shadow price commodities and factors of production differs in one important respect from that encountered in most empirical studies of investments in less developed countries, including those of the Asian Rice Project. 32 These other studies most often begin by classifying goods and services into two categories: those whose shadow prices in terms of foreign currency are equal to their domestic currency border prices at the official exchange rate and those whose shadow prices are appreciably different from this. The former category consists of tradable goods and services and is made commensurate with the latter group of non-tradables, which includes primary factors, by converting foreign currency prices to domestic currency equivalents using the shadow rate of exchange. The shadow exchange rate thus emerges as a crucial relative price between tradables and nontradables.

A shadow exchange rate is not required, however, to calculate social profitability with the present methodology. When used to estimate the shadow price of an output, intermediate input, or primary factor, equation (1) takes into account the effects of distortions in product prices caused by government taxes and subsidies including those on trade. The resulting shadow price, expressed in terms of foreign currency, equals the opportunity cost of the resource on the world market adjusted for changes in consumption and production of other goods and services whose prices are distorted by taxes and

subsidies. Rather than a single shadow rate of exchange, there is a multiplicity of shadow exchange rates, each defined as the ratio of the shadow price of the good or service to its domestic market price.³³

The foreign exchange shadow prices estimated from Equation (1) differ from other formulations in several respects.³⁴ First, the effects of consumption taxes and subsidies, as well as of distortions affecting international trade, are included. Thus there are separate terms for consumption and production of tradables, as well as a term which shows the effects of distortions in the markets for nontradables. Second, intermediate inputs are explicitly introduced into the analysis, thus relating the result to the concept of effective rather than nominal rate of protection. Third, the formula is expressed in terms of consumption and production rather than of imports and exports.

Adjusting the market prices of resources in this way requires that the main impact of resource reallocation should be felt primarily in a few closely related markets. This is assured by the assumption that the reallocation is sufficiently small that factor prices remain unchanged. Since prices of tradables are also constant, the only prices which change are those of nontradables other than primary factors. Nontradable intermediate inputs pose no problem since they are assumed to be produced at constant costs and can be broken down into tradables and primary factors. Prices of nontradable consumer goods, on the other hand, can change in response to alterations in

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demand conditions. It is reasonable to assume, however, that under West African conditions, the impact of most of these demand changes is limited to a few related markets.

There is one way, however, in which changing demand conditions could be transmitted to a broad segment of the economy. This would occur if there were changes in foreign exchange holdings induced by the resource reallocation which resulted in widespread changes in consumption. If this were true to an important extent, these changes would have to be estimated and incorporated into equation (1). This would require determining how any net foreign exchange earned or saved might be allocated and what the response of consumers to this allocation would be.

An alternative approach would be to value primary factors in terms of foreign currency at the shadow exchange rate which incorporates these changes in consumption in order to make them commensurable with the border prices of traded goods and services. The elasticity approach to estimating the shadow price of foreign exchange in this way is used fairly extensively.³⁶ It suffers, however, from a number of important defects. First, it ignores the effects of consumption taxes on both tradables and nontradables. Second, it assumes that there is initial balance of trade equilibrium (though this assumption is not necessary if the formula is complicated somewhat). Third, and more important, the relevant elasticities should be general, not partial, equilibrium in that they should show the impact of changes in income and prices of nontradables in addition to that resulting from changes in the availability of foreign exchange. In practice, however, only estimates for partial equilibrium are available.

Fourth, an even more severe problem exists if effects on consumption and production of a change in foreign exchange availability occur for reasons other than movements in prices. Foreign exchange accruing to the government, for example, may be allocated independently of market considerations. The use of price elasticities would not be appropriate in this case.

Empirical estimates of the shadow price of foreign exchange using the elasticities approach indicate that overvaluation of official exchange rates in these countries is probably not more than 25 percent. To the extent that foreign exchange accrues to the government and is spent on public inputs, the degree of overvaluation is even less because of the absence of taxes on most of these inputs. Therefore, the method outlined in this paper and used in the empirical calculations should yield more reliable results than the elasticity approach.

