DRPS

Development Research Papers Series

Optimal Pricing Model for Primary Commodities in Developing Countries:

An Application to the Cocoa Subsector in Côte d'Ivoire and Ghana

Mamou Kouyaté-Ehui

Research Paper No. 1

United Nations
Economic Commission for Africa
Socio-Eonomic Research
and Plannind Division

DEVELOPMENT RESEARCH PAPERS SERIES (DRPS) is devoted to Africa's development problems and their solutions. The aim is to encourage and promote discussions of development research findings and methodologies relating to the African region and to make available to a wider audience the results of research, especially in the areas of basic development policies and trends, economic projections and forecasting, socio-economic transformation and the dynamics of change, and economic integration.

Additional copies of the published papers can be obtained by writing to:

The Director
Socio-economic Research and Planning Division
United Nations Economic Commission for Africa
P.O. Box 3001
Addis-Ababa, Ethiopia
Tel. (251-1) 51 72 00
Telex 21029 UNECA ET
FAX (251-1) 51 44 16

ECA/SERP/1992/003

OPTIMAL PRICING MODEL FOR PRIMARY COMMODITIES IN DEVELOPING COUNTRIES: AN APPLICATION TO THE COCOA SUBSECTOR IN COTE D'IVOIRE AND GHANA*

By

Mamou Kouyate-Ehui

Research Paper No. 1

---

* This paper was written while the author was a postdoctoral fellow at the United Nations Economic Commission for Africa 1990-91. The author wishes to thank Prof. O. Terriba and Dr. M. El-Egaily, for their assistance and comments on the early draft of the paper. 1991

I. INTRODUCTION

Virtually all African economies depend on a single or few primary export commodities. Agricultural and/or mineral commodities account for a significant proportion of their Gross Domestic Product (GDP), and are a major source of government revenues as well as export earnings (Franco, 1981; Thompson, 1983). Yet, despite the crucial role of the commodities, government policies in many countries have slowed down their expansion and have in many instances contributed to their decline (Franco, 1981; Lutz and Scandizzo, 1980). Policies have taken various forms, including the setting of producer prices below the international market price levels, direct or indirect taxation of commodity exports, and overvaluation of national currency. Various arguments have been put forth to justify these policies. They relate essentially to the need to generate revenues, in order to industrialize and to finance public expenditures, especially non-revenue yielding public services and other components of economic and social infrastructure (Peterson, 1979).

The problem is that prices received by farmers in most developing countries are not optimal in the sense that they do not optimize government revenues. Tax rates are often imposed on a cost plus- basis which does not take into account the foreign demand and export supply relationships in the world market. The use of export tax is, at times, based upon the assumption that the tax imposing country has some degree of monopoly power in the world market, i.e. the demand for its export is less than perfectly elastic and therefore restriction of its export will increase its revenues. Where this is true, imposing tax on export of primary commodities can be a viable means of raising government revenues.

Today, in the face of the continued decline in prices of internationally traded commodities, many developing nations face a challenge: How to set producer prices so as to maximize government revenues. They must impose tax on agricultural exports in order to generate revenue. However, inappropriate imposition of the tax can have deteriorious effects on economic welfare.

The purpose of this study is to develop a model for the optimal pricing of primary commodities in developing countries, taking into account the excess supply and demand relationships as well as the social rate of time discount and commodity storage costs.

The model is applied to the cocoa subsector in Cote d'Ivoire and Ghana, two countries in Africa that depend heavily on the export of cocoa, and the cocoa export trade is regulated through marketing boards. Since 1970, Cote d'Ivoire has been the world's largest cocoa producer with a 27 percent share of the world total output. The marketing of cocoa is regulated by a parastatal organization, " the Caisse de Stabilisation et de Soutien des Prix de Produits Agricoles" (CSSPA). The organization guarantees a fixed price to farmers throughout the crop year. In Ghana, prior to 1985, the producer price was also fixed in consultation with the Cocoa Marketing Board on the basis of the estimated government revenue and the world price. After 1985, a new policy was implemented using production costs as the most important factor in the producer price determination. Until recently, international prices were sufficiently high to pursue that policy. Today, in face of the slump in world prices the main policy question facing these countries is how to devise a cocoa pricing strategy which can be sustainable over the long run.

The paper is divided into five sections. Section two discusses the theoretical framework using the concept of producer and consumer surplus. First, we derive the optimal producer price and tax rate for a country assuming static conditions. Next, we relax that assumption and the optimal producer price and tax rate are derived using an intertemporal framework. To the end, an optimal control model is developed; thus, permitting us to account for the commodity stock-flow relationship as well as the time factor. Based on these models, quantitative results which highlight the role of certain key parameters in determining the optimal tax rate (or prices) are derived in section III. This is followed by the discussion of the procedure and data used in the analysis. Results are reported in the fourth section. In the final section of the paper, i.e. section V, some concluding comments are presented.

II. THEORETICAL FRAMEWORK

Despite the widespread concern about inappropriate price policies for primary commodities , research on optimal pricing of these commodities is scarce. Nascimiento and Rafinot (1985) and, most recently, Berte and Eplin (1989) derived the price levels which maximize revenues generated by the marketing boards of groundnuts and cotton in Senegal and Cote d'Ivoire, respectively. Although their method gives insights into the nature of commodity pricing, the approach they used is inappropriate for three reasons: First, it implicitly assumes a perfectly elastic demand schedule, which is most unlikely to hold for commodities in which countries have a large market share. Second, when the demand schedule is perfectly elastic, the optimal tax rate is zero since the imposition of a tax cannot drive up the international price, in order to compensate for the net social loss due to the tax. Third, their analysis was cast in a static framework, assuming implicitly that governments have a very high social discount rate.

Using an intertemporal framework, Imran and Duncan (1988) developed a formula for determining optimal export taxes for some selected commodities. While their optimal tax formula emphasizes the role of short and long run demand elasticities, it has several shortcomings. First, it assumes that the import demand relationship is exponentially weighted and the relationship between short and long-run elasticities is strongly dependent on the specification of the model functional form. This is not likely to be true in general. Where such demand functions do not hold, the results will be biased, thus making the tax formula rather inflexible. Second, the commodity stock-flow relationship is absent from their model. Normally, exporters of perennials maintain stock from which part of the quantity exported is obtained.

1. The traditional static approach

The basic idea behind optimum taxation is that a nation facing a less than perfectly elastic demand curve can exploit its international market power via tax or export control to offset the combined deadweight losses caused domestically. As it faces the rest of the trading world, such a nation can select an optimal tax for its own benefit.

International prices are determined mainly by the volume of world export; hence, countries with large market shares can exert some influence on world prices. This case is depicted in Figure 1 where D_f denotes the foreign demand curve. The export supply curve S_x is the horizontal difference between the domestic supply S_d and the domestic demand D_d. In the absence of any export tax, there is a single price P_w (with marketing costs ignored) at which producers produce OF, domestic consumers demand OB and the volume of export is OU. When the exporting country fixes the domestic price at P_d, below the international price, it implicitly sets a tax on exports. Consumption increases to OC and production falls to OE. The tax being imposed generates a new excess supply curve S_x'and the country can only export OX. Under these circumstances the world price rises to P^*_w since foreign demand is imperfectly elastic.

Export tax revenues of P_w*HUY accrues to the government. There is a reduction of the producers surplus by the area KLP_dP_w which is only partially offset by a gain in consumer surplus equal to the area P_wJAPd. The gain in the government revenue collected at the expense of the producers and the foreign sector is the area QSLA. This leaves areas JQA and SKL (the sum of which is equal to HDV) as deadweight losses. Area SKL is the production loss while area JQA is the consumption loss. Area P_w*HDW is the loss of foreign consumer surplus out of which P_w*HVW is collected by the government of the exporting country while area HDV is the deadweight loss from an international point of view. This suggests that as long as the foreign demand for the export commodity is not perfectly elastic, there is an optimum export tax that maximizes the revenue accruing to the government.

