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# A Dynamic Theory of Primary Export Taxation: Evidence From Sub-Saharan Africa.

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# A DYNAMIC THEORY OF PRIMARY EXPORT TAXATION:

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"Agriculture is dead, assasinated by the state." [Kenneth Kaunda, 1994]

Abstract: Why do governments tax primary exports at rates that are ultimately self-defeating? The answer lies in the time inconsistent nature of a low tax policy. A government strapped for revenue always has an incentive to announce low taxes today in order to get farmers to plant. Once the harvesting season arrives however, the government can revert to a high tax policy by cheating farmers out of sunk costs. Alternatively, by sticking to a low tax policy, the government ensures continued planting and the associated future export earnings. In this paper, I show that whether a low tax policy is sustainable depends on three variables: the ratio of sunk costs to total costs; how heavily future revenue is discounted; and expected future export earnings. I use data on taxation, leadership duration and profitability to test this theory for 32 countries and six crops from Sub-Saharan Africa. Results indicate that cocoa, coffee and vanilla, the three crops with the highest ratio of sunk costs to total costs, tend to be taxed more heavily than cotton, groundnuts and tobacco, the three crops with the lowest ratio of sunk costs to total costs. Using the probability of remaining in power as a proxy for the discount factor, I also show that the likelihood of being in a low-tax regime is increasing in the discount factor. And finally, crops for which expected future profits are greatest tend to be less heavily taxed.

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## 1. Introduction

Why do African governments continue to tax agriculture so heavily?[1] Existing explanations rely mainly on the work of Bates (1981) and attribute taxation of agriculture to the need to subsidize the more politically powerful urban consumers and industrialists. This might explain why governments tax agriculture.[2] Yet, it leaves unanswered the following question: why would the government follow a pricing policy that reduces its tax base? Moreover, why have some crops been overtaxed while others have not? For example, major exporters of cocoa levied the equivalent of an average annual tax of 85% during the 1970s and 75% during the 1980s while major exporters of tobacco taxed at an annual average of only 12% during the 1970s and 6% during the 1980s. One answer may be that a pricing policy that encourages continued planting is dynamically inconsistent.

Time inconsistency is a powerful theoretical construct used by economists to explain why policymakers sometimes take actions that do not maximize social welfare. It has been used by macroeconomists to argue for rules over discretion in macroeconomic policy and by industrial organization specialists to explain intertemporal price discrimination (eg Kydland and Prescott (1977), Coase (1971), Bulow (1982)). More recently, Gilbert and Newbery (1994) argue that price regulation of investor owned utilities leaves scope for opportunistic behavior by regulators tempted to underreward past investment. Using a similar framework, Besley (1997) analyzes pricing policies for perennial crops in developing countries. To be sustainable, Besley argues that the pricing policy 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 and because African agriculture is dominated by state-run marketing boards, a tax policy that encourages planting may be difficult to sustain. In addition, by piecing together a new data set for thirty-two countries and six crops from Africa, I show that whether a low-tax policy is sustainable depends on three variables: (i) ratio of sunk costs to total costs, (ii) the governments discount factor, and (iii) expected future profitability of the crop.

[1] Even in late 1992, producer prices for the majority of Africa's major export crops were still government controlled.

[2] 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.

The unique institutional setup that continues to dominate much of Africa 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. The government's objective is to maximize the present discounted value of tax revenues plus producer surplus. Farmers maximize expected profits and decide how much to plant based on expected prices. Using this framework, two possible equilibria 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 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.

To test the predictive power of the theory, I construct a data set covering the period 1970-1989 and including annual observations on estimated tax rates and details on costs of production. Sub-periods of this twenty year period are classified 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. The empirical strategy consists of comparing predicted tax-regime based on the theory to the actual tax regime. Using contingency tables, a probit model and a linear probability model, I demonstrate the following. Crops for which the ratio of sunk costs 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 costs 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.

The remainder of the paper is organized as follows. Some background on the taxation of primary exports from Africa is provided in Section 2. Section 3 develops a simple theoretical framework for evaluating tax policy with a view toward empirical implementation. The data, empirical strategy and econometric model are described in Section 4. Results, including several tests of robustness, are presented in sections 5 and 6. Conclusions and policy implications are in section 7.

## 2. Primary Exports from Africa: Some Background

Government intervention in agriculture has a long history in Africa, starting in the colonial period. Reasons for intervention have included: (i) raising public revenue; (ii) ensuring food supplies; (iii) stabilizing farmer incomes; and (iv) exploiting market power. In most cases, intervention has proved costly and ineffective. The parastatals responsible for executing policy have become a drain on public sector budgets. Many countries that once exported food crops now import food. Farmer incomes have declined in both nominal and real terms. To a lesser extent, income of urban residents has also declined in both nominal and real terms. And finally, few countries enjoy market power.

After independence government intervention took the form of state-owned marketing boards or caisse de stabilization.[3] Virtually every country in Africa with a major export crop used this system to tax farmers directly by fixing producer prices below the world price. 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. Indirect taxation has been roughly the same in all regions of the world.

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: Krueger, Schiff & Valdes, 1993 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.

[3] Caisse is the francophone African equivalent of the Marketing Board.

