Why Kill the Golden Goose? A Political Economy Model of Export Taxation

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Abstract: Why do governments tax exports at rates that are ultimately self-defeating? An answer may lie in the time inconsistent nature of a low tax policy. Using a dynamic model of export taxation, I show that the sustainability of a low tax policy depends on three variables: the ratio of sunk costs to total costs; how heavily future export revenue is discounted; and expected future export earnings. Using data on taxation, leadership duration and profitability, I test this theory for thirty-two countries and six crops from Sub-Saharan Africa. These three variables are statistically and economically relevant predictors of tax regime.

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1. Introduction

Why do African governments tax agriculture so heavily? Current explanations influenced heavily by the work of Bates (1981), attribute taxation of agriculture to the political power of urban constituents. This might help explain why agriculture is taxed more heavily than other sectors.[1] Yet, it leaves unanswered the following question: why would the government impose such high tax rates that revenue falls, in a policy that is ultimately self-defeating? Moreover, why have some crops been subject to such heavy taxation while others have not?

For example, during the 1970s and 1980s, major exporters of cocoa levied the equivalent of an average annual tax of 51 percent, a tax on average 15 percent higher than the revenue maximizing tax rate. On the other hand, major exporters of tobacco taxed production at an annual average of only 19 percent, a tax on average 36 percent lower than the revenue maximizing tax rate.[2] Africa has lost substantial market share in almost all of its major export crops and economists and political scientists tend to agree that excess taxation is a big part of the explanation.[3] In other words, lower taxes would increase output, farmers' profits and government revenues.

I develop an explanation for this seemingly irrational behavior, based on the idea that a low-tax policy may be time inconsistent. The unique institutional setup that continues to dominate much of Africa (e.g. Marketing Boards) lends itself to a relatively simple theoretical framework. I model the problem as a repeated game between farmers, who face an unknown sequence of producer prices, and a government tempted to "cheat" farmers out of sunk costs. Using this

[1]Taxation of agricultural production can be justified on the grounds that there are no alternative tax bases. See Newbery and Stern (1987) for a comparison with the Diamond and Mirlees framework.

[2] Revenue maximizing tax rates are derived in Appendix 1 and discussed in detail in section 4.

[3] See for example Bates (1981) and Krueger et al. (1993).

framework, two types of equilibrium are identified, a low-tax equilibrium and a high-tax equilibrium. In the low-tax equilibrium, farmers may be taxed but they still recover their sunk costs and make zero profit. Farmers continue to plant and the government keeps any excess profit. In the high-tax equilibrium, farmers receive only harvesting costs and the government keeps the original excess profit plus an amount equal to the farmers' sunk costs. In this case, farmers stop planting for at least one season. Which equilibrium prevails depends upon which one yields a greater net benefit to the government. A comparison of these net benefits results in an empirically testable condition for predicting tax regime type.

The primary challenge of this paper lies in testing the theory. To do this, I construct a new data set using data on taxation and leadership longevity, plus new primary data on the costs of production. The data spans twenty-four countries and six crops over a twenty year period, 1970-1989. Because the theory does not predict precise levels of taxation but only whether we should observe a high-tax or a low-tax regime, two separate sets of tests are conducted with two alternative measures used for the dependent variable. First, a dichotomous variable describing regime type is constructed. I classify sub-periods of the twenty-year period into "low-tax" or "high-tax" periods for each country-crop pair depending upon the prevailing tax rate during that sub-period and the estimated revenue-maximizing tax. Second, a continuous variable describing deviations from the revenue maximizing tax is constructed by subtracting the revenue maximizing tax from the actual tax rate. The empirical strategy consists of comparing the predicted tax-regime based on the theory to the actual tax regime. In the first case, this is done using a probit model and in the second, a linear model. Both sets of tests demonstrate the following. Crops for which the ratio of sunk to total costs is relatively high, e.g. cocoa, coffee, and vanilla have been taxed more heavily than crops with relatively lower ratios of sunk to total costs, e.g. cotton, groundnuts and tobacco. Leaders with a relatively high probability of remaining in power tend to tax less heavily. And finally, crops with relatively higher expected future profitability tend to be less heavily taxed.

Empirical work in this area of research lags considerably behind the theoretical work. For example, the idea that governments need not be myopic for bad policy outcomes to prevail is not new to the political economy literature. Several papers use more sophisticated models to generate political-economic outcomes that are inefficient even from the standpoint of the politically powerful groups themselves (Rodrik, 1994). The idea that sunk costs leave investors vulnerable to revenue-hungry tax authorities is also not new. In a related paper[4], Besley (1997) argues that to be sustainable, a pricing policy for perennial crops must balance concerns about revenue extraction against the incentive by governments to cheat farmers out of sunk investments. Taking Besley's logic one step further, I argue that because African farmers incur sunk costs to produce cash crops for export (both perennials and annuals), a tax policy that encourages planting may be difficult to sustain. In addition, I provide empirical evidence that time consistency plays an important role in determining tax policy in Africa.

The paper is organized in the following way. Background information on the taxation of primary exports from Africa is provided in Section 2. Section 3 develops a theoretical model of predatory taxation in the presence of sunk costs. Section 4 discusses the data and develops the empirical models. Section 5 presents the estimation results and discusses robustness issues.

2. Primary Exports from Africa: Some Background

[4] Using a similar argument but less directly related McLaren (1996) argues that the International Coffee Agreement may be a consequence of sunk costs in planting of coffee and the inability of roasters to commit to a Pareto-efficient pricing policy.

Virtually every country in post-colonial Africa with a major export crop has used marketing boards or caisses de stabilisation[5] to tax farmers directly by fixing producer prices below world prices. In addition, farmers have been taxed indirectly through overvalued exchange rates. Table 1 shows that both direct and indirect taxation of agriculture has been twice as high in Sub-Saharan Africa than anywhere else in the world. Direct taxation, the main focus of this paper, has been almost ten times higher in Africa than in Asia and three times higher in Africa than in Latin America and the Mediterranean.[6] Indirect taxation has been roughly the same in all regions of the world.

Agricultural exports continue to be the single most important source of foreign exchange for the majority of countries in Sub-Saharan Africa. Table 2 shows that little has changed for the region since attaining independence. Fifty percent of Sub-Saharan African countries relied on one single commodity for more than thirty percent of export earnings at the time of independence. Sixty percent of these countries still relied on one commodity for more than thirty percent of export earnings between 1985 and 1989.

In spite of agriculture's importance, Table 3 shows that Africa's share of the world market in five out of six of its major export crops declined substantially between 1969 and 1991. Examples of the failure of agricultural pricing policy in Sub-Saharan Africa are well-documented in Krueger, Schiff and Valdes (1988), Schiff and Valdes (1992) and Jaffee and Morton (1995). All of these examples highlight the fact that bad policy has been responsible for lost opportunities. Unlike sisal and copper for example, where synthetic substitutes have been at least partially responsible for lost

[5] A caisse de stabilisation is the francophone African equivalent of a marketing board.

[6] The implicit argument of this paper is that this apparent Africa fixed effect is at least partly due to the fact that Africa, more than any other region of the world, relies heavily on export crops with very high sunk costs for a majority of its tax revenue. And, the institutional setup of marketing boards which is unique to Africa makes Africa particularly vulnerable to the time-consistency problem associated with sunk costs.

opportunities, the markets for coffee, cocoa, cotton and vanilla are as buoyant as ever. And while African countries have been losing ground, a few countries in Southeast Asia have successfully entered these markets over the last 20 years. For example, Asia's share of the world cocoa market increased from 0.4% in 1970 to 18.7% in 1993, while its share of the world vanilla market increased from 1% in 1969-71 to 41% in 1989-91.

The poor performance of African agriculture has not gone completely unnoticed. Bates (1981) documents the failure of agricultural policy in Africa and asks the question, “Why should reasonable men adopt public policies that have harmful consequences for the societies they govern?” He argues that because they have no economic justification, such policies persist for political reasons. Farmers are relatively disorganized and can be taxed to appease the better organized and more politically active urban population. This explains the political motive behind taxing farmers but still does not address the fact that excessive taxation would not ultimately be in the interest of the government nor in the interest of the recipients of the tax revenue, *i.e.* the industrialists. If the government needs revenue to fund urban food subsidies and urban industry, then it may need to tax agriculture. If it taxes agriculture, however, to the extent that farmers stop producing, then it loses favor with both the rural population and the urban population[7].