Whether or not the export tax increases or reduces national revenue depends on how much of it is passed onto foreign buyers or is born by domestic producers. This in turn depends on the foreign elasticity of demand and supply for the commodity. If the foreign demand is more elastic than the excess supply, the producers pay more of the tax. If on the other hand, demand is more inelastic, importers pay more. The more elastic is the foreign demand, the less is the foreign exchange earned. In particular, if the exporting country excess demand is perfectly elastic, then a zero tax should be the optimal policy (Appendix A).

Mathemathically we define government total revenue R as:

$$R = (P_w (Q) - P_d (Q))*Q \qquad (1)$$

Where $P_w(Q)$ and $P_d(Q)$ denotes the inverse excess demand and supply curves respectively. Totally differentiating (1) gives,

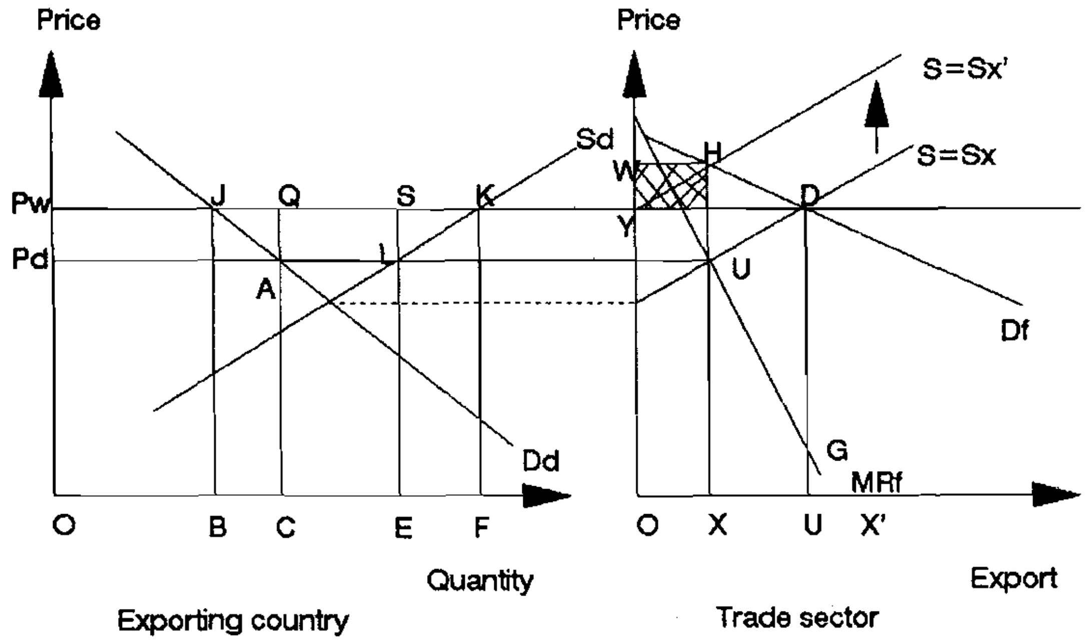

Figure 1: Effect of imposing export tax: downward slopping demand curve

$$dR = P_w*dQ+Q*\ dP_w/dQ*dQ-P_d*dQ-Q*\ dP_d/dQ*dQ = 0 \quad (2)$$

This is equivalent to (after rearranging terms):

$$P_w + P_w*(1/E_d) - P_d - P_d*(1/E_s)=0 \qquad (3)$$

Where E_d= $(dQ/dP_w)*(P_w/Q)$ and E_s= $(dQ/dP_d)*(P_d/Q)$ are the excess demand and supply elasticities. $P_w(1+1/E_d)$ is the marginal revenue (MR_f) and $P_d(1+1/E_s)$ is the marginal cost (MC_x)

Solving for the optimal producer price P_d* gives:

$$P_d* = (1 + 1/E_d) * (P_w*E_s/(E_s + 1) \qquad (4)$$

If the optimum export tax rate is expressed as a proportion of the world price P_w then expression (4) can be written as:

$$P_w(1-T*) = (1+1/Ed)*(P_w*Es/(1+Es)) \qquad (5)$$

The optimum tax rate becomes,

$$T* = 1-[(1+1/E_d)*(E_s/(1+E_s)] \qquad (6)$$

Most often, prices are fixed by the Marketing Board and do not vary with Q. In this case, the optimum tax rate is:

$$T* = -1/E_d \text{ and } P_d* = P_w - T* \qquad (7)$$

It is clear from (7) that when the excess demand curve is perfectly elastic ($E_d= \infty$), the optimum tax rate is zero. However, a maximum rate can be determined. (see appendix A for its mathematical derivation).

2. A generalized intertemporal approach.

So far the problem has been cast in a static framework. Governments normally manage stocks and have a long run view of the welfare of their communities. The model proposed here has for objective the maximization of the present value of the revenues derived from imposing an export tax subject to changes in the commodity stock over time.

Formally, the control problem over an infinite horizon can be stated as follows:

$$\text{Max } (W) = \int_0^{\infty} e^{-rt} (R (Q, S)) dt \qquad (8)$$

subject to :

$$R(Q,S) = (P_w (Q) Q - P_d (Q) Q) - C (S) \qquad (9)$$

$$\dot{S} = - \dot{Q} = 0 \text{ if } \dot{S} = 0 \qquad (10)$$

$$Q, S > 0 \qquad (11)$$

Where, W is the measure of present value of government revenues; r is the social discount rate. R(Q, S) represents the net government revenue and is defined as the difference between gross revenues from tax rate and the cost of managing the stock, C (S) equation (9) . Equation (10) describes the changes in the commodity stock over time. Equation (11) gives the non negativity conditions for the commodity stock, and the amount of commodity to be exported.

Assuming an interior solution, the current value Hamiltonian associated with the control problem described by (8)-(11) is given by (12):

$$H = P_w(Q)*Q - P_d(Q)*Q - C(S) + \lambda Q \qquad (12)$$

where, λ is the current value costate associated with the equation of motion (10). Assuming an interior solution, the maximum principle requires that (13) - (15) hold.

$$dH/dQ = Q*(dP_w/dQ) + P_w - P_d - (dP_d/dQ)*Q - \lambda = 0 \quad (13)$$

$$r\lambda - \dot{\lambda} = H_s = - C_s \qquad (14)$$

$$\lim_{t \to \infty} e^{-rt}\lambda(t)S(t) = 0 \qquad (15)$$

Equation (13) indicates that at any point in time, the quantity to be exported, Q, should be chosen so that the marginal revenue from imposing the tax is equal to the marginal cost of exporting Q plus the opportunity cost of holding the commodity stock (λ). Here, λ, measures the future benefits forgone by a decision to export quantity Q today. In other words, it is a measure of the marginal cost of " harvesting " Q at time t rather than saving it for future generations. Equation (14) implies that the commodity stock services should be employed up to the point where the marginal benefit of the stock is equal to the social cost of the capital. The right hand side of (14) represents the marginal benefit of the commodity stock while the left measures the cost of employing one unit of the commodity stock at any point in time. The cost includes both an interest charge ($r\lambda$) and a capital gain ($-\dot{\lambda}$). Finally equation (15) is the transversality condition.

Totally differentiating equation (13) with respect to time and combining it with (14) yield an expression for the time rate of change along the optimal path.

$$\dot{Q} = Q \frac{r(P_w(1+1/E_d) - P_d(1+1/E_s) + C_s}{P_w/E_d - P_d/E_s} = 0 \quad (16)$$

where C_s is the marginal cost of the commodity stock.