Although direct causation is difficult to prove, economists and political scientists tend to agree that taxation of export crops in Africa is too high. In other words, lower taxes would increase farmers' profits and government revenues. Table 1 compares actual taxes with revenue-maximizing taxes to show how often actual tax rates for different crops have actually been greater than the revenue-maximizing tax. Since supply elasticity estimates vary substantially depending on the source, a range of revenue maximizing taxes is reported. Minimum in Table 2 refers to the revenue-maximizing tax calculated using the lowest reported supply elasticity estimate and maximum to the largest. Even using the most conservative supply elasticity estimates, Table 2 shows clearly that governments have taxed cocoa at a rate greater than the revenue maximizing tax rate 63% of the time in the 1970s and 25% of the time in the 1980s. Coffee has been overtaxed 35% of the time in the 1970s and 23% of the time in the 1980s and vanilla is always overtaxed in both periods. Using more generous elasticity of supply estimates, Table 1 shows that cocoa, coffee, cotton and vanilla have been overtaxed, respectively, 83%, 59%, 53%, and 100% of the time in the 1970s and 63%, 50%, 33%, and 100% of the time in the 1980s.

Table 2

**Comparison of Actual Tax Rates to Revenue Maximizing Tax Rates in Africa**

| | Revenue Maximizing Tax | | Frequency Greater than Revenue Maximizing Tax | | | |
|---|---|---|---|---|---|---|
| | Inelastic | Elastic | Inelastic | | Elastic | |
| | | | 1970-79 | 1980-89 | 1970-79 | 1980-899 |
| Cocoa | 69% | 36% | 63% | 83% | 25% | 63% |
| Coffee | 69% | 39% | 35% | 59% | 23% | 50% |
| Cotton | 80% | 33% | 11% | 53% | 4% | 33% |
| Groundnuts | 81% | 56% | 5% | 18% | 30% | 37% |
| Tobacco | 68% | 55% | 33% | 33% | 33% | 33% |
| Vanilla | 69% | 39% | 100% | 100% | 100% | 100% |

Notes: (1) "Inelastic" refers to results obtained using the lowest reported supply elasticity estimate and "Elastic" refers to results obtained using the highest reported supply elasticity estimate. (2) Elasticities obtained from Marian Bond (1983), Akiyama and Duncan (1992), and Coleman and Thigpen (1993). (3) Taxes are from Jaeger (1992). (4) Revenue-maximizing tax rates are derived in Appendix 1.

There are at least three points worth emphasizing about the results in Table 2. First, the generous supply elasticity estimates are long-run supply elasticity estimates while the lower supply elasticity estimates are short run supply elasticity estimates. From the standpoint of a forward looking government, it is the long-run supply elasticity estimates that are relevant. Hence, in the 1970s, four out of six crops were overtaxed a majority of the time and in the 1980s, three out of six crops were overtaxed a majority of the time. Second, the data show that taxes have been persistently high so that it is not just a case of trial and error by a government that does not know the exact value of the revenue-maximizing tax. Finally, these supply elasticity estimates do not account for the possibility of cross border smuggling which would tend to raise the supply elasticity estimates.[4]

Agricultural exports continue to be the single most important source of foreign exchange for the majority of countries in Sub-Saharan Africa. Yet, 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 (1993) 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 opportunities, the markets for coffee, cocoa, cotton and vanilla are as buoyant as ever.

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.

[4] The presence of smuggling implies the immediate availability of output to a government willing to raise its price just slightly above its neighbor's price.

While African countries have been losing ground, a few countries in Southeast Asia have successfully entered these markets over the last 20 years. Asia surged ahead in both cocoa and vanilla. Its 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. After groundnuts, the four crops that lost the most ground also happen to be the most heavily taxed. The average tax during the period 1970-1989 on cocoa was 43%, coffee 26%, cotton 38%, and vanilla 94%.

These failures have not gone completely unnoticed. As early as 1967, Bauer warned us of the likely consequences of heavy state intervention. Bates (1981) actually 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.

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 large part to the fact that members of the elite derive a large portion of their incomes from the production of export crops.[5] 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?

The data (described in section 4.1) indicate that taxes have been variable both over time and across countries. Between 1970 and 1989, direct taxes on agricultural export crops ranged from a high of 85 % to a low of 1 %, while sometimes export crops were subsidized. 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 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 a one-period model and then extended to an infinite number of periods. In both the static game and the dynamic game, the government has complete control over the price paid to farmers. The first-best policy is defined as the pricing policy that maximizes the government's welfare or the sum of tax revenue and producer surplus. In the static game, farmers anticipate that the government will underpay them. Hence, there is no planting and payoffs to all are zero. Once the relationship endures, an infinite number of Pareto

[5] Actually, she says that this explanation holds for the period 1970-1987, while Bates' (1981) explanation holds more power for

preferred subgame-perfect Nash equilibria can be supported. I am interested in determining the unique optimal outcome from the government's point of view and the conditions under which it can be supported.

### 3.1. Static Game

Farmers plant $I_{t-1}$ in period t-1 which yields an output of $Q_t$ in period t. For simplicity, I assume a fixed coefficients production function so that $I_{t-1} = Q_t$. Farmers plant either 1 or 0.[6] The government then pays farmers, $P_t^f$ , which in turn determines whether farmers harvest. If the farmgate price does not cover harvesting costs, then farmers revert to subsistence farming. Finally, the government's welfare,

$$\max_{P_t^f} W_t = (P_t^w - P_t^f)Q_t + a(P_t^f - c)Q_t \tag{1}$$

$W_t$ and farmer profits, $\pi_t$ are realized. The government maximizes the following objective function by choosing the price it pays farmers in period t, $P^f$ .[7] $P^w$ is the world price at time t, Q is output at time t, c are farmers total costs of production and $\alpha$ is the weight that the government attaches to producer surplus. $\alpha$ is restricted to be less than one since if $\alpha$ 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 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, $I_t$, 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

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the period 1960-1970.