Puzzled by these striking failures, some have tried to find a "rationale" for the over-taxation of agriculture. For example, Widner (1993) points to the Ivory Coast as an example of a country which has followed a relatively favorable policy toward agriculture by paying farmers a higher share of the world price for their output than other African countries. She attributes this in

[7] Even in a general equilibrium setting, industrialists may prefer to keep the agricultural sector viable if (a) the tax revenue generated by the agricultural sector is transferred to the industrialists and (b) if taxed out of existence, farmers choose to revert to subsistence rather than move into the industrial sector.

large part to the fact that members of the elite derive a large portion of their incomes from the production of export crops.[8] Indirectly, then, she is arguing that the reason for myopic policies in other countries is the fact that individuals setting the prices in those countries did not own large farms. This explanation is unsatisfactory because even elites who do not own farms may derive a large portion of their income from the production of export crops in the form of rents and taxation. Moreover, there are few African elites who do not own land or who could not own land if they wanted to.

Contrary to Widner, Cardenas (1994), in a political economy model of marketing boards, suggests that taxation of coffee farmers in the Ivory Coast may have been too high. The central argument of Cardenas' paper is that institutional differences are helpful in explaining different patterns in the behavior of domestic prices. He finds that heavy intervention on the part of the government has been responsible for higher levels of taxation. He attributes this to an underestimation of the supply response of agriculture. Cardenas’ paper is important because it documents the problem, but his explanation for the persistence of high taxation is again unsatisfactory. As noted in the introduction, elasticity estimates were well documented in 1983 and were certainly known before this time. Also, why would some governments but not others underestimate the supply response for some crops? More importantly, wouldn’t governments learn fairly quickly if this was the problem?

Most importantly, none of these theories can explain the large variation in tax rates both over time and across countries (see Table 4). Between 1970 and 1989, direct taxes on agricultural export crops ranged from a high of 94% to a low of 1%. While Widner’s comparison of the Ivory Coast and Ghana is a step in the right direction, a more complete theory would be able to explain

[8] Actually, she says that this explanation holds for the period 1970-1987, while Bates’ (1981) explanation holds more power for the period 1960-1970.

cross-country differences for all of the countries in Sub-Saharan Africa. I provide one such theory in this paper.

3. A Simple Theory of Primary Export Taxation

The interaction between the government and the farmers is captured in an infinite horizon game-theoretic model in which the government has complete control over the price paid to farmers[9]. The first-best policy is defined as the pricing policy that simultaneously maximizes government tax revenue while inducing planting. Because there are an infinite number of possible equilibria it is not possible to completely characterize the equilibrium of this game. However, it is possible to determine the conditions under which the first-best or low-tax policy can be supported. Under these conditions, the government pays farmers just enough to cover their total costs of production keeping the difference between this and the world price.

3.1 Dynamic Game and First-Best Pricing Policy

Formally, the government solves the following problem,

$$\max \; E_t \sum_{t=0}^{\infty} \beta^t [(P_t^w - P_t^f) Q_t + \alpha (P_t^f - (s+h)) Q_t] \;\; \text{s.t.} E_t(\pi \geq 0) \;\; \text{and} \;\; P_t^f \geq h. \qquad (1)$$

Where, Q is ouput, the price paid to farmers by the government is P^f , farmer profits are π , P^w is the world price, s is the farmer's sunk costs of production, h is the farmer's variable cost of production, β represents the government's discount factor, and α is the weight that the government attaches to producer surplus. α is restricted to be less than one since if α were greater than or equal to one, then the government would either want to transfer all surplus to farmers or be indifferent. Neither of these cases is interesting or realistic. Although the industrial sector is not modeled explicitly, it is as if the government was balancing the welfare of the industrialists, who

9 The finite horizon game has a unique Nash equilibrium in which farmers anticipate negative profits and never plant.

receive all of the tax revenue, against the welfare of the farmers, who must give up some of their revenue to the industrial sector.

The government is constrained by the farmers' objective of making a non-negative economic profit. Farmers choose investment in period t, based on what they think the government will pay them for the output that this investment yields in period t+1. The farmers' costs, c, can be divided into harvesting costs, h, and all other costs, s, which I will call sunk costs. Sunk costs include land preparation, the cost of seeds and fertilizers, sowing and weeding costs, and the cost of any animals used in tending the crop.[10] For smallholders, these costs are typically irretrievable expenditures or sunk costs. Thus, in any one period, the government will be tempted to cheat farmers out of sunk costs and pay them only harvesting costs. Farmers choose Q to maximize profits in period t,

Starting from any period, t, if the government pays farmers h+s, then its per period revenue is P^w- (s+h) per unit of output. If the government pays farmers anything greater than s+h, say s+h+ε, then its per period revenue per unit of output is $P^w - (s+h)+(\alpha-1)\varepsilon$ and because $\alpha < 1$, this is less desirable than paying farmers s+h. Finally, if the government pays a price s+h-ε, it receives more in any single period, $P^w - (s+h)-(\alpha-1)\varepsilon$, but farmers will no longer plant in subsequent periods.[11] Thus we have proposition 1.

Proposition 1: A commitment to P^f=s+h is the first-best pricing policy because it induces efficient planting and extracts the maximum possible revenue.[12]

[10] Some of these are variable costs but for our purposes they may be classified as sunk on the grounds that they are irretrievable.

[11] The payoffs to the government of paying each of the possible prices, s+h or s+h±ε is found by substituting the relevant price into the government's welfare function, $(P^w+(\alpha-1)P^f - \alpha(s+h))Q$.

[12] Technically, this outcome is unique only when the constraint that expected per-period profits be non-negative is binding. Alternatively, allowing prices to vary subject to the constraint that expected profits average zero would provide the government with the same welfare.

In the absence of a commitment mechanism, the first-best pricing policy may not be a sub-game perfect Nash equilibrium of the repeated game. The commitment problem arises due to the government's ability to act strategically with respect to farmers' sunk costs. To address this issue, a more formal specification of the game without commitment is required.

3.2 Sustainability of the First-best Pricing Policy

The sustainability of the first-best pricing policy depends on the government's incentive to deviate from this pricing policy. In order for this to be well defined, we need to specify what happens once there is a deviation. I assume that farmers would prefer the first-best pricing policy to any other opportunities and so have no incentive to defect unless the government does not honor its commitment. The government may be tempted, however, to deviate from the first-best pricing policy in order to gain revenue.[13]

Consider the following strategy pairs. The government pays farmers a price equal to the sum of harvesting and sunk costs as long as farmers continue to plant and zero otherwise. Farmers respond by planting as long as their total costs are covered, and reverting to subsistence farming if ever the government pays them a price less than their total costs of production. In other words, assume that farmers are not organized enough to control the price they receive and so collectively respond to a payment less than $s+h$ by planting 0 for k periods. Note that this does not preclude farmers from harvesting output of perennial crops that continue to produce even though no new planting has taken place. This is not unrealistic as anecdotal evidence suggests that farmers have

[13] Essentially, what I do here is derive the conditions under which these strategies are sub-game perfect. To do this, I only need to ask whether the government has any incentive to pay a price different from $s+h$ when farmers are planting. This is because when farmers are not planting, there is nothing the government can do to get them to plant and I assume that when the government is paying farmers $s+h$, the farmers have no better alternative. Note that if this pricing policy is not sub-game perfect, then nothing that gives the farmers any greater share of the world price will be sub-game perfect.

responded to low prices by refusing to plant[14]. Also, notice that this behavior corresponds to the worst possible punishment the farmers could collectively impose on the government. There is no need to do the same for farmers because, starting from a low-tax equilibrium, farmers have no incentive to deviate.