In a steady state, the rate of change in the commodity stock is necessarily zero. Setting $\dot{S}_t = \dot{Q}_t = 0$ in equation (16), a steady state commodity stock S* is uniquely defined by

$$r(P_w(1 + 1/E_d) - Pd(1 + 1/E_s)) = - C_s \quad (17)$$

Solving for P_d* in (17) gives:

$$P_d^* = (1+1/E_d)(P_wE_s/(1+E_s) + C_sE_s/(r(1+E_s)) \quad (18)$$

The optimum tax rate is obtained by solving $P_d^* = P_w(1\text{-}T^*)$

$$T^* = 1 - (1+1/E_d)(E_s/1+E_s) - C_s{}^*E_s/(rP_w(1+E_s)) \quad (19)$$

Observe from equations (18) and (19) that the optimal producer price and the export tax differ from those obtained under the static framework by the factor $Cs^*Es/(r^*P_w{}^*(1+Es))$. Comparative statics results can be obtained by taking the partial derivatives of Pd* and T* with respect to Cs and r.

$$dP_d^*/dC_s = -E_s/(r(1+E_s)) < 0 \quad (20)$$

$$dT^*/dCs = Es/(rPw(1+Es)) > 0 \quad (21)$$
$$dPd^*/dr = CsEs/(r(1+Es) < 0 \text{ and} \quad (22)$$
$$dT^*/dr = CsEs\ /\ (rPw(1+Es) > 0 \quad (23)$$

The following major conclusion can be drawn from the analysis:

C.1. The optimum producer price depends on the marginal cost of commodity stock, the exporting country's supply elasticity, the import demand elasticity ,and on the social rate. When the problem is cast in a static framework or when the foreign elasticity of demand is not taken into account, the results are biased.

C.2. An increase in the marginal cost of the stock leads to a decrease in the optimal producer price and an increase in the maximum tax rate. The social rate of time discount has the opposite effects. A higher value of r leads to a decrease in the optimal producer price and an increase in the optimal tax rate.

In case where domestic price is fixed,

$$T^* = -1/E_d - C_s/rP_w \qquad (24)$$

It is clear from the results that a shortsighted trade policy that neglects commodity stock-flow relationships and the social rate of time discount will result in a serious overtaxation of the export sector. A tax rate too high would result in considerable welfare losses through restrictions in the volume of trade, and short falls over time in export earnings.

III. THE MODEL

In order to compute the optimal producer price and tax rate, import demand and excess supply elasticities are required. This section describes the estimation procedures and data used for deriving these parameters.

1. Computing the import demand elasticity facing an exporting country (Ed)

The demand for import commodity i facing exporting country j (M_{ij}) is defined as the difference between the sum of the total world demand for commodity i and the sum of quantities supplied by all other exporters to the world market (S_{ir})

$$\text{Thus,} \quad M_{ij} = \Sigma^w M_{iw} - \Sigma^r S_{ir} \qquad (25)$$

By differenciating the above identity with respect to the price of the commodity i, P_i, we have.

$$dM_{ij}/dP_i = \Sigma^w(d\, M_{iw}/dP_i) - \Sigma^r(dS_{ir}/dP_i) \qquad (26)$$

Multiplying both side by (Pi/Mij) and rearranging gives,

$$(dM_{ij}/dP_i)*(P_i/M_{ij}) = \Sigma(P_i/M_{ij})*(dM_{iw}/dP_i)* M_{iw}/M_{iw}) - \Sigma(P_i/M_{ij})*(dS_{ir}/dP_i)*(S_{ir}/S_{ir}) \qquad (27)$$

This can be rewritten as:

$$E_d = M_{iw}/M_{ij}*E_{dw} - S_{ir}/M_{ij}*E_{sr} \qquad (28)$$

where, E_d is the elasticity of import demand facing exporting country j, E_{dw} is the elasticity of the world demand for commodity i. E_{sr} is the elasticity of supply of the rest of the world (ROW). M_{iw}/M_{ij} will be denoted as the inverse of the jth country market share in the world. S_{ir}/M_{ij} is the rest of the world export share divided by country's j export share of commodity i.

From equation (28), we can say that for any given value of the world elasticity of demand (E_{dw}), the demand elasticity faced by a particular supplier (E_d) will be greater, the smaller its share of market, and the larger the supply response of ROW.

Computing the total world import demand elasticity (Edw)

In order to reveal the different responses of individual markets, the functional form of demand for each importing country will be associated with market share functions. We assume that the imported products are close but not perfect substitutes so that an increase in price of say Ivorian cocoa will not lead to its disappearance from the import market or a fall its price will not lead to the extinction of competing varieties and its complete dominance of the market. A second assumption is that if the price of an exporting country's cocoa changes, consumers will change their purchases gradually rather than instantaneously since it is not known to them whether the price change is temporary or permanent. Assuming that the functional form is known, then the import equation system used for each major importing country m in this study will be of this form:

$$M_{im}(t) = (\gamma a)_m + (\gamma\beta)_m P_t + (1 - \gamma)_m M(t-1) + \alpha_{mg} GNP + \alpha_{mx} EXC + \delta_m et \qquad (29)$$

$$S_{ij} = (\delta_a)_j + (\delta\beta)_j P_t + (1 - \gamma)_j M(t-1) + \alpha_{jg} GNP + \alpha_{jx} EXC + \gamma_j vt \qquad (30)$$

where, M_{im} is the total import of commodity i by country m in tons. S_{ij} is the export share of that market by exporting country j in tons, P_t is the export price of commodity i in dollar. GNP is the real per capita gross domestic product in US dollar in the importing country. The coefficients $\gamma\beta$ and $\delta\beta$ represent the short run response to price changes while, γ stands for the coefficient of adjustment. The expected signs are negative for $\gamma\beta$, $\delta\beta$ and positive for $(1-\gamma)$, a_{mg}, α_{jg}. The others are inconclusive.

Computing the domestic supply elasticity (E_s) and the rest of the world supply elasticity (E_{sr})

Supply elasticities for each exporting country are derived using a Nerlove (1958) model as described by Askari and Cummings (1977). The general form of the model is:

$$A_t = a_o + a_1 P_t^e + a_2 Z_t + U_t \qquad (31)$$

$$P_t^e = P_{t-1} + b(P^e_{t-1} - P_{t-1}) \qquad (32)$$

$$A_t = A_{t-1} + f (A^d_t - A_{t-1}) \qquad (33)$$

where A_t is the proportion of actual area of perennial crop under cultivation at time t, A^d_t is the area desired to be under cultivation at time t, P_t^e is the expected price at time t, Z_t are other exogenous factors affecting supply of perennial crop at time t, b and f are expectation and adjustment coefficients. Equation 32 describes a price expectation formulation. Equation (33) stipulates that the actual area planted in each period is adjusted as a fraction of the difference between the desired (long run) area and the previous period's actual area (partial adjustment). P_t^e is modelled as adaptative. The expectation of P_t given I_{t-1} will take this form:

$$P^e t|_{t-1} = f(P_{t-1}, P_{t-2}, \ldots P_{t-k}), \text{ or}$$

$$P^e_t = \Sigma \gamma i \, P_{t-i} \qquad (34)$$

where P_{t-i} is the producer price at time t-i, and

$$\Sigma \gamma i = 1.$$

In most developing countries, prices are set by the government and most often have a positive rate of growth. The least price that the farmer can expect in the next period is the present price. Thus, price movement may not follow Nerlove's adaptative expectation model and therefore cannot be represented as a moving average of all past prices. In this case the price expectation will follow this adhoc formula:

$$P^e_t = \gamma_1 P_{t-1} + \gamma_2 P_{t-2} + \gamma_3 P_{t-3} \qquad (35)$$

where, $\gamma 1 + \gamma 2 + \gamma 3 = 1$ and, $\gamma 1, \gamma 2, \gamma 3 > 0$.