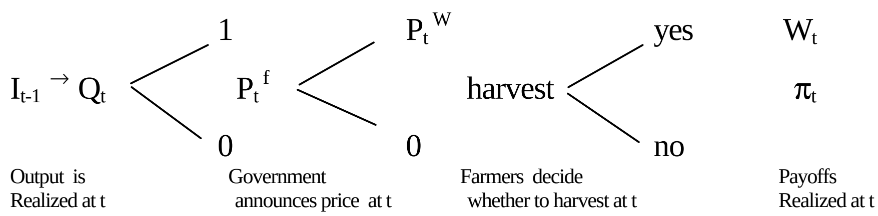
6 A continuous version of this model derived by allowing costs to vary produces similar results. The discrete version better highlights the nature of the problem.

7 A natural question is what allows me to model the government in this way. This is particularly relevant in light of all the recent literature on political economy in which the government is held hostage to various interest groups through the process

used in tending the crop.[8] 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 $Q_t$ to maximize profits in period t,

$$\max_{Q_t} E_t(p) = (P_t^f - s - h)Q_t \,. \tag{2}$$

The timing is depicted using a simple decision tree.




The static game is solved by backward induction. If farmers harvest, they get $P^f$ -s-h. If they don't harvest, they get -s. Hence, farmers will only harvest if the price they receive from the government, $P^f$ , covers harvesting costs, h. The government, knowing this, has no incentive to pay a price greater than harvesting costs, since its payoff is given by $(P^w + (\alpha\text{-}1)P^f - \alpha(s+h))Q$. Finally, farmers, choosing between planting 1 or 0 and knowing that the associated payoffs are -s and 0, will choose not to plant. Thus, any attempt by the government to announce a price greater than harvesting costs is not credible and payoffs to all are 0. The striking thing about this result is that for the inefficient outcome to be an equilibrium, it is not necessary for the government to care nothing about farmers. It is

of lobbying. This government can be thought of as a "predatory" government. For an extensive discussion of this issue, see Findlay (1990).

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

sufficient that the government care more about its own revenue than about producer surplus to end up with the "bad" equilibrium.

### 3.2. Dynamic Game and First-Best Pricing Policy

A standard result of supergame theory is that an infinite number of Pareto-preferred subgame-perfect Nash equilibria can be supported once the relationship is repeated over an infinite horizon. I am interested in determining the pricing policy that is optimal for the government, which I will call the First-Best Pricing Policy.[9] How can the government get farmers to continue planting and at the same time maximize welfare? By committing to a price that just covers the farmers' total costs, h+s, the government can get farmers to plant 1. In this case, farmers make zero profit and the government keeps the difference between the world price and what it pays to farmers.

Formally, the government solves the following problem,

$$\max E_t \sum_{t=0}^{\infty} b^t [(P_t^w - P_t^f) Q_t + a (P_t^f - (s+h)) Q_t] \;\; s.t. E_t(p \geq 0) \;\; and \;\; P_t^f \geq h. \tag{3}$$

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)+(α-1)ε and because α<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)-(α-1)ε, but farmers will no longer plant in subsequent periods.[10] Thus we have proposition 1.

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[9] The assumption is made throughout that the world price is greater than the cost of production. Also, I do not consider the possibility of a pricing policy in which the price paid to farmers could vary from year to year still leaving farmers with zero expected profit and maximizing government welfare. The justification is that the maximum is the same in both cases and a constant pricing policy is administratively simpler.

[10] 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, ($P^w$+(α-1)$P^f$ - α(s+h))Q.

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.[11]

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. As in the static 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.

### 3.3. 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.[12]

Consider the following strategy pairs. The government makes the following take it or leave it offer,

$$P_t^f = \begin{cases} s+h & if\ Q_t = 1 \\ 0 & otherwise. \end{cases} \tag{4}$$

Further, suppose that the farmers'response is given by the following,

[11] 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.

[12] 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 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.

$$I_t = \begin{cases} 1 & if \ P^f_{t-1} \geq s+h \\ 0 & if \ P^f_{t-1} < s+h \ . \end{cases} \quad (5)$$

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. This is not unrealistic. Also, notice that this behavior corresponds to the worst possible punishment the farmers could collectively impose on the government. Now, compare the gains to the government from deviation (one-period increase in revenues) with the long-run loss to the government (long-run revenue loss due to underinvestment by farmers) to find the set of parameters for which the equilibrium can be sustained. 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 given by (4) and (5) 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 by (4) and (5) are,

$$P^w_t - (s+h) + E_t \sum_{t=1}^{\infty} b^t (P^w_{t1} - (s+h)) \ . \quad (6)$$

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

$$P^w_t - as - h + E_t \sum_{t=1}^{\infty} b^t (P^w_{t1} - (s+h)) \ . \quad (7)$$

The parameter β represents the government's one-period discount factor. Subtracting equation (7) from equation (6) 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,

$$(1-a)\frac{s}{s+h} < \frac{b-b^{k+2}}{1-b}\left[\frac{P_{t+1}^{w}}{s+h}-1\right] \tag{8}$$

### 3.4. Interpretation

The left-hand side of inequality (8) is the ratio of sunk costs to total costs and represents the short-run gain from deviating from the first-best pricing policy. The right hand side of inequality (8) 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. Equation (8) can be interpreted according to each of the four variables in the inequality, s/(s+h), β, $E_t$ ($P_{t+1}^{w}$/(s+h)) and α.

(i) The set of parameters for which the first-best pricing policy is sustainable is greater the greater the ratio of harvesting costs to total costs or, the lower the ratio of sunk costs to total costs (the left hand side of the inequality). This is intuitive. When harvesting costs are high, the government's opportunities for short-run gain decrease because in any one period, the government must pay at least harvesting costs to get any output at all. The lower the harvesting costs and hence the greater the proportion of sunk costs in total costs, the greater the potential gain from underpaying farmers.