Can the strategies described above support efficient planting as a sub-game perfect Nash equilibrium? In order for these strategies to work, the stream of revenues from following these strategies must be greater than the stream of revenues the government gets if it deviates in any one period. Payoffs from following the strategies defined above are,

$$E_t \sum_{t=0}^{\infty} \beta^t (P_t^w - (s+h)) \ . \qquad (2)$$

Payoffs from deviating from these strategies, assuming k periods of "punishment", are,

$$P_t^w - \alpha s - h + E_t \sum_{t=k+1}^{\infty} \beta^{t+k+1} (P_{t+k+1}^w - (s+h)) \ . \qquad (3)$$

Subtracting equation (3) from equation (2) gives the conditions under which the outcome associated with the first-best pricing policy, *i.e.* low taxes and efficient planting, is sustainable. To simplify the final expression, I assume that $E_t P_{t+k}^w$ is the same for all periods.

Proposition 2: The first-best pricing policy is sustainable if and only if,

[14] The fact that output has fallen in many countries is indirect evidence that farmers stop planting in response to high taxes. Because many other factors such as weather influence production statistics and even statistics on area planted, it is difficult to prove this using aggregate data. Nonetheless, informal evidence such as articles in the newsmagazines *West Africa* (1970-1988) and the *Africa Coffee Bulletin* (1989) suggest that farmers have responded to high taxation by not planting.

$$(1-\alpha)\frac{s}{s+h} \leq \frac{\beta-\beta^{k+2}}{1-\beta}\left[\frac{P_{t+1}^{w}}{s+h}-1\right] \tag{4}$$

The left-hand side of inequality (4) is the ratio of sunk to total costs and represents the short-run gain from deviating from the first-best pricing policy. The right hand side of inequality (4) is the present discounted value of the expected loss in revenue from over-taxation. In this simplified expression, farmers revert to subsistence farming forever and the government's loss is the present discounted value of all future tax revenue. Thus, the low-tax equilibrium is more likely to be sustained, the greater the weight placed on producer surplus, the lower the ratio of sunk to total costs, the greater the discount factor and the greater expected future world prices. This is intuitive. When sunk costs are high relative to discounted future revenues, opportunistic taxation becomes attractive. In the next section of the paper, I test the explanatory power of this model using data from Sub-Saharan Africa.

4. Can the Theory Predict Tax-Regime Type?

Equation (4) is a condition for sustaining the first-best pricing policy. One way of testing this condition is to assume that, in the real world, equilibria can be characterized as "low-tax" or "high-tax." If condition (4) is met, then the low-tax equilibrium prevails; if not, then I assume that the one period Nash or high-tax equilibrium prevails. Hence, if I take as my dependent variable the observed tax regime, I should be able to use observed values of the variables in inequality (4) to determine whether, in fact, this model is a good predictor of tax-regime type.

Specifically, the model suggests the following questions: (a) is the share of sunk costs in total costs a reliable predictor of tax-regime type? (b) are expected future profits from a crop a reliable predictor of tax- regime type? and (c) does the government's discount factor play a role in determining regime type? The remainder of this paper is concerned with answering these three questions. I do not try to measure α, the weight on producer surplus, directly. Rather, in both the probit and the linear analysis, α is allowed to take on country-specific values and is treated as an unobservable. To simplify notation, I rename each of the three variables I am interested in testing. The ratio of sunk costs to total costs is called STC. The government's "collapsed" discount factor is $\delta(k)$ and $\delta(k) = (\beta-\beta^{k+2})/(1-\beta)$. It is expressed as a function of k to remind us that its value depends on the length of punishment, k. The expected future profit margin is $PROF^e$. Rewriting equation (4) with the new variable names gives the following condition for sustaining the cooperative equilibrium,

$$STC\,(1-\alpha) < \delta(k)\,(PROF^{e} - 1) \qquad (5)$$

Of the three variables in equation (5), only STC is directly observable. Though observable, its measurement is non-trivial since data on costs of production in Sub-Saharan Africa are not readily available. $PROF^e$ depends on expected future commodity prices, which depend on the way in which expectations are formed about future world prices and on costs of production. Throughout my analysis, I assume that the real costs of production do not change and so all of the uncertainty about future profits comes from the uncertainty over future commodity prices. Finally, $\delta\,(k)=(\beta-\,\beta^{k+2})/(1-\beta)$, if taken literally, could be measured simply as the time value of money using the world interest rate because governments earn dollars for all of these commodities. This would not be very interesting nor would it be entirely accurate since different governments are likely to have different preferences across time. Instead, I interpret the one-period discount factor, β, as the probability of remaining in power.

4.1. The Data

Descriptive statistics are reported in Table 4 on the following page. The odd numbers of observations for the data on taxation reflect missing observations. The number of observations is 47 for the ratio of sunk costs to total costs since I assume that this variable doesn't change over time and since cost data is only available for a limited number of country crop combinations. The data on costs of production and profitability are annual data over 20 years for the 32 country-crop combinations for which data on costs of production were available.

The crops included in this study are cocoa, coffee, cotton, groundnuts, tobacco, and vanilla. Except for vanilla, these are the same crops used by Jaeger (1992). These crops have two main characteristics in common, they are a primary source of income to the exporting country and they are primarily grown by smallholders.[15] A detailed list of the countries and crops used in this study is provided in appendix 2.[16] Results in sections 5.1 and 5.2 include only the thirty-two country-crop combinations for which data on costs of production are available (see appendix 3).

Data on taxation of export crops in Sub-Saharan Africa were obtained from Jaeger.[17] Jaeger uses the same methodology to estimate nominal protection coefficients (NPCs) used in Krueger, Schiff and Valdes (1988,1983) and recommended by Westlake (1987). And, where the country crop combinations are the same, Jaeger's estimates are practically identical to those reported in Krueger et al (1988,1993). All three of these studies point to the importance of properly adjusting international reference prices to reflect value-added and transport costs. Previous studies often looked only at the ratio of the farmgate price to the world price without accounting for processing

[15] Crops that are important to Sub-Saharan Africa which are not included are tea and sugar. These are not included in Jaeger's study because they are mainly estate crops.

[16] This covers twenty-four different countries in Sub-Saharan Africa and includes most of the countries included in the Africa Adjustment Study by the World Bank plus Sudan and Zaire. Countries excluded due to a lack of data are those countries in Sub-Saharan Africa with a population less than 500,000.

[17] In fact, Jaeger's calculations stop in 1987. In 1995, I was hired by the World Bank to extend and update the series for a supplement to their publication Adjustment in Africa.

and transport costs and hence grossly overestimated the rates of taxation[18]. A better estimate of the level of taxation is the ratio of the farmgate price to the border price adjusted for transport and processing costs and is a measure of the divergence between what farmers could get if they sold their product directly to world markets and what they actually get due to government intervention. The tax rate is then one minus the NPC.

Calculation of the nominal protection coefficient requires data on prices paid to farmers, world prices, and an estimate of any value added to the crop between the time of pickup from farmers and export. Several sources including the Food and Agricultural Organization of the United Nations (FAO)

and the World Bank now publishes data on prices paid to farmers and world prices. However, to estimate the true nominal protection coefficient, one must convert these farmgate prices into their equivalent in terms of the processed good and adjust the world price for transport and marketing costs.

For example, in 1986 farmers in Madagascar received the equivalent of $0.89/kg. of dry robusta coffee cherries. The world price for roasted robusta coffee beans was $2.57/kg. Since 1 kg. of roasted coffee equals approximately 1.32 kgs. of dry cherries and because the world price is for dry cherries, first the farmgate price is converted to its international equivalent by multiplying .89 by 1.32 to get $1.17 per kg. We now adjust the world price for transport and processing charges by subtracting .27 per kg. and .10 per kg. to get $2.20 per kg. Hence, the NPC is 0.53 and the corresponding tax rate is 47%. Details of the conversion factors, transport costs, processing margins, and freight charges used by Jaeger are provided in Appendix 4.

[18] See Westlake (1987) for the details.