In addition to the perennial crop price, another major explanatory variable to consider is the price of food crops (P_f). In smallholder agricultural systems, annuals and perennials are intercropped, particularly during immature phases of perennials development, implying joint utilization of resources. To incorporate technological progress and other unidentified variables, a time trend variable will be included. The derived model to be estimated for each exporting country area response is of the form:

$$A_t = a_o (1-a) A_{t-1} + a_1 P_t^e + a_2 P_f + a_3 \text{ Time} + V_t \qquad (36)$$

A significant positive response to perennial crop price would suggest that price is a source of incentive for growing perennial crop. If a_2 is positive, it may indicate that farmers prefer to increase perennial crop acreage and generate cash. On the other hand, a significant negative a_2 would suggest that perennial and food crops compete for factors of production as hypothesized earlier; and that farmers respond to price changes by adjusting plantings. The time variable which is a proxy for technological change is expected to be positively signed ($a_3 > 0$).

2. Estimation procedures and data

World cocoa exporters and importers were identified and ranked to identify the major markets. The top five exporters include Cote d'Ivoire, Brazil, Ghana, Malaysia, Nigeria. Together these countries exported almost 80 percent of the world cocoa to the top four importers including Germany, (F.R), U.S.A., Netherlands, and Italy in 1988. Each importer's equation was jointly estimated with each of the exporter's share equation. One reason for using this method is to avoid aggregation problems and to identify the different responses in individual markets. If the parameters of the above demand specification are elasticities, then the price elasticity of the demand for an exporter to an importing country is the sum of coefficients from the two equations respectively ($r\beta + \delta\beta$). The elasticity estimate from the specific importing country equation is then weighted by its share of the exporter's given period market share and added to other similarly weighted elasticity estimates from the rest of the exporter's markets to get a total elasticity of import demand for that exporter. Area responses are estimated separately. For some functions, dummy variables were introduced to capture the effects of country specific variables as specified earlier (e.g. changes that occurred in Ghana and Nigeria in 1985 and 1986 respectively). In sum, the econometric model includes 6 blocs of demand equations and 5 supply equations. Each import demand equation (corresponding to one bloc) is associated with share equations. The demand equations were estimated simultaneously by bloc using System Regression Method. The supply equations were estimated separately using ordinary least square (OLS) regression method .

The data series used for estimation span from the period 1964 to 1989. Data on volume, value of export and import were collected at Marketing Board and/or statistics offices in each country during field trip undertaken by the author. The export prices were calculated by dividing value by volume of export. Price indices (for cocoa, major food crops,..) were compiled from each country's data base. Various sources like FAO statistics books were also utilized for data on other variables such as gross domestic product, exchange rate, etc.

IV. RESULTS

This section reports the estimated import demand and supply elasticities for Cote d'Ivoire and Ghana. Using these elasticities, the optimal tax rates are calculated and then compared with the actual tax situation in each country. Alternative calculations of the optimal export tax rate are made for short and long run elasticities with and for the static and dynamic approaches respectively.

1. Export Shares and Supply Elasticities

Table 1 gives the export shares for cocoa held by the major exporters in 1988 and estimates of the short and long run supply elasticity for each exporter. Table 2 gives the weighted price elasticities for the rest of the world (Esr). The empirical model results for acreage response function are presented in appendix B. All signs are as expected, except for the rainfall variable. Its coefficient is not statistically significant different from zero and can be regarded as inconclusive. The coefficients of P_t are all significant at 1 percent level, supporting the hypothesis that farmers do respond to price changes. The results also support the hypothesis that in Nigeria, cocoa and cassava compete for resources used, and that a significant amount of land is still being allocated to food crops. The positive and significant time trend coefficient is consistent with improvement of technology in cocoa industry in Ghana. The results are inconclusive for other variables. Acreage response to economic incentives is apparently limited: the short run elasticities being fairly low, ranging from .049 to .60. Thus, one can say that any conscious short run variation of production by producers within the constraints set by the available stock of trees is quite possible. Any attempt to maintain a high price for cocoa by limiting acreage, might have to be accompanied by considerable storage in order to be successful. It is more difficult to come to confident judgement about long run supply elasticities, since the specification does not allow for long term effects of inter sectoral resource flows. Therefore, the estimates may be on a lower side.

Table 1
Export Shares, Short and Long Run Supply Price elasticities (Es)
for Major exporting countries

	Export share(%)	Short run elasticity	Coefficient of adjustment	Long run elasiticity
Ghana	13.6	.235	.59	.40
Cote d'Ivoire	33.0	.60	.70	.85
Brazil	18.0	.112	.21	.54
Nigeria	06.0	.099	.87	.113
Malaysia	10.0	.049	.97	.048

Table 2

Short and long run weighted price elasticities for the rest of the world
(ROW) (Sir/Mij*Esr).

	Short run elasticity	Long run elasticity
Ghana	5.45	9.80
Cote d'Ivoire	0.99	2.22

2. Import Demand Elasticity Estimates

Estimates of cocoa import demand elasticities are presented below in Table 3. The short and long run world price elasticities (Edw's) were calculated using the formula derived earlier. They provide a useful check of the estimates from the import demand functions as well as information on the various consuming countries. The long run elasticity estimates are imprecise because of wrong signs generated for some coefficients of adjustment. (Appendix B.)

3. Calculation of the Optimal Prices and Export Tax Rates

The import demand elasticities facing each of the major exporters (Cote d'Ivoire and Ghana) and their optimal price/tax rates are calculated using the formulas derived earlier. Optimal price and tax rate calculations are made for short-long run import price elasticities and with - without application of the social rate of time discount. We will examine first the static case.

Static case. We hypothetized earlier that the government wants to maximize revenue from cocoa export. In this context, any rational policy from the viewpoint of the government will set the producer price P_d^* such that: $P_w > P_d > P_d^*$ where P_w and P_d are the international and domestic prices after the tax. The closeness of is P_d to P_w or P_d^* depends on the excess demand and supply elasticities.

Results for optimal prices are reported in Table 5 above. In the short and long runs, the optimal prices derived for Cote d'Ivoire are in general higher than the actual prices, suggesting that farmers have been over taxed. Optimal producer prices are about 1.2 times greater than the actual prices. Toward the end of the 1980's, however, the government objective of raising revenue became more rational than in the past in the short run.