(ii) The set of parameters for which the first-best pricing policy is sustainable is greater the more the government values future revenue. Thus, deviations from the first-best pricing policy are less likely the closer the discount factor is to one. Again, the discount factor is a measure of the weight the government places on future revenue relative to revenue earned today. Usually, the discount factor is interpreted as one over one plus the interest rate and represents the time value of money. This interpretation is narrow, however, and leaves little room for variation of the discount factor from government to government. A broader definition of the discount factor may include measures of the government's probability of remaining in power, risk-aversion, and/or impatience. Although next to impossible to measure, the discount factor may also be interpreted as a policy variable that reflects the idiosyncratic nature of government decision-making under different leaders.

(iii) The set of parameters for which the first-best pricing policy is sustainable is greater the greater the future expected world price. This is because deviations today imply a greater loss in future export earnings when world prices tomorrow are expected to be high.

(iv) Finally, the set of parameters for which the first-best pricing policy is sustainable is greater the greater is $\alpha$, the weight the government places on producer surplus. The greater $\alpha$ is, the more the government cares about farmers and hence the lower the value it places on "stolen" revenue.

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 (8) 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 (8) is met, then the low-tax equilibrium prevails; if not, then I assume that the 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 (8) 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 $\alpha$, the weight on producer surplus, directly. Rather, in the non-parametric tests, I treat it as a pan-African constant whose value is between 0 and 1. In the parametric analysis, $\alpha$ 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 called $\delta(k)$ and $\delta(k) = (\beta-\beta^{k+2})/(1-\beta)$. It is expressed as a function of k to remind us that its value will depend on the length of punishment, k. The expected future profit margin is $PROF^e$ . Rewriting equation (8) with the new variable names gives the following condition for sustaining the cooperative equilibrium,

$$STC(1-a) < d(k)(PROF^e - 1) \qquad (9)$$

Of the three variables in equation (9), only STC is 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 are not directly observable because they depend on the way in which expectations are formed 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, $\beta$, as the probability of remaining in power adjusted for the time value of money at an interest rate of five percent.

### 4.1. The Data

Descriptive statistics for the four variables of interest over the period 1970-1989 are reported in Table 4 on the following page. Data on taxation are missing for some years, hence the uneven number. 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 things in common, they are a primary source of income to the exporting country and they are primarily grown by smallholders. A detailed list of the countries and crops used in this study is provided in

Table 4

**Descriptive Statistics for Period 1970 to 1989**

| Variable | Mean | Standard Deviation | Minimum | Maximum | Number of Observations |
|---|---|---|---|---|---|
| *Tax Rate* | 0.29 | 0.39 | -0.17 | 0.94 | 930 |
| *Tax Rate by crop:* | | | | | |
| Cocoa | 0.47 | 0.24 | 0.03 | 0.78 | 161 |
| Coffee | 0.41 | 0.26 | 0.07 | 0.81 | 304 |
| Cotton | 0.30 | 0.20 | 0.01 | 0.61 | 250 |
| Groundnuts | 0.31 | 0.23 | -0.17 | 0.59 | 141 |
| Tobacco | 0.34 | 0.31 | 0.08 | 0.77 | 59 |
| Vanilla | 0.93 | 0.01 | 0.92 | 0.94 | 15 |
| *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 | 1120 |
| *Expected Profit* | 1.71 | 0.26 | 1.45 | 2.36 | 6 |

Notes: (1) Countries included are listed in appendix 1. (2) 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. (3) n.a. stands for not applicable.

appendix 2. Results in section 4.3 include the 56 country-crop combinations for which data on taxation were available. Results in sections 4.4 and 4.5 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. To determine the level of taxation, Jaeger estimates the nominal protection coefficient (NPC). Broadly speaking, the NPC is the ratio of the farmgate price to the border price and is supposed to be 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. I chose to use Jaeger's estimates because he very carefully accounts for transport costs to and from the farm, processing factors and margins, and freight charges. Not accounting for these can lead to the false conclusion that a commodity is being taxed when, in fact, it is being subsidized, and vice-versa.

Data on actual costs of production for cocoa, coffee, cotton, groundnuts, tobacco, and vanilla have been obtained from several sources (see appendix 3).[13] Overall, groundnuts have the lowest ratio of sunk costs to total costs. This is because groundnuts are a relatively low-cost crop to produce, with relatively 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

[13] 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

that the ratio of harvesting costs to total costs is a technological coefficient that does not vary over time. This assumption is particularly problematic where a large portion of sunk costs comprises something other than labor and where those inputs are imported. For most of these crops, smallholders use relatively little imported inputs and so the assumption seems reasonable. Of course, actual data for all years would be preferable.

The discount factor, $\delta$ (k) is equal to ($\beta$-$\beta^{k+2)}$/(1-$\beta$). $\beta$ is estimated as one minus one over the past values of the mean time in power for each country. 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 in Ghana in 1981 was 3.14 years. Hence, Rawlings probability of remaining in power in 1982 is estimated at 31.45%. This is done to avoid the endogeneity problem between tax rates and the current probability of remaining in power. The discount factor is also adjusted for the time value of money at an interest rate of five percent. One over the mean time in power for a particular country gives us a hazard rate based on *past* realized values of time in power.[14] 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, I model this as an unobservable component of the error term. Following the recommendation of Deaton and Miller (1995), I estimate of the expected future profit margin was by taking an average of actual profits over the twenty-year period, 1970-1989. [15]

## 4.2. Empirical Strategy

Since commodity prices reached historical highs in the late 1970s and then plummeted in the early 1980s, the data are first divided into four sub-periods, 1970-1974, 1975-1979, 1980-1984 and

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[14] 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 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.