Data on actual costs of production for cocoa, coffee, cotton, groundnuts, tobacco, and vanilla have been obtained from several sources (see appendix 3).[19] Overall, groundnuts have the lowest ratio of sunk to total costs. This is because groundnuts are a relatively low-cost crop to produce, with few input and maintenance requirements. Hence, a large part of the work in producing groundnuts is performed around the time of harvesting. Tobacco also has a relatively low ratio of sunk costs to total costs but for a different reason: tobacco harvesting is a fairly complex and labor-intensive process which requires smallholders to pick, cure, and bale the tobacco. Cotton follows tobacco as it is relatively more input and management-intensive than either groundnuts or tobacco and requires the greatest attention during the growing phase. All three of the perennial crops have a higher ratio of sunk costs to total costs, as expected. Coffee has a higher ratio of sunk costs to total costs than cocoa because it requires relatively more care during the growing period. Vanilla is the most costly perennial and, because it requires hand pollination prior to harvesting, has the highest ratio of sunk to total costs.

Rather than trying to measure STC directly, I have assumed that all costs other than harvesting costs are sunk and then estimated the ratio of harvesting costs to total costs. This is reasonable because smallholders use very little, if any, equipment and most of the expenses prior to harvesting are for seeds, chemicals, labor, and sometimes animals. This assumption simplifies measurement since it narrows the search to an estimate of total costs and harvesting costs. Throughout the analysis I assume that the ratio of harvesting costs to total costs is a technological coefficient that does not vary over time. This assumption is problematic if a large portion of sunk costs comprise something other than labor and if those inputs are imported. For most of these

[19] I also estimated typical farm budgets to better understand the cost requirements of individual crops. These are not included here but are available upon request. Where possible, second sources were used to double check cost figures

crops however, the assumption seems reasonable since smallholders use relatively little imported inputs.

An additional complication is the fact that many governments chose to subsidize inputs such as seeds and fertilizer. Because the cost data in table A.3 is based on observed market prices and because harvesting costs include primarily non-subsidized costs, we can be fairly certain that our data on the ratio of harvesting costs to total costs are net of subsidies. It is also fairly well documented that governments claiming to subsidize inputs actually did a poor job of getting these inputs to smallholders. "Free" inputs were usually hijacked by large farmers or distributed to a select few in return for political favors[20]. Finally, data on fertilizer usage over the period in question suggests that for the crops used in this study, fertilizer usage was minimal.[21]

The discount factor, δ (k) equals $(\beta-\beta^{k+2)}/(1-\beta)$. β is estimated as the probability of remaining in power using Bienen and Van de Walle's (1991) data on leadership duration. For each country and each year, past values of the mean time in power are computed. The hazard rate, or likelihood of losing power in any one country at a particular point in time is then computed as one over the mean time in power. Thus, the probability of remaining in power is computed as one minus the hazard rate. For example, when Rawlings came to power in Ghana in 1981, Ghana had already had seven leaders whose duration in power lasted from eight to less than one year. The average duration in power for past leaders in Ghana in 1981 was 3.14 years. Hence, based on *past* data, the likelihood of losing power in Ghana in 1981 is one over 3.14 or 31.45 percent. So, Rawlings probability of remaining in power in 1981 is estimated at 68.55%. Calculating the

[20] "It is commonly and almost universally found that the poorer, small-scale, village level farmers do *not* secure farm inputs that have been publicly provisioned and publicly subsidized as part of a program in agricultural development. The evidence suggests that the benefits of these programs have been consumed chiefly by the larger farmers at the expense of their smaller counterparts." Bates, p.54-55, 1981.

[21] FAO statistics 1970-1997.

discount factor on a rolling basis is done to avoid the endogeneity problem between tax rates and the current probability of remaining in power.[22]

Ideally, the government's discount factor would include a component that captures the "personality" of different governments. Although we know that idiosyncrasies of particular regimes are important, they are, by their very nature, next to impossible to measure in any systematic way. Instead, in the probit specification, I model this as an unobservable component of the error term and in the linear estimation, this is modeled as a country fixed effect. Following the recommendation of Deaton and Miller (1995), I estimate the expected future profit margin by taking an average of actual profits over the twenty-year period, 1970-1989. [23]

4.2 Econometric Models

4.2.1 Probit Model

Up to this point, we have ignored α, the government's weight on producer surplus. Since α is not observable, I model the net benefit of a low-tax policy as an unobserved variable y^* where,

$$y^*_{ijt} = STC_{ijt}(1-\alpha_{ijt}) - \delta(k)_{ijt}(PROF^e_{ijt} - 1). \qquad (6)$$

where i indexes country, j indexes crop and t indexes time. Further, we do not observe the net benefit of a low-tax policy, only whether the low-tax regime prevails. Hence, I allow the dependent variable y_{ijt} to equal one if a low-tax regime prevails and zero otherwise. It is defined by,

[22] Bienen and Van de Walle (1991) allow the hazard rate to vary with time and then add covariates including variables such as (i) whether entry was constitutional or not, (ii) whether or not the government is military, (iii) mean duration of time in power, (iv) age at entry, (v) year of entry, and (vi) whether leader was a first-time leader or not. They also test demographic variables such as population and literacy rates but find that these are not statistically significant. The advantage of the current methodology is that the estimates more accurately reflect individual country experiences.

[23] I did however experiment with several alternative measures, which yield roughly similar results.

$$y_{ijt} = \begin{cases} 1 & \text{if} \quad y^*_{ijt} \le 0 \\ 0 & \text{if} \quad y^*_{ijt} > 0. \end{cases} \tag{7}$$

Thus, the probability that a low-tax regime prevails is,

$$\text{prob}(y_{ijt} = 1) = \text{prob}(y^*_{ijt} \le 0) = \text{prob}[(1-\alpha_{ijt})\text{STC} < \delta(k)_{ijt}(\text{PROF}^e_{ijt} - 1)]. \tag{8}$$

Estimation of (8) requires an assumption about the distribution of 1-$\alpha_{ijt.}$ Recall that α_{ijt} is the weight that the government places on producer surplus relative to its own. Hence, it lies between negative infinity and one and is likely to be grouped between zero and one. Therefore, it is reasonable to assume that the distribution of 1-α_{ijt} is log normal with mean μ and variance $\sigma^{2.}$ Hence,

$$\text{prob}(y_{ijt} = 1) = \Phi[\frac{\mu}{\sigma} + \frac{1}{\sigma}(\log(\delta(k)_{ijt}(\text{PROF}^e_{ijt} - 1)/\text{STC}_{ijt})]. \tag{9}$$

where Φ is the cumulative distribution function of the normal distribution with mean 0 and standard deviation one, and μ and σ account for the fact that log(1-α_{ijt}) may have a normal distribution with a mean other than zero and variance not equal to one.

To simplify notation, define the following,

$$NETBEN_{ijt} = \log[d(k)_{ijt}(PROF^{e}_{ijt} - 1)/STC_{ijt}]. \quad (10)$$

Then, we can use a binary probit to estimate the following equation,

$$\text{prob}(y_{ijt} = 1) = \Phi[\gamma_0 + \gamma_1 \text{NETBEN}_{ijt}], \quad (11)$$

As NETBEN increases, we would expect the probability of a low-tax equilibrium to increase and thus for γ_1 to be greater than zero. Rewriting NETBEN in log-linear form yields an alternative and less restrictive test of the model given by the following equation:

$$\text{prob}(y_{ijt} = 1) = \Phi[\gamma_0 + \gamma_1 \ln(\delta(k)_{ijt}) + \gamma_2 \ln(\text{PROF}^{e}_{ijt} - 1) + \gamma_3 \ln(\text{STC}_{ijt})]. \quad (12)$$

Note that the theoretical model implies the following two restrictions on these coefficients which are tested in Section 5.2, (1) $\gamma_0 = 0$ and (2) $\gamma_1 = \gamma_2 = -\gamma_3$.