Table 3
Short Run and Long Run Weighted Price Elasticities

	Cote d'Ivoire	Brazil	Ghana	Nigeria	Malaysia
	Short run Weighted Price Elasticities				
The Netherlands	-0.0074	-0.0009	-0.007	-0006	...
USA	...	-0.0170	-0.0068	-0.0051	-0.0033
UK	-0.015	-0.0112	-0.0076	...	0.0057
Germany	-0.280	...	-0.0025	...	...
Italy	0.00004	0.0003	...	...	...
ROW	-0.025	-0.0047	-0.0150	-0.0047	-0.0024
Total Weighted (E_{dw})	-0.330	-0.0250	-0.0022	-0.0110	-0.0580
	Long Run Weighted Price Elasticities				
The Netherlands	0.270	-0.720	0.081	0.103	...l
USA	...	-0.132	-0.320	-0.280	-2.120
UK	-0.170	-0.140	-0.150	...	-0.210
Germany	-0.380	...	-0.420	...	...
Italy	0.002	0.034	...	...	...
ROW	-1.420	-1.750	...	-1.690	-2.060
Total Weighted (E_{dw})	-0.575-0.500	-0.109	-0.112	-0.248	

Table 4

Optimal pricing in the short and long run:
Ghana and Côte d'Ivoire, case I (prices are in dollar/ton)

	P_w	P_d	P_{ds}^*	P_{dl*}	P_w	P_d	P_{ds*}	
1964	491.49	369.160	434.17	466.92	475.81	285.7	266.46	406.33
1965	380.48	369.60	336.34	361.45	349.21	322.34	195.56	298.22
1966	363.48	246.04	321.32	345.31	427.42	238.30	239.36	365.02
1967	453.73	194.04	401.09	431.04	533.33	284.63	298.67	455.46
1968	508.36	233.24	449.39	490.18	643.59	282.90	360.42	549.63
1969	684.35	251.86	604.96	650.13	823.53	251.87	461.18	703.29
1970	802.18	288.12	709.13	762.07	673.43	289.80	377.12	575.11
1971	603.82	161.70	533.77	573.63	670.07	325.30	375.24	572.24
1972	533.98	229.32	472.04	507.28	556.6	331.97	311.69	475.34
1973	788.24	318.92	696.80	748.83	875.52	352.52	490.30	747.69
1975	1489.13	478.82	1316.39	1414.67	1301.76	790.27	728.98	1111.70
1976	1366.77	510.97	1208.22	1298.43	1534.36	704.25	859.24	1310.34
1977	2290.70	638.72	2024.98	2176.16	2544.94	765.14	1425.16	2173.37
1978	3061.50	483.87	2706.36	2908.43	2920.90	1196.17	1635.70	2494.45
1979	3555.56	668.12	3143.12	3377.78	3196.49	1243.78	1790.03	2729.80
1980	3350.71	1452.00	2962.02	3183.17	2797.10	1328.61	1566.42	2388.78
1981	2063.38	1452.00	1824.03	1960.21	1675.64	1043.84	938.36	1430.99
1982	1596.69	1356.00	1411.47	1516.85	1530.33	892.19	856.98	1306.90
1983	1517.57	396.00	1394.57	1498.69	1474.51	718.77	825.73	1259.23
1984	2330.42	400.00	2060.09	2213.89	2027.61	729.77	1135.46	1731.58
1985	2078.31	480.00	1837.23	1974.39	2133.08	991.93	1194.53	1821.06
1986	2353.93	622.60	2080.87	2236.24	2177.56	1239.30	1219.43	1859.64
1987	2382.00	422.105	2105.68	2262.90	2382.00	1498.13	1335.82	2048.52
1988	1783.00	420.00	1576.17	1693.85	1783.00	1333.00	998.48	1533.38
1989	1795.00	396.00	1409.98	1515.25	1595.00	1333.00	893.20	1371.70

It is quite obvious that Ghana has been facing net social loss as optimal prices depart a lot from actual prices. By examining Table 4 above, it can be noticed that for all years, the estimated optimal prices are about 1.5 times greater than the actual prices, and the gap was quite high in the 1980's. This suggests clearly that cocoa farmers were being over taxed in Ghana as well. Some results of perfectly elastic foreign demand case are presented in Appendix B. If it is assumed that Cote d'Ivoire is a price taker in the world cocoa market, then it can be observed that the pricing policy has been rational in general except in 1969 and 1977, when the price set was lower than the estimated optimal price. This means that pricing policy was consistent with government objective of generating revenue. Prices set in Ghana were lower than the estimated optimal prices, except in 1974, 1984, and 1987. This suggests also that there were some foregone earnings in foreign exchange for farmers as well as revenue for the government. Long run results are somewhat mixed. Producer pricing policy has been rational in Cote d'Ivoire more than 70 percent of the time. Most of the irrational prices were set during the 1970's, a period when world prices were at their highest level. Ghana set irrational prices during the study period.

The dynamic approach

The demand elasticities faced by each major supplier to the world cocoa market and the optimal tax rates are presented in Tables 5 and 6. The import demand elasticity for each supplier is inversely related to its share in the world market and inversely related to its maximum export tax. Cote d'Ivoire faces the least inelastic demand because it holds the largest share. In the long run, the demand elasticities become much higher. The maximum tax for Cote d'Ivoire is the highest in static case I (foreign demand elasticity is finite) and dynamic case III. Again, these vary considerably depending on the assumptions used.

Of the taxes in effect (since 1982), Cote d'Ivoire had by far the lowest of the two countries; and lower than its maximum tax calculated in case I and III using short run elasticities but not lower than that calculated using long run parameters. The export taxes levied in Ghana were much higher than the maximum level under cases I and III. Case II confirms the theoretical hypothesis that as the import demand becomes more elastic, there is nothing the country can do but tax heavily the producers. For example, in Ghana where the import demand is very elastic, the maximum tax rate has been quite high (70 percent).

Cote d'Ivoire increased its tax rate from 23 percent in 1983 to 25 in 1985. The upward revision brought the tax rate close to its maximum level in terms of short run elasticities. The impact of Cote d'Ivoire adjusting toward its optimum tax rate is examined by analyzing the steady state solution in case III. In 1987, the optimal producer price needed to maximize revenue is 573,585.60 CFA per ton ($US1 = 383 at the 1987 exchange rate). The actual price for the same period was 346,920 CFA. The tax rate of 25 percent corresponds to 166,740 CFA. Yet, to be able to levy a 48 percent of taxZ rate, the exchange rate should have been set at around 1$ = 700 CFA and the world price should have risen much higher so that the maximum rate of 48 percent could be levied.

Table 5
Import Demand Elasticities Facing Côte d'Ivoire and Ghana
and their Optimal Export Taxes, 1964-1988, Cases I and II

	Import Demand Elasticities		Export tax (per cent)				
				Optimal tax			
				Short run		Long run	
Country	Short run	Long run	Actual Tax	Case I	Case II	Case I	Case II
Cote d'Ivoire	-2.27	-6.84	25	44.0	62.5	14.0	54.0
Ghana	-8.56	-21.13	70	11.6	81.0	5.0	72.0

It becomes apparent then that given the long gestation period before cocoa trees yield fruits, and the relatively low supply elasticity for Cote d'Ivoire, one of the long run strategies for maximizing cocoa revenue from taxes is an exchange rate devaluation. In this case, producers would be receiving the optimal prices and the tax rate will likely be close to 48 percent.

Table 6
Import Demand Elasticities Facing Côte d'Ivoire and Ghana
and the Different Tax Rates 1980-1989, Case III

	Import Demand Elasticities		Export Tax (Percent)	
Year	Short Run	Long Run	Actual	Optimal (Short run)
		Côte d'Ivoire		
1980	-2.27	-6.84	25	45.0
1981	---	---	---	45.0
1982	---	---	---	46.5
1983	---	---	---	47.0
1984	---	---	---	46.0
1985	---	---	---	46.0
1986	---	---	---	47.0
1987	---	---	---	47.0
1988	---	---	---	47.0
1989	---	---	---	47.0
		Ghana		
1980	-2.27	-6.84	25	45.0
1981	---	---	---	45.0
1982	---	---	---	46.5
1983	---	---	---	47.0
1984	---	---	---	46.0
1985	---	---	---	46.0
1986	---	---	---	47.0
1987	---	---	---	47.0
1988	---	---	---	47.0
1989	---	---	---	47.0

But devaluation for Côte d'Ivoire alone cannot be an instrument that can be used indefinitely to maintain competitiveness because of its appurtenance to the franc zone.

The second long run strategy would be to build up stocks, with a view to increasing world prices given Cote d'Ivoire's significant market share. However, one has to compare the marginal cost of holding stocks with the marginal benefit. From table 7 below,and based on historical data for the period from 1980 to 1989, it would have been beneficial to hold stocks, ceteris paribus.