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

1985-1989.[16] Then, for each sub-period, I compute averages of the four variables, taxation, STC, $\delta(k)$, and $PROF^{e}$. This is meant to uncover regularities in the data that we may call either low-tax or high-tax regimes. At the same time, these sub-periods acknowledge the shock to commodity prices that occurred around 1980. Statistical tests are performed both for the individual sub-periods and then for the pooled data.

Second, countries are classified based on the level of actual taxes. Crops that are taxed at a rate less than or equal to the revenue maximizing tax are classified in the low-tax category; crops taxed at a rate greater than the revenue-maximizing tax are classified in the high-tax category. Long run elasticities are used for calculating the revenue maximizing taxes on the grounds that this a model that describes long-run behavior. 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.

Once the country-crop combination has been classified according to regime type (high-tax or low-tax), contingency tables are constructed to determine whether there is any relationship between regime type and each of the three explanatory variables, STC, $\beta$, and $PROF^{e}$ . The advantage of the contingency tables is that they show very clearly which crops and countries fall into the various categories for each of the three explanatory variables. The disadvantage is that this analysis does not allow a comparison of magnitudes nor does it allow for interactions. To get at these relationships, a discrete choice model is used to test the actual functional form implied by the theory. Finally, a less restrictive linear version of the same model is used to quantify and isolate the impact of each explanatory variable on the probability of achieving a low-tax regime.

### 4.3 Econometric Model

16 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.

Up to this point, we have ignored α, the government's weight on producer surplus. In principle, α will vary from country to country and so it makes sense to allow α to vary by adding to it a subscript for country giving us $\alpha_i$. Since $\alpha_i$ is not observable, I model the net benefit of a low-tax policy as an unobserved variable $y_i^*$ where,

$$y_i^* = STC_i(1-a_i) - d(k)_i(PROF_i^e - 1). \tag{10}$$

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 $y_i$ to equal one if a low-tax regime prevails and zero otherwise. It is defined by,

$$y_i = \begin{cases} 1 & if \quad y_i^* \le 0 \\ 0 & if \quad y_i^* > 0. \end{cases} \tag{11}$$

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

$$prob(y_i = 1) = prob(y_i^* \ge 0) = prob[(1-a_i) < d(k)_i(PROF_i^e - 1)]. \tag{12}$$

Estimation requires an assumption about the distribution of 1-$\alpha_{i.}$ Recall that $\alpha_i$ 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-$\alpha_i$ is log normal with mean $m$ and variance $\sigma^{2.}$

$$prob(y_i = 1) = \Phi[\frac{m}{s} + \frac{1}{s}(\log(d(k)_i(PROF_i^e - 1)/STC_i)]. \tag{13}$$

Hence,

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

To simplify notation, define the following,

$$NETBEN_i = \log[d(k)_i (PROF_i^e - 1) / STC_i]. \qquad (14)$$

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

$$prob(y_i = 1) = \Phi[g_0 + g_1 NETBEN_i]. \qquad (15)$$

As NETBEN increases, we would expect the probability of a low-tax equilibrium to increase and thus for $\gamma_1$ 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:

$$prob(y_i = 1) = \Phi\, [g_0 + g_i \ln(d(k)_i) + g_2 \ln(PROF^e - 1) + g_3 \ln(STC_i)]. \qquad (16)$$

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

## 5.0 Results

### 5.1. Bivariate Test

Contingency tables indicate that none of the three variables of interest are statistically independent of tax regime. The $\chi^2$ statistic is reported at the bottom of the tables and is calculated from the data in the table. In each of the following three tables, the null hypothesis is that regime type and the relevant explanatory variable are independent. In each table, the probability that the null hypothesis is true is reported. Table 5 indicates that the hypothesis that STC and regime type are independent can be rejected at the 99% level of confidence.

Table 5

**Ranked from Lowest to Highest Ratio of Sunk Costs to Total Costs**

| Regime | Groundnuts | Tobacco | Cotton | Cocoa | Coffee | Vanilla |
|---|---|---|---|---|---|---|
| L | B.Faso | Zambia | Burundi | Gabon | Cameroon | |
| O | Gambia | Zimbabwe | C.A.R. | Nigeria | Ethiopia | |
| W | Ghana | | Cameroon | | Gabon | |

| | | | | | | |
|---|---|---|---|---|---|---|
| TAX | Guinea<br>G.Bisau<br>Malawi<br>Mali<br>Nigeria<br>Senegal<br>Sudan | | Gambia<br>Malawi<br>Senegal<br>Sudan<br>Tanzania<br>Uganda<br>Zambia<br>Zimbabwe | | Guinea<br>Ivory Coast<br>Kenya<br>Liberia<br>Rwanda<br>Sierra Leone | |
| | 100 | 67 | 69 | 22 | 53 | 0 |
| HIGH TAX | | Malawi | Benin<br>B.Faso<br>Chad<br>Mali<br>Togo | Cameroon<br>Congo<br>Ghana<br>Ivory Coast<br>Liberia<br>Sierra Leone<br>Togo | Burundi<br>C.A.R.<br>Congo<br>Madagascar<br>Tanzania<br>Togo<br>Uganda<br>Zaire | Madagascar |
| % | 0 | 33 | 31 | 78 | 47 | 100 |

Pearson Chi2(5) = 14.51 p-value=.01

The hypothesis that regime type and probability of remaining in power are independent can be rejected at the 95% confidence level. According to Table 6, countries where the average length