To test equations (11) and (12), the data on taxation is averaged over five year sub-periods and then for each sub-period, countries are classified based on the level of actual taxes. Thus, the dependent variable takes a value of one for crops that are taxed at a rate less than or equal to the revenue maximizing tax and a value of 0 otherwise. Long run elasticities are used for calculating the revenue maximizing taxes[24] on the grounds that this a model that describes long-run

[24] In addition, I perform sensitivity analyses to show that the results are not extremely sensitive to the exact cut-off chosen.

behavior.[25] The explanatory variables are then averaged over these same sub-periods to determine whether these variables have any ability to predict tax regime type. Statistical tests are performed both for the individual sub-periods and then for the pooled data. Long-run averages of the data are meant to uncover regularities that we may call either low-tax or high-tax regimes. The sub-periods chosen, 1970-1974, 1975-1979, 1980-1984 and 1985-1989, are meant to reflect the fact that commodity prices reached historical highs in the late 1970s and then plummeted in the early 1980s.[26]

4.2.2 Linear Model

A less direct test of equation (5) where the unobserved weight on producer surplus is not explicitly modeled is provided by the following equations:

$$\frac{tax_{ijt} - rmt_j}{rmt_j} = \gamma_0 + \gamma_1 \ln NETBEN_{ijt} + \varepsilon_{ijt}, \qquad (13)$$

$$\frac{tax_{ijt} - rmt_j}{rmt_j} = \gamma_0 + \gamma_1 \ln(\delta(k)_{ijt}) + \gamma_2 \ln(PROF^{e}_{ijt} - 1) + \gamma_3 \ln(STC_{ijt}) + \varepsilon_{ijt}. \qquad (14)$$

The dependent variable is now percentage deviations from the revenue maximizing tax. According to the theory, we are more likely to see positive deviations from the revenue maximizing tax when the discount factor and expected future profits are high and when sunk costs are relatively low. Thus, in equation (13) we expect γ_1 to be less than zero since an increase in the relative benefits of the low-tax regime should reduce the percentage deviation from the revenue maximizing tax. For

[25] This seemed preferable to the somewhat arbitrary cutoff point of 30% used by Jaeger (1992) to differentiate between favorable and unfavorable policy environments for agriculture. However, even using the estimated revenue-maximizing tax may be problematic unless we take into account the fact that inputs may have been subsidized. On this, we rely on the arguments set forth on the relatively minor importance of input subsidies.

[26] These sub-periods are similar to the sub-periods used by Bevan, Collier and Gunning (1993) in a comparative analysis of Tanzania and Kenya and the impact of the boom in coffee prices.

the same reasons, we expect the coefficients in equation (14) to be of the following signs, $\gamma_1 < 0$, $\gamma_2 < 0$ and $\gamma_3 > 0$.

I use the same five-year averages to test equations (13) and (14) that we used to test equations (11) and (12) again because the theory is meant to describe long-run behavior. Allowing the dependent variable to remain continuous has several advantages. First, it allows for more variation in the data. Hence, our estimates can be more precisely measured. Second, it is now straightforward to test for unobserved country-specific and/or crop-specific, time-invariant heterogeneity ("fixed effects")[27]. And finally, the coefficients in equations (13) and (14) can now be interpreted directly as elasticities. The disadvantage of the specifications in (13) and (14) is that we are now following less closely the theoretical model hence, it is less clear what to do about the unobserved weight on producer surplus.

5.0 Results

5.1 Probit Estimates

Table 5, on the following page reports estimation of equations (11) and (12) using standard probit techniques. Model 1 is the restricted model, equation (11) while Model 2 is the unrestricted model, equation (12). The coefficient of NETBEN is positive and statistically significant for the pooled data and for each of the individual sub-periods indicating that an increase in NETBEN does increase the probability that a government chooses the low-tax equilibrium. This is the result

[27] The probit specification yields biased estimates in the presence of fixed effects, however, it is possible to control for fixed effects using the conditional logit specification developed by Andersen (1973) and Chamberlain (1980). Results of this analysis were reported in an earlier version of the paper and are similar to those presented here.

predicted by the model because increases in NETBEN are associated with increases in the cost of heavy taxation today relative to its current benefit.

Overall, NETBEN is a statistically significant predictor of tax regime type and the hypothesis that the coefficient on NETBEN equals zero can be rejected at the 1% significance level. The statistical relationship is strongest between 1975 and 1979 and weakest between 1980 and 1984. This may be partly due to the fact that coffee and cocoa prices skyrocketed during sub-period 2 and then plummeted during sub-period 3. To the extent that movements in taxes are driven by movements in world prices, this would result in more variation in tax rates during sub-period 2, when coffee and cocoa prices were abnormally high.

No economic significance can be directly attributed to the coefficients reported in Table 5 because of the non-linearity of the probit specification. Therefore, average elasticities have been calculated[28] as an indication of the average impact of a one percent increase in NETBEN on the probability of being in a low-tax regime. For the entire sample, a one percent increase in NETBEN increases the likelihood of being in a low-tax regime by .27 percent.

Results of estimating the less restrictive equation (12) are also reported in Table 5 as Model 2. Together, the three variables in the regression do a fairly good job of explaining regime type. Although not reported, the pseudo R2 for these regressions are significantly better than when we restricted the functional form to NETBEN and the hypothesis that the coefficients are jointly zero

can be rejected at the 1% level in all cases but sub-period three. Table 5 shows clearly that the most statistically significant predictors of regime type are the ratio of sunk costs to total costs,

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[28] The average elasticity is calculated as the average over the entire sample of the point elasticity at each observation or,

$\phi(x\gamma) * \gamma * 1/\Phi(x\gamma)$.

STC, and the discount factor. Both are significant at the 1% level for the entire sample. STC is significant at the 1% level in all sub-periods but two. The discount factor alone is significant in all sub-periods but the first. This probably reflects the fact that most African nations achieved independence during that period and so there would be little variation in leadership tenure at that early stage. In the last three sub-periods the discount factor is significant at the 5% level. Expected future profits enter with the correct sign but do not appear significant. Not surprisingly, the following hypothesis test implied by the model, $H_0 : \gamma_1 = - \gamma_2 = \gamma_3$, is strongly rejected. The model is an oversimplification of the real world which, in this case, has done a good job of pointing out important determinants of tax regime type.

Quantitatively, the marginal impact of STC appears far greater than the marginal impacts of the other two explanatory variables. Averaging over the entire sample, a one percent increase in STC reduces the probability of a low-tax equilibrium by 2.52 percent. The effects of the discount factor are significantly more modest. A one percent increase in the probability of remaining in power increases the likelihood of a low-tax regime by only .11 percent and a one percent increase in expected future profitability increases the likelihood of a low-tax regime by only .06 percent.

5.2 OLS Estimates

Results of estimating equations (13) and (14) are presented in Table 6. Estimates in rows A through D use the same samples as rows A through D of Table 5. The only difference is that in Table 6 the dependent variable is now continuous and measures the percentage deviation from the revenue-maximizing tax rate. Hence, we can use ordinary least squares to estimate the coefficients. Reported coefficients can be interpreted as the elasticity of the percentage deviation from the revenue maximizing tax with respect to a one percent increase in the explanatory variable. Thus, for example, a one percent increase in the benefit cost ratio reduces the percentage deviation from the revenue maximizing tax by .39 percent.

The relative explanatory power of the independent variables is similar to what we found using the probit specification. However, we cannot directly compare the elasticities in Table 6 to those in Table 5 since in Table 5 we are measuring the influence of the explanatory variables on probabilities

while here we are measuring the impact of the explanatory variables on percentage deviations from revenue maximizing tax rates. Row A of Table 6 indicates that a 1 percent increase in the ratio of sunk to total costs increases the percentage deviation from the revenue maximizing tax rate by 3.06 percent and a one percent increase in the probability of remaining in power reduces the percentage deviation from the revenue maximizing tax rate by .39 percent. Expected future profitability has the correct sign but does not appear to determine deviations from revenue maximizing tax rates. Like the results in Table 5, the most influential variable in terms of magnitude is the ratio of sunk to total costs.