The tax level in Ghana is well above its existing tax level because of their highly elastic foreign demand. The existing Ghanaian export tax is 70 percent. This is much larger than the maximum level under consideration in cases I and III. Since Ghana holds only 13.6 percent of the world market share, we can argue that Ghana is a price taker. In this case, it can adjust more quickly toward the maximum export tax rate of 81 percent. But because of its level of development, it will not be justified to advise the country to move quickly toward the optimum tax rate under any pressure.

Table 7
Comparing present value of marginal cost of storing cocoa beans (Cs/r) with the benefits forgone by not exporting cocoa beans today (λ) Cote d'Ivoire, 1980/89.

	Indirect contribution (in monetary terms) of the incremental cocoa stocks (λ)	Interest charge rλ	Present value of the marginal cost (Cs/r) ($/ton)
1980	17409.67	1915.06	35.82
1981	10386.20	1142.48	44.54
1982	9492.62	1044.18	36.73
1983	9137.40	1005.11	40.191
1984	12587.89	1384.67	42.73
1985	13253.30	1457.86	38.18
1986	13487.19	1483.59	27.27
1987	14711.47	1618.25	49.04
1988	11043.88	1214.83	50.00
1989	9879.43	1086.74	50.00

V. CONCLUSIONS

In this study, a theoretical framework was developed to analyze the optimal pricing of primary commodities in developing countries. The study was undertaken for two reasons. First, in order to generate revenue governments implicitly tax the export of primary commodities but the imposition of the tax rate is done on adhoc basis ignoring the excess supply demand and supply elasticities. Second,little theoretical and empirical studies are available which analyze the optimal taxation of primary commodities. The theoretical framework was applied to the cocoa subsector in Cote d'Ivoire and Ghana.

The analysis was conducted in two steps: An estimation of the structural models of supply and demand for cocoa subsector in Cote d'Ivoire and Ghana, followed by the derivation of optimal prices and tax rates, taking into account the elasticities of supply and demand in a static and dynamic framework respectively. This section presents the summary of each step. Suggestions for future research and a summary of policy implications are also discussed.

1. Summary

The first analytical model of cocoa acreage response indicates that cocoa producers do respond to prices of cocoa and food crops by adjusting to the acreage planted. Import demand functions were estimated for major importing countries simultaneously with export shares. Linearizations were imposed on the functional forms. The estimated equations exhibit a relatively good fit thus, suggesting the possibility of using the model for forecasting purposes and policy analysis. But the explanatory power could be improved with better information on several key aspects of cocoa importation.

A second model was developed to demonstrate the pricing and tax rules which optimize revenue generated by the cocoa board for the government. The elasticity estimates were used to evaluate the pricing policy of the board in each country. Since the results of the maximization are crucially dependent upon the econometric model (because of elasticities), accurate information on the relationship between cocoa prices, rural wages and production in each country need to be better integrated for the empirical results to be meaningful. The model demonstrates that the optimal prices depend on the marginal cost of the commodity stock, the exporting country's supply elasticity and on the social rate of time discount. When the problem is cast in a static framework, or when the foreign demand elasticity is not accounted for, the results could be biased.

2. Policy implications

The results of the policy modelling exercise strongly suggest that, in general, the price and taxing behavior of the two countries did not optimize the net revenues of national cocoa boards during the study period. In a static framework with infinite import demand elasticity, the pricing policy in Ghana seems to be reasonably consistent with the objective of generating government revenue; the computed optimal tax rates were closer to their actual levels, indicating that the country can adjust more quickly to the optimal tax rate. But, because of its level of development, it will not be justified to advise the country to move quickly toward the optimal tax rate under much pressure. The modelling results also suggest that, faced with relatively stagnant production and demand (inelastic responses), the long-run optimal policy would be to lower price incentives to curtail investment in cocoa production. Any attempt to raise prices must be followed by a successful storage policy. Otherwise, diversification may be desirable.

There is a possible explanation for over taxation of cocoa in Cote d'ivoire in the 1970's and a significant downward adjustment of domestic prices in the 1980's. One reason might be the contribution to Ivorian economy of cocoa export during the 1970's when world prices were very high and when Ivorian cocoa production and export quantity increased sharply. The situation changed in the mid 1980's when world prices weakened and there was a sharp appreciation of the CFA franc vis-a-vis the US dollar .

The price setting behavior of the Ghanaan cocoa Board during the 1970 and 1980's, was "non optimal" from the point of view of maximizing the revenues. This can be explained by the underlying fear of the authorities that lowering domestic prices in Ghana to "optimal levels" will generate a booming cocoa contraband in favour of Cote d'Ivoire. The substantial divergence between the controlled domestic price and the export price generated a steady flow of illegal cocoa export in the 1970's. The size of this flow is perceived as being directly proportional to the magnitude of the tax rate. Therefore, a lowering of the domestic price while the export price remains constant could potentially contribute to the expansion of the illegal export flows. Rather than facing this situation, the Board may have opted for "non optimal" pricing, guaranteeing that export receipts would at least remain in the hands of the government. Moreover, the political pressures exerted by Ghanean cocoa growers has always been a significant factor in the downward inflexibility of the domestic prices. Conversation with cocoa growers reveal that there is a strong feelings of dissatisfaction with current taxation levels and that further cuts in domestic prices would certainly provoke a strong protest.

Another issue that should be of interest to policymakers is the impact of time factor in their taxation decisions. Since the estimate of the optimal tax is based on the price elasticity of demand and the price response of the commodity from other exporters should the policymakers look at short or long term elasticities? The difference is crucial, especially when there is a large gap between the two. Government weighting the optimal export tax has a choice: accepting lower tax revenues now and reaping higher revenues in the future, or setting their sights on high short run tax revenues and loosing out in the long run.

A comparison of the estimated optimal export tax rates for Cote d'Ivoire and Ghana with their current taxes show the following. When the government depends heavily on the tax for its revenue, it taxes on the basis of the short run elasticities. This tax rate is much higher than if the long run elasticities were used, which is usually the case when the taxes are a small proportion of government revenue. But the higher tax rate makes the country susceptible to loss of market share over time because it reduces the incentive for its own producers (while raising world prices) and encourages the substitution of the commodity by other producers. Actual export tax rates by Ghana on cocoa were much higher than the optimal rates even when based on short run elasticity estimates. This may well have contributed to the reduction in the country's share of the world market.

Regardless of the reasons for the non optimal pricing and taxation behavior, the policy framework presented in this study is expected to be of potential use to primary commodity producing countries as a yardstick against which to measure feasible policies. It should provides a basis for sound economic arguments to induce policy changes in the direction that could maximize the revenue of the governments.

In particular, we expect the results of this study to be taken into consideration by policy makers. Government officials, in charge of cocoa boards management, essentially ministers and their counsellors, are the target of this study. If these policymakers change their policies and allow the internal prices of cocoa to approach the world market prices levels, the resulting effects on the agricultural output in Cote d'Ivoire and Ghana would increase the welfare of producers and also the revenue of the government in the two countries. If however the implicit tax remains too high, thereby, constituting a disincentive for farmers, then unless government officials reverse the policy or decrease the tax rate, perhaps gradually over time, there is little hope in the long run for their agriculture to sustain their country's economic growth.

APPENDIX A

Case of a country facing a perfectly elastic exess demand curve.