SUMMARY

The estimation of shadow prices used in this study is based on the concept of maximizing economic efficiency. Shadow prices of tradable inputs and outputs equal their prices on the world market. For domestic factors of production, shadow prices are measured as the value in world prices of national output foregone by shifting these factors out of their alternative uses.

Where factor markets function well, the accounting prices for domestic resources have been estimated by adjusting market prices for government-induced distortions in related product markets. These

distortions include those affecting the final consumption of tradables and nontradables that are close substitutes for or complements to rice and those affecting the producer prices for tradable outputs and intermediate inputs affected by resource shifts into rice.

The shadow price of rice output has been estimated at \$300-\$400 (in 1975 US\$) per metric ton depending on quality and point of delivery. Although fluctuations in world prices are substantial, this range is consistent with long-run projections and should serve as the basis for decisions regarding rice development efforts.

The shadow price of labor, in most instances, is well approximated by market wage rates varying from US \$.60 to US \$1.80. There appear to be few imperfections in the labor market, and most labor is withdrawn from subsistence production which is neither taxed nor subsidized. Secondary consumption influences appear minimal because of offsetting price and income effects. In the traditional sector, however, the use of the market wage probably overestimates somewhat the shadow price of labor because it includes transfer costs not actually incurred.

The shadow price of capital varies because of highly segmented capital markets caused by foreign concessional aid, the rationing of public and modern sector credit, and high transaction costs in the traditional credit market. In general, real rates of interest vary from 2.5-5 percent for public funds to 15-40 percent in the traditional sector. No adjustments are made for distortions in product markets because marginal additions to public capital are obtained primarily

from abroad, and the corrections which should be made to traditional interest rates are small relative to the magnitude of error in these estimates.

Neither land nor irrigation water is scarce in most circumstances, so that shadow prices for these inputs are assumed to equal zero. Sensitivity analysis is important here, however, because scarcity will increase in the future.

The methodology employed in this study does not require estimation of a separate shadow price of foreign exchange. Such a rate could be estimated using the methodology, however, but is unlikely in any country to be more than 25 percent in excess of the official exchange rate. In most instances it would be much less.

FOOTNOTES

¹See Bruno (8) for the derivation of shadow prices in an open economy using a linear programming framework of analysis.

²The theory of optional policy to achieve noneconomic objectives is developed in Bhagwati and Srinivasan (3).

³This approach is discussed in detail in Little and Mirrlees (15), Squire and van der Tak (21), and Dasgupta, Marglin, and Sen (10).

⁴This approach to shadow price estimation is due primarily to Little and Mirrlees (15). Other more recent contributions have been made by Findlay and Wellisz (12), Srinivasan and Bhagwati (22), and Bhagwati and Wan (5).

⁵This is similar to the case of less than fully traded goods discussed in Appendix A. There it was assumed that if imports of tradable inputs are restricted by quota, this restriction would be relaxed to allow the additional demand for the protected input arising from the expansion of the rice sector to be satisfied from increased imports.

⁶As suggested, for example, by Little and Mirrlees (15, p. 161) and by Scott (20, p. 176).

⁷Some recent examples of general equilibrium analysis are Broadway (7), Dasgupta and Stiglitz (9), and Warr (24).

⁸This equation is an extension of one developed by Bertrand (2). The convention introduced by Little and Mirrlees of taking foreign currency as the unit of account and valuing nontraded goods in terms of foreign exchange is also adopted here. This is consistent with the method and assumptions of the resource cost ratio outlined in Appendix A. No adjustment is made for changes in the prices of goods

subject to quantitative restrictions in lieu of taxes or subsidies since controls of this type are relatively uncommon in the countries concerned. In addition, the potential effects of monopoly power in trade are ignored because of the small size of these countries. Finally, to simplify the analysis somewhat, all nontradable goods are to be used only for final consumption. The extension of this equation to include their use as inputs in production is straightforward.

⁹Two examples already mentioned are quantitative restrictions on trade and nonfully traded inputs discussed in Appendix A.

¹⁰In this case, millet is assumed to be an inferior good. If the opposite were true, the right hand side of equation (3) would be positive and the market wage rate should be adjusted upward if millet consumption is taxed and downward if subsidized.