Table 6

**Ranked from Highest Probability of Remaining in Power to Lowest**

| Regime | Top Quintile | Second Quintile | Third Quintile | Fourth Quintile | Bottom Quintile |
|---|---|---|---|---|---|
| LOW TAX | Gambia-Cotton<br>Gambia-Groundnuts<br>Ivory Coast-Coffee<br>Malawi-Cotton<br>Malawi-Groundnuts<br>Zambia-Cotton<br>Zambia-Tobacco<br>Zimbabwe-Cotton<br>Zimbabwe-Tobacco | Cameroon-Coffee<br>Cameroon-Cotton<br>Ethiopia-Coffee<br>Guinea-Coffee<br>Guinea-Groundnuts<br>Liberia-Cocoa<br>Liberia-Coffee<br>Senegal-Cotton<br>Senegal-Groundnuts<br>Tanzania-Cotton | C.A.R.-Cotton<br>Gabon-Coffee<br>G. Bisau-Groundnuts<br>Kenya-Coffee<br>Mali-Groundnuts<br>Rwanda-Coffee | B.Faso-Groundnuts<br>Ghana-Groundnuts<br>Nigeria-Cocoa<br>Nigeria-Groundnuts<br>Uganda-Cotton | Burundi-Cotton<br>Sierra Leone-Coffee<br>Sudan-Cotton<br>Sudan-Groundnuts |
| % | 82 | 82 | 55 | 45 | 36 |
| HIGH TAX | Ivory Coast-Cocoa<br>Malawi-Tobacco | Cameroon-Cocoa<br>Tanzania-Coffee | C.A.R.-Coffee<br>Gabon-Cocoa<br>Madagascar-Coffee<br>Madagascar-Vanilla<br>Mali-Cotton | B.Faso-Cotton<br>Chad-Cotton<br>Congo-Cocoa<br>Congo-Coffee<br>Ghana-Cocoa<br>Uganda-Coffee | Benin-Cotton<br>Burundi-Coffee<br>Togo-Cocoa<br>Togo-Coffee<br>Togo-Cotton<br>Sierra Leone-Cocoa<br>Zaire-Coffee |
| % | 18 | 18 | 45 | 55 | 64 |

Pearson Chi2(4) = 8.13 p-value=.04

of stay in power is relatively longer are less likely to end up in a high-tax regime. Eighty-two percent of the country-crop combinations where the government has the highest probability of remaining in power fall into the low-tax category. By contrast, sixty-four percent of the country-crop combinations where the government has the lowest probability of remaining in power fall into the high-tax category.

Table 7 ranks crops according to expected profitability measured as the average profit for each crop over the period 1970-1989. Vanilla and cocoa, the second and third most profitable of the six crops, end up in the high tax regime most of the time and so cannot be explained by expected future profitability. However for tobacco and groundnuts, expected future profitability does appear to be a good predictor of regime type. Overall, independence is rejected with 90% confidence.

Table 7

**Ranked from Most Profitable to Least Profitable**

| Regime | Tobacco | Vanilla | Cocoa | Groundnuts | Cotton | Coffee |
|---|---|---|---|---|---|---|
| L | Zambia | | Gabon | B.Faso | Burundi | Cameroon |
| O | Zimbabwe | | Nigeria | Gambia | C.A.R. | Ethiopia |
| W | | | | Ghana | Cameroon | Gabon |
| | | | | Guinea | Gambia | Guinea |
| T | | | | G.Bisau | Malawi | Ivory Coast |
| A | | | | Malawi | Senegal | Kenya |
| X | | | | Mali | Sudan | Liberia |
| | | | | Nigeria | Tanzania | Rwanda |
| | | | | Senegal | Uganda | Sierra Leone |
| | | | | Sudan | Zambia | |
| | | | | | Zimbabwe | |
| % | 67 | 0 | 22 | 100 | 69 | 53 |
| H | Malawi | Madagascar | Cameroon | | Benin | Burundi |
| I | | | Congo | | B.Faso | C.A.R |
| G | | | Ghana | | Chad | Congo |
| H | | | Ivory Coast | | Mali | Madagascar |
| | | | Liberia | | Togo | Tanzania |
| T | | | Sierra Leone | | | Togo |
| A | | | Togo | | | Uganda |
| X | | | | | | Zaire |
| % | 33 | 100 | 78 | 0 | 31 | 47 |

Pearson Chi2(5) = 8.61 p-value=.07

To summarize, the individual relationships between tax regime type and all three of the explanatory variables, STC, $\delta$ (k) (when measured as the probability of remaining in power), and expected future profitability are statistically significant. To account for interactions and to quantify the magnitude of the impact of these variables on policy, I turn now to the results from estimating the probit model.

## 5.2. Probit Estimates

Table 8, Model 1, on the following page reports estimation of equations (15) and (16) using standard probit techniques. Heteroskedasticity has been corrected for using White's method. 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 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 with more than 99% confidence. 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 8 because of the non-linearity of the probit specification. Therefore, average elastcities have been calculated[17] 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.

Table 8
**Tax Regime Modeled as Probit Specification, by sub-period and coefficient groups**

| | Model 1 | Model 2 | | |
|---|---|---|---|---|
| Dependent Variable: Tax Regime Type | Log Benefit cost ratio (NETBEN) | Log Sunk over total costs (STC) | Log Discount factor ($\delta(k)$) | Log Profit margin ($PROF^e$-1) |
| **A. Entire Sample** (N=128) | | | | |

[17] The average elasticity is calculated as the average over the entire sample of the point elasticity at each observation or, $\phi(x\gamma) * \gamma * 1/\Phi(x\gamma)$.

| | | | | |
|---|---|---|---|---|
| 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) | (.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.