The foreign demand curve for the small country's commodity is assumed to be perfectly elastic and is represented by P_w (world's price). If supply function is not perfectly inelastic, but rather depicted as in Figure A.1 and if the transactions costs are zero or more than what they could be in a pure market economy, government revenue is equal to:

$$R = (P_w - P_d)\, Q_t, \qquad (37)$$

Where, R is the government revenue, P_w and P_d represent the world price, and the producer price, respectively, and Q_t is the total quantity exported. At $P_w = P_d$, production and export sales are maximized, but government revenue is nil. At price P_d, the government gain is depicted in the graph as area P_wP_dCB, but the export revenue drops by $(Q_w - Q_t)P_w$. Assuming that ACQ_tQ_w is the increase in the cost due to the production increase from Q_t to Q_w, a lower producer price results in a deadweight loss equal to triangle ABC. Then in this case, the optimum tax rate is zero in a sense that no additional revenue can be generated to compensate for the deadweight loss. The world price can not be pushed up by the exporting country. The only thing it can do is to tax heavily the producers. The maximum revenue tax, however, occurs when the ratio of the domestic price to the tax is exactly equal to the price elasticity of the exporting country's excess supply curve as we will demonstrate.

The optimal producer price which maximizes revenue from the viewpoint of the board can be derived as follows:

Totally differenciating equation (37) , we have:

$$dR = P_w{*}dQ + Q{*}dP_w - P_d{*}dQ - Q{*}dP_d = 0 \qquad (38)$$

Since foreign demand curve is assumed to be perfectly elastic, $dP_w/dP_d = 0$. Multiplying equation (38) by $P_d/Q * 1/dP_d$ gives.

$$P_w{*}(P_d/Q){*}(dQ/dP_d) - P_d{*}(P_d/Q){*}(dQ/dP_d) - Q{*}(P_d/Q) = 0. \qquad (39)$$

This is equivalent to:

$$P_w{*}E_s - P_d{*}E_s - P_d = 0, \qquad (40)$$

Where, $Es = (dQ/dP_d){*}(P_d/Q)$ is the export supply elasticity.

Solving for the optimal producer price $P_d{*}$ gives:

$$P_d^* = (P_w{}^*E_s) / (1 + E_s). \qquad (41)$$

Since the maximum tax rate T* is a proportion of the world price P_w, substituting for P_d^* gives

$$T^* = 1- E_s/(E_s+1). \qquad (42)$$

From (41) and (42), the following relationship can be derived:

$$E_s = P_d^*/T^*, \qquad (43)$$

which means that the maximum tax occurs when the ratio of the domestic price to the tax is exactly equal to the price elasticity of the exporting country's excess supply curve.

Few points are worth mentioning here. Note that equation (6) differs form equation (42) by the factor (1 + 1/Ed). This represents the contribution of the foreign demand function in the optimal producer price formula. Recall that when foreign demand is infinitely elastic, (Ed = ∞), equations (6) and (42) are equivalent. Clearly, in the case that Ed is finite, using equation (42) to determine optimal producer prices will yield biased results; the bias factor being (1 + 1/Ed).

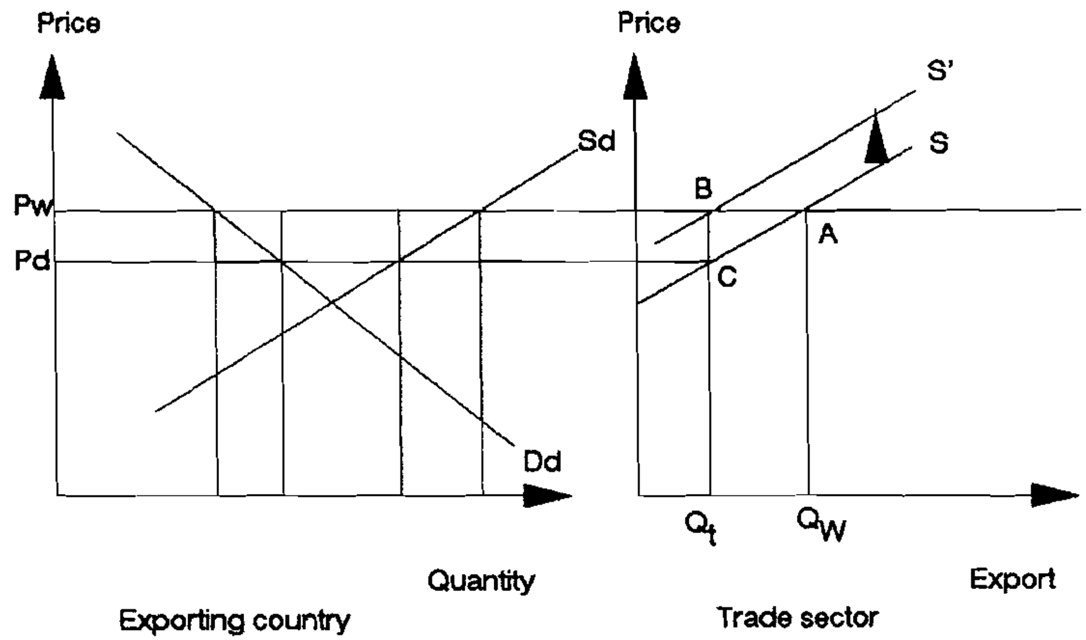

Figure A1: Effect of imposing export tax: pefectly elastic demand curve

Table A1. **Optimal pricing in the short run: Cote d'Ivoire and Ghana case II (prices are in dollar/ton)**

	Cote d'Ivoire			Ghana		
	P_w	P_d	P_{ds}*	P_w	P_d	P_{ds}*
1964	475.81	285.7	178.43	491.49	369.60	93.52
1965	349.21	322.34	130.75	380.48	369.60	72.32
1966	427.42	238.30	160.28	363.48	246.04	69.16
1967	533.33	284.63	199.99	453.73	194.04	86.33
1968	643.59	282.90	241.35	508.36	233.24	96.73
1969	823.53	251.87	308.82	684.35	251.86	130.22
1970	673.43	289.80	252.54	802.18	288.12	152.64
1971	670.07	325.30	251.27	603.82	161.70	114.89
1972	556.6	331.97	208.73	533.98	229.32	101.61
1973	875.52	352.52	328.32	788.24	318.92	149.98
1974	1263.41	494.90	473.77	1287.26	383.23	244.94
1975	1301.76	790.27	488.16	1489.13	478.82	283.36
1976	1534.36	704.25	575.38	1366.77	510.97	260.06
1977	2544.94	765.14	954.35	2290.70	638.72	435.88
1978	2920.90	1196.17	1095.33	3061.50	483.87	582.55
1979	3196.49	1243.78	1198.68	3555.56	668.12	676.56
1980	2797.10	1328.61	1048.94	3350.71	1452.00	637.58
1981	1675.64	1043.84	628.36	2063.38	1452.00	392.63
1982	1530.33	892.19	573.87	1596.69	1356.00	303.82
1983	1474.51	718.77	552.94	1517.57	396.00	300.18
1984	2027.61	729.77	760.35	2330.42	400.00	443.44
1985	2133.08	991.93	799.91	2078.31	480.00	395.47
1986	2177.56	1239.30	816.58	2353.93	622.60	447.91
1987	2382.00	1498.13	893.25	2382.00	422.05	452.58
1988	1783.00	1333.00	668.63	1783.00	420.00	338.78
1989	1595.00	1333.00	598.13	1795.00	396.00	303.05

APPENDIX B

Table B1. Estimation Results for Cocoa Import Equations, 1964-88 (The t-values are in Parentheses)