Rows F and G control for the possibility of crop and country fixed effects. Expected future profitability is omitted from these specifications because of multicollinearity between it and the dummy variables. Estimates in both rows confirm that the results in rows A through D are not too sensitive to unobserved, time-invariant country or crop heterogeneity. However, the results in row F are particularly interesting because we can interpret the crop dummies as a proxy for expected future profitability. Doing this reduces slightly the magnitude of the impact of the ratio of sunk to total costs and significantly increases the explanatory power of the model. Country dummies are included in the estimation in row G and may be loosely interpreted as controlling for alpha, the weight on producer surplus. A comparison of the results rows A through E with the results in rows

F and G suggests that the results are generally robust to unobserved time-invariant country-specific and crop-specific heterogeneity.

5.3 Robustness Tests and Econometric Issues

The first assumption I examine is that the sub-periods chosen reflect accurately the timing of regime switches. The sub-periods used in section four are the four consecutive five-year sub-periods between 1970 and 1989. To see that this might be a problem, consider a country that had one leader from 1970 to 1982 who kept taxes very low. Then, suppose that another leader took over from 1983 onward and taxed agriculture heavily. I will have classified the first two and the last sub-periods correctly but the sub-period 1980-1984 will be classified based on an average and it will inevitably be incorrect. To determine whether accounting for this would change the results, two alternative methods were used for identifying sub-periods.[29] First, a five-year moving average of tax rates was calculated for each country-crop combination. Then, breaks in the series were determined by plotting the moving average over time and drawing a horizontal line at the height of the revenue-maximizing tax. Periods for which the moving average was above the line were classified as high-tax periods and periods for which the moving average was below the line were classified as low-tax periods. Second, using the residuals from the regression of tax on world price, I isolated movements that were strictly due to policy and not to movements in the world price. Both methods produced results statistically and quantitatively similar to those in Tables 5 and 6.

Next, I test the sensitivity of the results to the choice of revenue maximizing tax rate. To do this, I estimate both the probit and the linear models using the smallest and largest elasticity in the reported range for each crop as the revenue maximizing tax. While the results are generally robust to all three assumptions, the results using short run elasticities are not as sharp. This is

[29] I did not use the method developed by Bai and Perron (1995) of looking for structural breaks based on the time series, due to the short length of my series.

because when short-run elasticities are used, less regimes are classified as high-tax. Consequently, there is less variation in the dependent variable. I chose as my baseline results those using the long-run elasticities on the grounds that this is a model that describes long-run behavior. Most economists agree that the supply response of agriculture is quite substantial in the long run.[30]

6. Conclusion and Policy Implications

Results presented in this paper are consistent with a model in which the government finds it difficult to commit to a low-tax policy because farmers incur sunk costs to produce export crops. By quantifying the magnitude of the time consistency problem associated with agricultural pricing policy in Africa, I show that the problem is both economically and statistically relevant. Thus, the paper suggests an economic answer to the question of why African governments pursue policies that are ultimately self-defeating. As a result, the paper offers some insight into the possible solutions.

Changes in technology or institutions that enable producers to escape taxation or retaliate against it, as well as changes enabling governments to make credible commitments could help to lessen the problem of predatory taxation. An important question that remains unanswered is which among the possible solutions would be most politically and economically feasible in this context. For example, it is probably true that marketing boards represent an institutional weakness or in Collier's words, a weak agency of restraint. By granting the government monopsonistic power, they facilitate taxation. This may be one of the reasons that the World Bank has encouraged Africans to dissolve marketing boards. But there is understandably strong resistance. Furthermore, based on the analysis in this paper, it is not at all clear that eliminating marketing boards will solve the

[30] Even Bevan, Collier and Gunning (1993) who argue in their comparative analysis of Tanzania's and Kenya's response to the boom in coffee prices that the supply response in Tanzania was close to zero, however, agree that in the long -run the supply response is likely to be quite substantial.

problem. This is because the sources of the problem are the sunk costs and low discount factors, not the marketing boards. Alternatively, one way of precommitting to a low-tax policy might be to subsidize farmers' sunk costs. However, this would be expensive and requires cash precisely at the time governments are most strapped for revenue (e.g. pre-harvest). In addition, such a scheme may be difficult to implement and monitor.

Finally, this paper highlights an important issue for future research. How can a government restore credibility once it has "cheated"? The theoretical model is silent on this issue but its practical relevance is undoubtedly important. The data used here lends itself nicely to this type of extension. The sample includes several countries that have switched from a high-tax regime to a low-tax regime. This means that somehow the government managed to regain credibility after its reputation had been destroyed. Studying these countries could provide both theoretical and empirical insight into how some African governments manage to restore credibility.

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Appendix 1:Derivation of Revenue-Maximizing Tax Rate

Define Tax Revenue as,

$$TR = P^w Q(P^f) - P^f Q(P^f) \qquad (A.1)$$

where P^w is the world price of the crop, Q is output and is a function of the price paid to farmers by the government or P^f. Setting the first order condition of A.1 with respect to P^f equal to zero allows us to solve for the revenue-maximizing tax, t^*, where t is defined as the percent of the world price received by farmers or P^f/P^w.

$$t^* = 1/(1+\varepsilon^s). \qquad (A.2)$$

Using A.2 and estimated crop elasticities, we get the revenue-maximizing taxes reported in Table A.1.

Table 1
Direct, Indirect and Total Nominal Tax Rates of Agriculture, by Region 1960-1984 (percent)

Region	Direct Taxation	Indirect Taxation	Total Taxation
Asia	2.5	22.9	25.2
Latin America	6.4	21.3	27.8
Mediterranean	6.4	18.9	25.2
Sub-Saharan Africa	23.0	28.6	51.6

Source: Schiff & Valdes, 1992 Note: Direct taxation is one minus farmgate price over world price. Measures of indirect taxation vary depending on availability of data, but include at least some measure of exchange rate misalignment.

Table 2

Shares of Selected Agricultural Commodities in Countries Total Exports

Country	Crops	1966-73	1974-79	1980-84	1985-9
Benin	Cocoa, Cotton	29	39	27	..
Burkina Faso	Cotton	20	31	47	43
Burundi	Coffee, Cotton	90	91	8	84
Cameroon	Cocoa, Coffee	49	55	31	51

Central African Rep.	Coffee, Cotton	49	55	31	51
Chad	Cotton	71	61	..	..
Cote d'Ivoire	Cocoa, Coffee & p	53	57	51	51
Ethiopia	Coffee	53	56	62	65
Gambia	Groundnuts & p	92	84	54	28
Ghana	Cocoa	55	60	57	51
Kenya	Coffee	18	26	24	29
Madagascar	Coffee, Vanilla	37	45	57	43
Malawi	Tobacco	42	52	53	60
Mali	Cotton, Groundnuts & p	44	61	47	54
Nigeria	Cocoa	14	4	2	..
Rwanda	Coffee	53	69	59	80
Senegal	Groundnuts & p	44	32	13	10
Sierra Leone	Cocoa, Coffee	9	23	23	20
Sudan	Cotton, Groundnuts & p	66	67	43	42
Tanzania	Cotton, Coffee	31	42	42	51
Togo	Cocoa, Coffee	47	30	21	25
Uganda	Coffee, Cotton	71	92	97	96
Zaire	Coffee	6	12	18	9
Zimbabwe	Cotton, Coffee		7	6	7

Source: Gersovitz & Paxson (1990), International Financial Statistics 1985-1990 Notes: (1) & p stands for and associated products such as groundnut oil and .. is not available. (2) The following countries and crops are excluded on the grounds that they are mainly estate crops:Kenya, Malawi and Rwanda (tea), Malawi (sugar) and Tanzania (sisal).

Table 3

World Market Shares of Sub-Saharan Africa for Major Agricultural Exports

(percent of world export value)

Crop	Coffee	Cocoa	Cotton	Groundnuts*	Tobacco	Vanilla
1969-71	27.3	77.9	16.0	65.0	7.7	95.0

1989-91	17.8	67.1	13.1	19.0	13.5	55.0

Source: "Marketing Africa's High Value Foods", World Bank, 1995, FAO Trade Statistics, 1970-89.
Note: *Includes groundnut oil.