Results of estimating the less restrictive equation (16) are also reported in Table 8 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 99% level in all cases but sub-period three. Table 8 shows clearly that the most statistically significant predictors of regime type are the ratio of sunk costs to total costs, STC, and the discount factor. Both are significant at the 99% level for the entire sample. STC is significant at the 99% 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 95% 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.

## 6.0. Robustness Tests and Econometric Issues

Results in section 5 clearly depend on a number of assumptions. These can be grouped into three broad categories. First, I imposed conditions to identify a low(high)-tax regime and the length of the "long-run" or equilibrium. Second, I ignore the possibilities of specification and measurement error. Finally, I assume at least implicitly that the quality of the data are reasonable. Justifications for and consequences of relaxing these assumptions are discussed below.

## 6.1. Timing of Regime Switch and Classification of Regime Type

Perhaps the two most problematic assumptions are (i) that the sub-periods reflect accurately the timing of regime switches and (ii) that the revenue maximizing taxes derived using long-run elasticities provide a reasonable way of classifying tax regimes. First, I address the choice of sub-periods. 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.[18] 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 tried to isolate 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 Table 7. I also ran regressions in which I varied the cutoff point for low and high tax regime in a number of ways. For example, I ran the regressions using the smallest and largest elasticity in the reported range for each crop to calculate the cutoff . I also tried the cutoff point of thirty percent used by Jaeger. While the results are generally robust to all three assumptions, the results using short run elasticities are not quite as convincing. This is because revenue-maximizing taxes cluster around seventy percent and so most regimes would be classified as low-tax regimes. 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.[19]

## 6.2. Specification and Measurement Error

Dummy variables provide one useful way of controlling for unobserved crop-specific and/or country-specific time-invariant heterogeneity ("fixed-effects"). Since the probit specification yields biased estimates in the presence of fixed effects, I chose to estimate the model using the conditional logit specification developed by Andersen (1973) and Chamberlain (1980). Unlike the probit model, it

[18] 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.

[19] 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 respones is likely to be quite substantial.

is possible to find a transformation of the logit model that yields unbiased estimates in the presence of fixed effects. An alternative would have been to use the linear probability model but there are several other problems associated with the linear probability model.

A fixed effects logit model that accounts for unobserved, time invariant heterogeneity is

$$\Pr(y_{it} = 1) = \frac{e^{y_i + j'X}}{1 + e^{y_i + j'X}} \quad , \tag{17}$$

where $\psi_i$ represent the fixed effects, X is a vector of explanatory variables, and $y_{it}=1$ if a low-tax equilibrium is observed. Since the sum of the observed outcomes ,$s_{ik}$ , is a sufficient statistic for $\psi_i$ , it is possible to eliminate the fixed effects by conditioning on observed outcomes. This procedure yields the conditional choice probability,

$$\Pr(y_i | s_i) = \frac{e^{\sum_t j'X}}{\sum_{d \in A_i} e^{\sum_{t,k} d_{tk} j'X}} \tag{18}$$

where j is the observed outcome at time t (high-tax or low-tax), and $A_i$ denotes the set of all

possible choice sequences resulting in the same vector $y_i$ :

$$A_i = \left\{ y = (y_{tk})_{t=1,\dots,T,k=0or1} \mid y_{tk} \in \{0,1\}, \sum_k y_{tk} = 1, \sum_t y_{tk} = s_{ik} \right\} \tag{19}$$

Estimation of equation (18) is straightforward and can be done using conventional multinomial logit packages. The main disadvantage of the conditional logit model is that since the fixed effects are conditioned out, we have no estimate for them. Hence, it is not possible to estimate crop-specific or country-specific choice probabilities. However, because the log odds are linear, it is still possible to calculate aggregate elasticities. These are,

$$e_{ij}^{k} = \frac{\partial \log P(i;X)}{\partial \log X_{j}^{k}} = j^{k} X_{j}^{k} \left[p_{ij} - P(j;X)\right], \tag{20}$$

where $X^k{}_j$ refers to the mean of the kth explanatory variable in alternative j (aggregated over all countries or crops in all periods), P(j;X) is the corresponding aggregate choice probability of alternative j, and $\pi_{ij}$=1 if and only if i=j.

Results of estimating equation (18) are presented in Table 9. The first row reports estimation of the simple logit model without fixed effects. This was done for purposes of comparison with the results in Table 8. As expected, the point estimates are somewhat higher but the elasticities are practically identical. This confirms that the results are not too sensitive to the choice between the logit and probit models. The next two rows report results controlling first for crop fixed effects and second for country fixed effects. A comparison between rows two and three and row one indicates that the results are generally robust to unobserved time-invariant country-specific and crop-specific heterogeneity.

Table 9
**Tax Regime Modeled using Logit and Conditional Logit Specification, with country and crop dummies**

| | Model 1 | Model 2 | | |
|---|---|---|---|---|
| Dependent Variable: Tax Regime Type | Log Benefit cost ratio (NETBEN) | Log Sunk over total costs (STC) | Log Discount factor (δ(k)) | Log Profit margin ($PROF^e$-1) |
| Coefficients | .11 | -1.35 | .08 | .01 |
| T-statistics | (5.17) | (2.54) | (2.65) | (.33) |
| Average Elasticity | .29 | -2.28 | .13 | .02 |
| Likelihood Ratio Test | 18.19 | | 34.21 | |

**B. Crop Dummies**

| | | | | |
|---|---|---|---|---|
| Coefficients | .19 | -1.68 | .11 | .35 |
| T-statistics | (2.05) | (2.46) | (1.11) | (1.32) |
| Average Elasticity | ..27 | -1.97 | .13 | .41 |
| Likelihood Ratio Test | 15.29 | | 25.24 | |
| **C. Country Dummies** | | | | |
| Coefficients | .11 | -1.82 | .11 | |
| T-statistics | (4.25) | (2.76) | (3.22) | |
| Average Elasticity | .27 | -2.27 | .14 | |
| Likelihood Ratio Test | 16.47 | | 22.51 | |

Note: (1) Since x's are in logs, elasticities are given by $\varphi^k(\pi_{ij} - P(j;X))$. (2)Averages are taken over the two conditioning events, the high-tax and low-tax equilibria. (3) Average elasticity is the average percent increase in the probability of observing a low-tax equilibrium due to a one percent increase in the value of the explanatory variable. (4)Expected profitability is omitted from the estimation with country dummies due to multicollinearity.