¹¹This result obtains even if the supply of labor is infinitely elastic, making the market wage invariant with respect to taxes or subsidies. The amount of the tax equals the difference between the value of the marginal product of labor and the market wage, and it is the value of the marginal product which is treated here as labor's shadow price.

¹²The transport margin is a rough estimate based on shipping conference rates in effect between West Africa and various parts of the world in 1974. It does not allow for discounting below these negotiated rates.

¹³During the period 1955-74, the Thai export price for 25 to 35 percent brokens averaged 32 percent less than the price for 5 percent brokens. This discount has been somewhat smaller since 1974, ranging from 16 to 26 percent (13).

¹⁴Additional adjustments were required for Mali to account for the cost of transport between the port and Bamako. These are explained below.

¹⁵The equivalent c.i.f. price of domestically produced rice equals the observed c.i.f. price only when the two types of rice are of comparable quality. If domestic rice is of higher quality, its equivalent world price will exceed that of imports, and vice versa. This usually implies that locally produced rice is a nontradable, i.e., its domestic price lies between the f.o.b. and c.i.f. prices of rice of comparable quality traded on the world market. In the absence of government restrictions, the failure to import rice of comparable quality implies that this rice can be obtained at a lower price locally than on the world market. Therefore, the quality-adjusted world market price tends to overestimate the true social value of the domestically produced rice. The approach used in Senegal -- to break down locally produced rice into its two tradable components -- is valid only as long as there is an import market for each quality.

¹⁶Numerous interviews with farmers confirmed the wide range of ways in which they can occupy themselves during the dry season. Some of these include migration to the forest zone to harvest coffee and cocoa or to clear land, repair of huts and tools, fishing either at home or elsewhere, and participation in social activities reserved for the off-season.

¹⁷The reason why women and children are paid less than men is presumably because they are less efficient, but the difference in efficiency varies enormously among tasks. Men, for example, clearly have an advantage in heavy clearing operations, but women are often better at weeding and some harvesting tasks. At the margin, however, the market wage is probably the best indicator of the value of foregone output resulting from the employment of each type of worker.

¹⁸Because of the large uncertainty in the number of days required, in the number of hectares a single person can watch, and in the relative frequency of child and adult participation, this adjustment has little significance.

¹⁹A second possible imperfection in the labor market exists if wages paid to members of one ethnic group are lower than those paid to others equally qualified. This possibility was examined by Rader (19) in the Gagnoa region of the Ivory Coast, where different activities are pursued by local and immigrant ethnic groups. A series of interviews revealed that among workers paid by the day, there was no evidence of wage discrimination between ethnic groups.

²⁰A note has been prepared which documents these calculations and is available from the authors.

²¹Among the numerous discussions of this problem for various parts of the world, see (6), (11), and (16).

²²Borrowing on the traditional money market is expensive but does not carry any implicit costs associated with increased social obligations, as might be the case if money is borrowed from friends.

²³For a review of the empirical evidence, see (23).

²⁴In Sierra Leone, for example, the cost of credit used to finance the purchase of fishing equipment has been estimated at 43 percent after some incomplete adjustment for default (14). Without any adjustment, nominal interest rates for seasonal credit in the Gagnoa region of the Ivory Coast are 60 to 80 percent.

²⁵The approach taken here is national rather than global in perspective since the cost of capital to the borrower is used rather than the social value to the world of the output or consumption foregone from wherever that capital is removed.

²⁶Such a problem could arise, for example, if there were two techniques and the shadow price of land used for one was calculated by estimating its return in the other, and vice versa.

²⁷Frequently, land suitable for one technique or crop is not desirable for others. Techniques involving pumping, for example, can usually be undertaken over a wider area than those using natural flooding.

²⁸Similar calculations have not been performed for the other countries. Certainly in the Sahelian countries the shortage of firewood is becoming a problem. The available information, however, does not permit dealing with this problem except through sensitivity analysis.

²⁹The best indication of this is the importance of cotton cultivation in the Sudan, where ecological conditions in the Gezira Scheme are similar to those of the Office du Niger.