Table 4

Descriptive Statistics for Period 1970 to 1989

Variable	Mean	Standard Deviation	Minimum	Maximum	Number of Observations
Tax Rate	0.42	0.22	0.01	0.94	538

Tax Rate by crop:

Cocoa	0.51	0.21	0.05	0.85	119
Coffee	0.39	0.21	0.02	0.81	176
Cotton	0.40	0.15	0.06	0.82	136
Groundnuts	0.24	0.16	0.01	0.63	36
Tobacco	0.19	0.18	0.02	0.56	53
Vanilla	0.93	0.03	0.89	0.94	18
Deviation from Revenue Maximizing Tax Rate by crop:					
Cocoa	0.15	0.21	-0.35	0.51	119
Coffee	0.01	0.23	-0.39	0.51	176
Cotton	0.07	0.16	-0.32	0.49	136
Groundnuts	-0.31	0.16	-0.55	0.13	36
Tobacco	-0.36	0.18	-0.54	0.05	53
Vanilla	0.54	0.03	0.50	0.59	18
Ratio of Sunk Costs to Total Costs	0.74	0.08	0.63	0.92	47
Ratio of Sunk Costs to Total Costs by crop:					
Cocoa	0.75	0.03	0.72	0.82	8
Coffee	0.77	0.07	0.63	0.88	24
Cotton	0.73	0.02	0.71	0.75	8
Groundnuts	0.66	0.02	0.64	0.68	2
Tobacco	0.68	0.04	0.65	0.74	4
Vanilla	0.92	n.a.	n.a.	n.a.	1
Cost of production per kilogram	1.28	2.97	0.07	22.04	640
Cost of production excluding vanilla	0.69	0.76	0.03	1.87	620
Discount Factor	0.80	0.20	0.17	0.95	640
Expected Profit	1.71	0.26	1.45	2.36	6

Notes: (1) Countries included are listed in appendix 3. (2) Revenue-maximizing tax rates are derived in appendix 1. Deviations are from the lowest revenue maximizing tax calculated using the lowest report elasticity of supply for each crop. (3) Total cost of production is reported first with vanilla and then without, since vanilla is an outlier with a mean cost per kg. of usd 17.13. (4) n.a. stands for not applicable.

Table 5

Tax Regime Modeled as Probit Specification, by sub-period and coefficient groups

	Model 1	Model 2		
Dependent Variable:	Log Benefit cost ratio	Log Sunk over total costs	Log Discount factor	Log Profit margin
Tax Regime Type				

	(NETBEN)	(STC)	(δ(k))	($PROF^e$-1)
A. Entire Sample (N=128)				
Coefficients	.33	-4.72	.19	.58
T-statistics	(4.87)	(2.76)	(2.01)	(1.16)
Average Elasticity	.27	-2.52	.11	.06
Likelihood Ratio Test	16.91		33.20	
B. 1970 - 1974 (N=32)				
Coefficients	.47	-7.80	.25	.30
T-statistics	(1.80)	(2.13)	(1.29)	(.60)
Average Elasticity	.39	-6.02	.19	.23
Likelihood Ratio Test	5.56		12.82	
C. 1975 - 1979 (N=32)				
Coefficients	.79	-3.16	.41	.42
T-statistics	(2.73)	(1.87)	(1.89)	(1.86)
Average Elasticity	.53	-4.59	.59	.59
Likelihood Ratio Test	9.71		11.63	
D. 1980 - 1984 (N=32)				
Coefficients	.36	-4.85	.08	.36
T-statistics	(1.35)	(1.56)	(1.75)	(.67)
Average Elasticity	.27	-3.52	.06	.26
Likelihood Ratio Test	4.27		5.86	
E. 1985 - 1989 (N=32)				
Coefficients	.55	-7.73	.23	.08
T-statistics	(1.94)	(2.00)	(1.86)	(.14)
Average Elasticity	.28	-3.27	.11	.05
Likelihood Ratio Test	5.59		10.41	

Note: (1) The average elasticity is calculated as the average over the entire sample of the point elasticity at each observation or, $\phi(x\gamma) * \gamma * 1/\Phi(x\gamma)$. (2) Likelihood ratio tests are for the null hypothesis that the coefficients excluding the constant term are jointly zero for each model. Under the null, the test statistic is distributed as Chi-2(1) for results in column 1 and Chi-2 (3) for results in column two. In the first column, the null is rejected for values greater then 3.8 at the 5% level and in the second column, the null is rejected for values greater than 7.8 at the 5% level. (4)Standard errors are robust to heteroskedasticity.

Table 6

Determinants of Deviations from Revenue Maximizing Tax Rates

	Model 1	Model 2		
Dependent Variable: Percent Deviations from Revenue Maximizing Tax	Log Benefit cost ratio (NETBEN)	Log Sunk over total costs (STC)	Log Discount factor (δ(k))	Log Profit margin ($PROF^e$-1)
A. Entire Sample (N=128)				

Coefficients	-0.39		3.06	-0.39	0.09
T-statistics	(4.43)		(4.48)	(2.67)	(0.86)
R^2	0.16			0.21	
B. 1970 - 1974 (N=32)					
Coefficients	-0.25		3.74	-0.17	0.15
T-statistics	(1.43)		(3.64)	(1.29)	(0.68)
R^2	0.14			0.32	
C. 1975 - 1979 (N=32)					
Coefficients	-0.46		2.92	-0.46	0.03
T-statistics	(3.16)		(2.42)	(1.88)	(0.14)
R^2	0.19			0.21	
D. 1980 - 1984 (N=32)					
Coefficients	-0.22		1.94	-0.13	-0.03
T-statistics	(1.85)		(1.73)	(0.52)	(0.13)
R^2	0.13			0.08	
E. 1985 - 1989 (N=32)					
Coefficients	-0.66		3.47	-0.96	0.255
T-statistics	(3.21)		(2.13)	(3.03)	(0.94)
R^2	0.23			0.36	
F. Entire Sample with Crop Dummies (N=128)					
Coefficients	-0.46		1.56	-0.35	
T-statistics	(3.85)	(1.97)	(2.51)		
R^2	0.33			0.37	
G. Entire Sample with Country Dummies (N=128)					
Coefficients	-0.67		2.43	-0.33	
T-statistics	(1.98)		(2.17)	(1.86)	
R^2	0.48			0.51	

Note: (1) Deviations are from the lowest estimated revenue-maximizing test. Results using the highest estimated revenue maximizing tax are similar to those in the table. (2) Expected future profitability is omitted from the last two rows due to multicollinearity between it and the dummy variables. (3) Standard errors are robust to heteroskedasticity.

Table A.1:Revenue-Maximizing Tax Rates

by crop and minimum and maximum elasticity of supply

Crop	ε^m_{in}	ε^m_{ax}	t^*_{min}	t^*_{max}
Cocoa	.45	1.78	36 %	69 %
Coffee	.45	1.56	39 %	69 %
Cotton	.25	2.03	33 %	80 %
Groundnuts	.24	.79	56 %	81 %
Tobacco	.47	.82	55 %	68 %

Vanilla	.45	1.56	39 %	69 %

Note: Elasticities obtained from Akiyama and Duncan (1982), Marian Bond (1983), and Coleman and Thigpen (1991)

Table A.2:Countries and Crops included in Analysis

Country	Crop					
	Cocoa	Coffee	Cotton	Groundnuts	Tobacco	Vanilla
Burkina Faso			X			
Burundi		X				
Cameroon	X	X				
Central African Republic			X			
Chad			X			

Congo	X					
Cote d'Ivoire	X	X				
Ethiopia		X				
Gambia			X	X		
Ghana	X					
Kenya		X				
Madagascar		X				X
Malawi					X	
Mali			X			
Nigeria	X					
Rwanda		X				
Senegal			X	X		
Sierra Leone	X	X				
Tanzania		X				
Togo	X					
Uganda		X	X			
Zaire		X				
Zambia					X	
Zimbabwe			X		X	

X means country-crop combination is included in the analysis.