## 7. Conclusion and Policy Implications

This paper conducts a systematic empirical test of the time-consistency problem. Specifically, I show that tax policy toward exports crops in Africa is related to each of the following: the ratio of sunk costs to total costs, the government's discount factor, and expected future profits. These results 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. The paper also highlights a non-trivial institutional weakness associated with state-run marketing boards. Marketing boards possess monopsonistic power which makes it more difficult for the government to pursue the socially optimal tax policy. Marketing Boards are an example of what Collier (1991) calls a weak agency of restraint. And it is precisely these weak agencies of restraint that have been responsible for Africa's poor economic performance. Finally, 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.

An important question that remains unanswered is which among the possible solutions would be most politically and economically feasible in this context. In general, solutions to the time-consistency problem fall into three categories:(i)increase the severity of the punishment for deviating from the ex ante optimal policy, (ii) precommit to the ex ante optimal policy or (iii) eliminate of the source of the problem. For example, the World Bank encourages Africans to dissolve marketing boards but there is understandably strong resistance. Furthermore, it is not at all clear that eliminating marketing boards will solve the problem. This is because the source of the problem is the sunk costs; not the marketing boards themselves. Those in favor of eliminating marketing boards argue that by allowing competition, you eliminate the ability of any single buyer to set the price and ensure that farmers cover their costs of production. However, the government still has the authority to levy direct taxes and would still have an incentive to cheat farmers out of sunk costs. Alternatively, one way of precommitting to a low-tax policy might be to subsidize farmer's 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, it may be difficult to implement and monitor. A third possibility suggested by Besley (1997) involves taking away at least some of the marketing board's responsibilities thus increasing the severity of the punishment inflicted in the event the government cheats.

An important issue not dealt with in the theoretical section of this paper is how governments can restore credibility once they have "cheated"? However, the data used here lends itself to an interesting extension of this research. 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

### 1. Derivation of Revenue-Maximizing Tax

Define Tax Revenue as,

$$P^w Q(P^f) - P^f Q(P^f) \tag{A.1}$$

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 $P^f$. To find the farmgate price that maximizes tax revenue, differentiate equation (1) with respect to $P^f$. The result is,

$$d\,TR/d\,P^f = P^w\, dQ/d\,P^f - Q(P^f) - P^f\, dQ/d\,P^f$$

$$= Q\, P^w / P^f\, (dQ/dP^f \times P^f/Q) - (dQ/dP^f \times P^f/Q)\, Q - Q$$

$$= Q\, (P^w / P^f\, \varepsilon^s - \varepsilon^s - 1) \tag{A.2}$$

Setting equation (A.2) equal to zero, we solve for the revenue maximizing tax,

$$t^* = 1 / ( 1 + \varepsilon^s ) , \qquad (A.3)$$

where $t^*$ is defined as the percent of the world price received by farmers or $P^f / P^w$.

## 2. Crop-Specific Revenue-Maximizing Taxes

Table A.1:Revenue-Maximizing Tax Rates
by crop and minimum and maximum elasticity of supply

| Crop | $\varepsilon^s_{min}$ | $\varepsilon^s_{max}$ | $t^*_{min}$ | $t^*_{max}$ |
|---|---|---|---|---|
| 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 % |

## Appendix 2

Table A.2:Countries and Crops included in Analysis

| Country | Crop | | | | | |
|---|---|---|---|---|---|---|
| | Cocoa | Coffee | Cotton | Groundnuts | Tobacco | Vanilla |
| Benin | | | X | | | |
| Burkina Faso | | | X | X | | |
| Burundi | | X | X | | | |
| Cameroon | X | X | X | | | |
| Central African Republic | | X | X | | | |
| Chad | | | X | | | |
| Congo | X | X | | | | |
| Cote d'Ivoire | X | X | | | | |
| Ethiopia | | X | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Gabon | X | X | | | | |
| Gambia | | | X | X | | |
| Ghana | X | | | X | | |
| Guinea | | X | | X | | |
| Guinea Bisau | | | | X | | |
| Kenya | | X | | | | |
| Liberia | X | X | | | | |
| Madagascar | | X | | | | X |
| Malawi | | | X | X | X | |
| Mali | | | X | X | | |
| Nigeria | X | | | X | | |
| Rwanda | | X | | | | |
| Senegal | | | X | X | | |
| Sierra Leone | X | X | | | | |
| Sudan | | | X | X | | |
| Tanzania | | X | X | | | |
| Togo | X | X | X | | | |
| Uganda | | X | X | | | |
| Zaire | | X | | | | |
| Zambia | | | X | | X | |
| Zimbabwe | | | X | | X | |

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

## Appendix 3: 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 |

Table A3 (*Continued*)

| | | | | | | |
|---|---|---|---|---|---|---|
| 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 |

Notes:

(1) No distinction is made between arabica and robusta in the analysis. 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.

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