³⁰Water everywhere, of course, has a very high value measured in terms of total consumer surplus. Rainwater used for upland cultivation, for example, may be very scarce in the sense that

farmers would be willing to pay a good deal for it. But it cannot be allocated, except insofar as land is distributed. Its economic value in this case is coincident with that of land.

³¹This could be the case in the Office du Niger, where substantial capital investments can be considered as sunk but water is not scarce in relation to current levels of cultivation. If cultivation were to be substantially expanded, however, water could become scarce and should then be priced or rationed accordingly.

³²See, for example, Pearson, Nelson, and Akrasanee (18).

³³The correspondence of this approach to the well known Little-Mirrlees criterion is apparent (15). The approach in this study differs, however, in that the shadow exchange rates thus derived avoid considerations involving distortions or imperfections in the factor markets. On this point see Scott (20).

³⁴See, for example, Bacha and Taylor (1).

³⁵Price changes can occur here even though technical coefficients and tradables and primary factor prices remain constant because of the possibility of shifting techniques for producing the same good. This is most likely to occur under changing demand conditions when there are constraints on altering the level of output using the same techniques.

³⁶The equation for estimating the shadow exchange rate using the elasticity approach is derived as a special case of equation (1) in the Annex to this Appendix.

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ANNEX

The elasticity approach to estimating the shadow price of foreign exchange is outlined below. If, as a special case, $t_i^c = t_i^d$ and $t_k = 0$, the shadow price of a unit increment of foreign exchange can, from equation (1), be expressed as

$$\begin{aligned}
 r^* &= r \left[1 + \sum_{i=1}^m p_i^w t_i (dx_i + d\hat{x}_i - d\bar{x}_i) \right] & (A-1) \\
 &= r \frac{\sum_{i=1}^m p_i^w (1 + t_i) (dx_i + d\hat{x}_i - d\bar{x}_i)}{\sum_{i=1}^m p_i^w (dx_i + d\hat{x}_i - d\bar{x}_i)} \\
 &= r \frac{\sum_{i=1}^m p_i^w (1 + t_i) dM_i - \sum_{i=1}^m p_i^w (1 - t_i^*) dX_i}{\sum_{i=1}^m p_i^w dM_i - \sum_{i=1}^m p_i^w dX_i}
 \end{aligned}$$

where M is imports for intermediate and final use, X is exports, and t_i^* is the tax rate on exports written with a negative sign since it results in a domestic price which is lower than the border price. The shadow price of foreign exchange thus equals its market price times a weighted average of market distortions, where the weights are the changes in imports and exports induced by the changing availability of foreign currency. Multiplying both numerator and denominator by $r/\sum p_i^w M_i dr = r/\sum p_i^w X_i dr$, from the balance of payments constraint, equation (A-1) can be expressed in elasticity form as

$$r^* = r \frac{\sum_{i=1}^m (1 + t_i) u_i \eta_i - \sum_{i=1}^m (1 - t_i^*) v_i \epsilon_i}{\sum_{i=1}^m u_i \eta_i - \sum_{i=1}^m v_i \epsilon_i} \quad (A-2)$$

where $u_i(v_i)$ is the share of the i^{th} import (export) in total imports (exports) and $\eta_i(\epsilon_i)$ is the elasticity of imports (exports) of good i with respect to the exchange rate.

This is the Harbinger-Schydrowsky-Fontaine (HSF) shadow price discussed in Bacha and Taylor (). It assumes that world prices are fixed so that a country cannot use tax policy to alter its terms of trade. To the extent that world prices are not fixed, the elasticities of demand for imports and supply of exports need to be replaced with the elasticities of demand for and supply of foreign exchange. If the country is able to influence the prices of one of its exports, for example, the elasticity of supply of exports ϵ_x would be replaced with the elasticity of supply of foreign exchange ϵ_f given by

$$\epsilon_f = \frac{\epsilon_x (\eta_x - 1)}{\epsilon_x + \eta_x} \quad (A-3)$$

where η_x is the price elasticity of foreign demand for the country's exports.