	Intercept	P_t	GNP	EXC	M(t-1)	R^2
			The Netherlands			
Total						
	9.16 (1.7)	-0.047 (1.42)	0.122 (0.76)	-0.17 (1.13)	0.68 (3.77)	0.93
Shares						
Côte d'Ivoire	3.17 (6.3)	-0.046 (1.5)	0.129 (0.93)	-0.15 (3.0)	0.66 (5.1)	0.93
Ghana	5.1 (1.5)	0.018 (0.48)	0.16 (1.45)	0.033 (1.65)	0.68 (2.96)	0.90
Brazil	6.44 (1.6)	0.011 (0.62)	-0.39 (0.14)	-0.049 (2.7)	0.27 (0.69)	0.92
Nigeria	0.47 (0.29)	-0.017 (0.55)	0.073 (0.43)	0.008 (0.22)	0.94 (7.8)	0.89
			USA			
Total						
	24.0 (3.2)	-0.103 (1.47)	2.07 (1.9)	0.066 (1.3)	0.285 (0.77)	0.62
Shares						
Ghana	12.9 (5.2)	-0.42 (3.5)	0.18 (0.24)	-0.02 (0.45)	0.34 (1.6)	0.74
Brazil	20.5 (3.26)	-0.11 (1.5)	1.02 (1.0)	0.061 (1.2)	-0.31 (1.0)	0.61
Nigeria	11.6 (4.0)	0.29 (2.5)	-0.33 (0.45)	-0.05 (0.41)	-0.11 (0.51)	0.65
Malaysia	12.6 (4.2)	-0.15 (1.8)	0.059 (0.07)	0.16 (1.3)	0.10 (0.45)	0.58

Table B1 Continued

	Intercept	P_t	GNP	EXC	M(t-1)	R^2
			UK			
Total						
	17.8 (4.4)	-0.108 (2.02)	---	0.025 (0.07)	-0.21 (0.95)	0.19
Shares						
Côte d'Ivoire	10.7 (4.9)	-0.15 (1.6)	---	-0.05 (0.07)	-0.19 (0.83)	0.18
Ghana	11.2 (5.2)	-0.11 (2.2)	---	0.025 (0.08)	-0.21 (8.3)	0.18
Brazil	13.26 (4.0)	0.123 (1.8)	---	0.002 (0.008)	0.43 (1.4)	0.32
Malaysia	10.22 (2.9)	-0.15 (1.8)	---	0.025 (0.29)	0.022 (0.26)	0.17
			Germany			
Total						
	12.9 (3.5)	-0.14 (1.75)	0.25 (0.61)	-0.29 (2.6)	0.17 (0.85)	0.79
Shares						
Côte d'Ivoire	7.09 (3.0)	-0.13 (2.6)	0.22 (0.66)	-0.25 (2.7)	0.15 (0.66)	0.82
Ghana	3.77 (2.6)	-0.07 (1.3)	---	0.017 (0.89)	0.43 (2.15)	0.78
			Italy			
Total						
	7.22 (3.1)	0.115 (1.4)	0.27 (0.93)	0.101 (0.13)	0.27 (1.5)	0.63
Shares						
Côte d'Ivoire	5.15 (2.2)	-0.12 (1.5)	0.25 (0.71)	-0.08 (1.3)	0.25 (1.1)	0.66
Brazil	3.06 (0.56)	-0.09 (2.4)	0.19 (0.37)	-0.014 (0.87)	0.06 (0.26)	0.76

Table B1 Continued

	Intercept	P_t	GNP	EXC	M(t-1)	R^2
			ROW			
Total						
	5.5 (1.6)	-0.95 (8.6)	-0.009 (0.08)	-1.4 (5.8)	0.12 (1.1)	0.62
Shares						
Côte d'Ivoire	14.0 (5.8)	-0.31 (4.2)	-0.003 (0.04)	0.40 (1.9)	-0.11 (0.06)	0.74
Ghana	12.8 (47.3)	-0.15 (3.0)	0.09 (1.8)	0.13 (0.81)	---	0.64
Brazil	8.43 (2.0)	0.023 (0.79)	0.15 (2.9)	-0.21 (2.4)	0.35 (1.5)	0.60
Nigeria	6.7 (2.3)	-0.22 (2.7)	-0.005 (0.07)	0.44 (1.9)	0.19 (1.0)	0.78
Malaysia	6.5 (3.4)	-0.05 (1.6)	---	-0.09 (1.2)	0.4 (2.2)	0.77

Table B2. **Computation of short run price elasticities**

	Cote d'Ivoire	Brazil	Ghana	Nigeria	Malaysia
Netherland	-0.093	-0.036	-0.029	-0.064	-
USA	..	-0.21	-0.52	-0.39	-0.25
UK	-0.25	-0.23	-0.21	..	-0.25
Germany	-0.26	..	-0.21	..	..
Italy	+0.001	+0.025	..	..	..
ROW	-1.26	-0.93	-1.1	-1.17	-0.99

Table B3. **Rate of cocoa import adjustment (1- λ) (where λ is the coefficient on parameter mi(t-1)**

	Cote d'Ivoire	Brazil	Ghana	Nigeria	Malaysia
Netherlands	-0.34	0.05	-0.36	-0.62	--
USA	--	1.59	1.62	1.39	1.18
UK	1.40	1.64	1.42	--	1.18
Germany	0.68	--	0.50	--	--
Italy	0.48	0.67	--	--	--
ROW	0.89	0.53	--	0.69	0.48

Table B4. **Acreage response to price,1965-88 (t values are in parenthesis)**

	Cote d'Ivoire	Ghana	Nigeria	Brazil	Malaysia
Intercept	2.002 (2.1)	.104	4.81 (.03)	3.38 (1.78)	6.54 (2.8)
P_{t-1}	.50	.60	.50	--	--
P_{t-2}	.30	.20	.30	--	--
P_{t-3}	.20	.20	.20	--	--
P_t	.23* (4.7)	.60 (2.0)	.099* (2.4)	.112* (4.6)	.043 (1.9)
PS_{t-1}	.125 (1.5)	--	--	--	--
PC_{t-1}	--	--	-.39 (.98)	--	--
A_{t-1}	.30 (3.2)	.41 (8.5)	.124 (.95)	.79 (.94)	.020 (1.8)
Rain	--	-.004 (.27)	--	--	--
Time	.0006 (.15)	.015 (3.0)	--	--	.13 (.19)

*** indicates the use of dummy variables as explained earlier Pst is the price of sheanut. Pct is the price of cassava.**

References:

Askari, H. and Cummings, T., 1977. Estimating agricultural supply response with the Nerlove model: A survey, International Economic Review., 18:257-292.

Bale, M. D. and Lutz, E., 1981. Price distortion and their effects: An international comparison, American Journal of Agricultural Economics.:8-22.

Franco, R. 1981. The monopolistic cocoa pricing. Journal of Development Economics. 8: 77-92.

Gbetibouo, M. and Delgado, C. Lessons and constraints of Export crop-Led Growth. In the Political Economy of the Ivory coast. Eds. J. W. Zartan and Delgado, C. (Praeger, 1974).

Lutz, E and Scandizzo, P. L.,1980. Price distortions in developping countries: A bias against agriculture. European Review of Agricultural Economics. 7: 5-27.

Lutz, E. and Saadat, Y.,1988. Issues relating to Agric Pricing Policies and their analysis in Developping Countries. Agricultural Economics. 2: 19-37.

Nasciento, J. C. and Raffinot, M.,1985. Politique de Prix Agricoles et Comportment des producteurs: Le cas de l'arachide au Senegal. Revue Economique.

Peterson, W.,1979. International Farm Price and the Social Costs of Cheap Food Policies. American Journal of Agricultural economics, 61: 12-21.

Deaver, R., May 1989. An integrated model of perennial and annual crop production for Sub-Saharan Countries, The World Bank, WPS 175.

Thompson, R. L., 1983. The Role of Trade in Food Security and Agriculture in the role of markets in the world food Economy. Eds D. G. Johnson and G.E. Schuh Westriew Press.