Table A.3: Total Costs of Production and Harvesting Costs as a Percentage of Total Costs by Crop

Crop	Total Cost (usd)	Harvesting Cost (usd)	Harvesting Cost over Total Cost	Crop Year	Country	Source(s):
Cocoa	1.26	0.25	0.20	1992/93	Cameroon	6,9
Cocoa	0.95	0.22	0.23	1994/95	Congo	6,9
Cocoa	0.59	0.13	0.22	1992/93	Ghana	2,6,9,
Cocoa	0.75	0.20	0.27	1992/93	Ivory Coast	2,6,9
Cocoa	0.50	0.14	0.28	1982/83	Ivory Coast	2,6,9
Cocoa	0.56	0.14	0.25	1992/93	Nigeria	6,9
Cocoa	0.76	0.14	0.18	1994/95	Sierra Leone	6,9

Cocoa	0.79	0.17	0.22	1994/95	Togo	6,9
Coffee[1]	1.27	0.30	0.24	1987-90	Burundi	2,3
Coffee	1.04	0.28	0.27	1987-90	Cameroon	2,3
Coffee	0.76	0.15	0.20	1982/83	Cameroon	2,3
Coffee	0.72	0.14	0.19	1982/83	Cameroon	2,3
Coffee	1.61	0.19	0.12	1987-90	Cameroon	2,3
Coffee	1.26	0.23	0.18	1982/83	Cameroon	2,3
Coffee	1.25	0.20	0.16	1982/83	Cameroon	2,3
Coffee	1.30	0.27	0.21	1987-90	Ivory Coast	2,3
Coffee	0.91	0.34	0.37	1982/83	Ivory Coast	2,3
Coffee	0.76	0.28	0.37	1982/83	Ivory Coast	2,3
Coffee	0.73	0.25	0.34	1982/83	Ivory Coast	2,3
Coffee	1.21	0.42	0.35	1987/90	Ethiopia	3
Coffee	2.63	0.76	0.29	1987/90	Kenya	2,3
Coffee	1.32	0.41	0.31	1981/82	Kenya	2,3
Coffee	1.58	0.49	0.31	1981/82	Kenya	2,3
Coffee	0.85	0.21	0.25	1987/90	Madagascar	3
Coffee	1.27	0.30	0.24	1987/90	Rwanda	2,3
Coffee	1.34	0.22	0.16	1981/82	Rwanda	2,3
Coffee	1.32	0.36	0.27	1987/90	Sierra Leone	3
Coffee	1.73	0.32	0.19	1987/90	Tanzania	3
Coffee	0.84	0.21	0.25	1987/90	Tanzania	3
Coffee	1.25	0.17	0.14	1987/90	Uganda	3
Coffee	0.75	0.17	0.23	1987/90	Uganda	3
Coffee	1.39	0.29	0.21	1987/90	Zaire	3
Cotton	0.30	0.08	0.27	1991/92	Burkina Faso	4,10
Cotton	0.35	0.09	0.26	1994/95	C. A. R.	4,10
Cotton	1.65	0.38	0.23	1994/95	Chad	4,10
Cotton	0.42	0.12	0.29	1994/95	Gambia	5
Cotton	0.39	0.11	0.28	1991/92	Mali	4,10
Cotton	0.39	0.10	0.26	1988/89	Senegal	4,8,10
Cotton	0.24	0.06	0.25	1994/95	Uganda	4,10
Cotton	0.37	0.10	0.27	1994/95	Zimbabwe	4
Groundnuts	0.19	0.07	0.36	1994/95	Gambia	5
Groundnuts	0.22	0.07	0.32	1988/89	Senegal	8
Tobacco	0.37	0.13	0.35	1993/94	Malawi	9,10
Tobacco	0.66	0.21	0.32	1994/95	Zambia	10
Tobacco	0.74	0.19	0.26	1994/95	Zambia	10
Tobacco	1.11	0.37	0.33	1994/95	Zimbabwe	10
Vanilla	13.08	1.05	0.08	1990/91	Madagascar	1,7

Table A.3 (*Continued*)

Notes:

(1) No distinction is made between arabica and robusta in the data on costs of production. For countries that export both and where data on both was available, an average of the two was used. (2) For coffee, differences in estimates in the same year for the same crop reflect differences in farm quality. (3) For

tobacco, differences in estimates in the same year for the same crop reflect differences in distance from the capital.

Sources:

(1) Blarel, B. and Dolinsky,D., “Market Imperfections and Government Failures: the Vanilla Sector in Madagascar”, 1995

(2) De Graff, J., “The Economics of Coffee,” 1986

(3) Landell Mills Commodities International

(4) International Cotton Advisory Committee

(5) Jallow, Yaya, Ministry of Agriculture, The Gambia

(6) Kotey,R. A., Okali, C. and Rourke,B.E., “The economics of cocoa production and marketing”, 1974

(7) Malagasy Republic, “Bilan et Perspectives de la Politique Vanillere”, 1975

(8) Martin,Frederic, “Budgets de Culture au Senegal”, 1991

(9) World Bank Commodities Division

(10) World Bank Country and/or Agricultural Economist

Table A.4:Estimates for Computing Farm Gate Equivalent of International Commodity Prices 1986

Country	Crop	Land Transport $/km-ton (1)	Ocean Freight $/kg (2)	Processing $/kg (3)	Conversion Factor (4)

Burkina Faso	Cotton	0.03	0.13	0.15	2.77
Burundi	Coffee (arabica)	0.15	0.20	0.25	1.32
Cameroon	Cocoa	0.19	0.25	0.06	1.00
Cameroon	Coffee (robusta)	0.17	0.20	0.19	2.12
Central African Republic	Cotton	0.11	0.13	0.17	2.77
Chad	Cotton	0.08	0.13	0.12	2.77
Congo	Cocoa	0.08	0.25	0.03	1.00
Congo	Coffee (robusta)	0.09	0.20	0.17	2.12
Cote d'Ivoire	Cocoa	0.09	0.25	0.05	1.00
Cote d'Ivoire	Coffee (arabica)	0.07	0.20	0.15	1.32
Ethiopia	Coffee (arabica)	0.13	0.20	0.27	1.32
Gambia	Cotton	0.05	0.13	0.20	2.77
Gambia	Groundnuts	0.12	0.05	0.15	3.30
Ghana	Cocoa	0.08	0.25	0.03	1.00
Kenya	Coffee (arabica)	0.19	0.20	0.35	1.32
Madagascar	Coffee (arabica)	0.07	0.20	0.10	1.32
Madagascar	Vanilla	0.11	0.13	0.73	1.00
Malawi	Tobacco	0.13	0.20	0.14	1.00
Mali	Cotton	0.07	0.13	0.17	2.77
Nigeria	Cocoa	0.14	0.25	0.16	1.00
Rwanda	Coffee (arabica)	0.11	0.20	0.27	1.32
Senegal	Cotton	0.08	0.13	0.19	2.77
Senegal	Groundnuts	0.05	0.05	0.13	3.30
Sierra Leone	Cocoa	0.05	0.25	0.10	1.00
Sierra Leone	Coffee (robusta)	0.17	0.20	0.32	2.12
Tanzania	Coffee (arabica)	0.31	0.20	0.36	1.32
Togo	Cocoa	0.08	0.25	0.03	1.00
Uganda	Coffee (robusta)	0.19	0.20	0.09	2.12
Uganda	Cotton	0.17	0.13	0.21	2.77
Zaire	Coffee (robusta)	0.09	0.20	0.10	2.12
Zambia	Tobacco	0.08	0.20	0.16	1.00
Zimbabwe	Cotton	0.11	0.13	0.37	2.77
Zimbabwe	Tobacco	0.09	0.20	0.14	1.00

(1) Transport costs per kilometer-ton and processing costs were estimated by Jaeger based on the large number of existing detailed studies and are based on distances from the major producing region for each commodity via the most commonly used mode of transport. These data are computed for each year between 1970 and 1989. Only 1986 data are reported here because of space constraints. Where data were missing, Jaeger used the CPI to extrapolate. (2) Several sources track actual ocean freight charges. These are annual averages for 1986 from Lloyd's shipping economist, London, Lloyds of London Press monthly publication. (3) The conversion factor accounts for the part of the crop that is lost due to processing or drying and is standard for each crop although in practice it may sometimes vary due to spoilage.