A Political Economy Model of Agricultural Taxation, R&D, and Growth in Africa

Margaret S. McMillan
Department of Economics
Tufts University

and

William A. Masters
Department of Agricultural Economics
Purdue University

Discussion Paper 99-03
Department of Economics
Tufts University

Department of Economics
Tufts University
Medford, MA 02155
(617) 627-3560
A Political Economy Model of Agricultural Taxation, R&D and Growth in Africa

May 1998
rev. January 1999

Margaret S. McMillan and William A. Masters
Department of Economics and Dept. of Agricultural Economics
Tufts University and Purdue University
Medford MA and West Lafayette, IN 47907
617 627 3217 and 765 494 4235
mmcmilla@emerald.tufts.edu and masters@agecon.purdue.edu

Abstract
Why do so many African governments adopt predatory policies towards the private sector, when pro-growth reforms might yield greater tax revenues as well as higher national income? In this paper we first use a growth regression which, controlling for the factors identified in previous studies, identifies taxation of primary exports and investment in agricultural R&D as independently significant correlates of economywide growth. We then posit a game-theoretic political economy model in which the government sets these two policy instruments in strategic interaction with domestic producers. We find significant evidence that some African policymakers could be trapped in a low-growth equilibrium, which they can break only when changes in game structure (and hence institutions such as political parties) allow them to make credible commitments to pro-growth, low-tax/high-investment strategies.

Acknowledgements
Many thanks to Andrew Warner and Phil Pardey for sharing data, and to USAID’s collaborative agreement on Equity and Growth through Economic Research (EAGER) for financial support.
Growth and Policy in Africa:
A strategic-interaction model of predatory regimes

I. Introduction

Is Africa destined to grow more slowly than other regions of the world for immutable reasons, or can reforms help the region converge to the real income levels enjoyed elsewhere? And if convergence were feasible, what factors could explain the persistence of policies that inhibit growth? This paper contributes to the literature on growth in Africa through an econometric model of conditional convergence, linked to a game-theoretic model of policy choice. Our objective is to use variability within Africa to identify factors that have helped Africa’s better performers succeed, in hopes of explaining the persistence of slow growth elsewhere and informing the design of successful reforms.

During the 25 years since Independence, much of Africa has experienced a substantial decline in living standards – but during the same period a dozen African countries saw sustained growth. Using a new panel data set we show that two types of policy—taxation of primary exports and spending on agricultural research—account for a significant fraction of the cross-country variation in economic growth, controlling for the factors already identified by the work of Sachs and Warner (1997) or Easterly and Levine (1997). Our game-theory model then attempts to explain these policy choices in terms of structural factors. Empirical tests support the model. Although much variation in policy remains unexplained, our approach highlights the role of structural conditions that influence policy choice, and helps specify the changes needed to sustain policy reform and thereby accelerate growth.

II. Theories of Economic Growth and Policy Choice

To explain economic growth we adopt a conditional-convergence model, based on the pioneering work of Abramovitz (1986), Baumol (1986), DeLong (1988), and Barro (1991, 1992). This literature is formalized in Barro and Xala-I-Martin (1995:88),
and our application to Africa builds on Savvides (1995), Sachs and Warner (1997), Easterly and Levine (1997) and Temple (1998). A central conclusion of this literature is that adopting growth-oriented policies might allow African countries, like other low-income nations, to converge on the income levels of wealthier regions. But what explains the persistence of growth-inhibiting policies? To explain policy choice we construct a repeated-game model designed to identify those conditions under which a government could not credibly commit itself to pro-growth policy, so that successive political regimes remain in a low-growth equilibrium with predatory policies and limited private investment or productivity growth. Breaking out of this equilibrium would require structural changes in political institutions, including for example the creation of long-lived political parties whose members discipline one another in pursuit of a collective commitment to growth.

**Economic Growth**

In the Barro (1991) framework used by Sachs and Warner (1997), economic growth is a transitional process in which countries are adjusting gradually from current per-capita income to their steady-state level of per-capita income. The production function is Cobb-Douglas, and in the neighborhood of the steady state, the time path of the log of per capita income is given by

\[
y(t) = (1-e^{\beta t}) y^{ss} + e^{\beta t} y(0)
\]

According to this equation, the log of real GDP is equal to \(y(0)\) at time 0 and, if \(\beta < 0\), \(y^{ss}\) in the limit as \(t\) approaches infinity. In between, output is on a path that is concave with respect to time, that is, growth will be fast at first and then will slow down as real GDP approaches the steady state. Growth will also be faster the larger is the initial income gap \(y^{ss} - y(0)\). In the cross-country empirical implementation of (1), \(y^{ss}\) may be thought of not as a constant value to which the economy is converging, but as a variable with its own trend growth rate.

Equation (1) embodies the idea that the transition from current GDP to potential GDP (or the potential GDP trend line) takes time. Empirical estimates of \(\beta\), the
convergence parameter governing the speed of adjustment, typically find that at least 15 years are needed to cut the income gap in half. But convergence rates are not necessarily uniform across countries: they are conditional on the country’s own potential GDP level (or growth rate). Here the growth-regression literature turns to the general framework of the Solow growth model, in which steady state output per worker is a function of the national savings rate and the level of total factor productivity or efficiency. In a standard Solow model, savings are assumed to be a fixed fraction of output, so income converges to a constant output per unit of efficiency-adjusted labor. Any growth in steady-state income is due to technical change.

The universe of variables that potentially affect steady-state growth has been surveyed by Xala-I-Martin (1997). In regressions on a worldwide sample of over 80 countries including 24 in Africa, Sachs and Warner (1997) identify seven variables of empirical significance. Two of these variables are immutable parameters of geographic location (tropical climate and landlockedness), two have both geographic and policy influences (life expectancy and natural resource dependence), and three represent the outcome of many government policies (openness, institutional quality, and government savings). Temple (1998) provides further empirical tests combining these variables with those of Easterly and Levine (1997) and others, finding the general results to be robust to outlier exclusion and specification tests.

For this paper we look within Africa and extend previous work to consider two very specific policy choices, so as to be able to link the economic-growth model to a political-economy model of government behavior. Our central hypothesis is that a major determinant of African growth has been governments’ taxation of primary exports and investment in R&D for agriculture, which are key sources of economic rents and productivity growth in these very capital-scarce countries. The importance of these two variables for economy-wide growth, and the degree to which so many African governments pursued tragically self-destructive policies, sets up our next task: to construct a model that links policy choices to observable features of African economies, so as to assess Africa’s future prospects for reform and growth.
Policy Choice

Figure 1 (on the last page) summarizes the sequence of decisions in a repeated-game model of interactions between government and farmers, in which government chooses how much to tax primary exports and invest in agricultural R&D, while farmers decide how much to produce. The model builds on Gilbert and Newbery (1994) and related work by Besley (1992). In this formulation, the game lasts two periods in order to capture the idea that payoffs to R&D spending are delayed. The game proceeds as follows. In period $t$, the government moves first and announces a support price and how much it will invest in R&D. Farmers then decide whether to plant and if they plant, whether to harvest. The government then pays farmers which in turn determines whether farmers harvest. In period $t+1$, the game continues if and only if farmers receive a price in period $t$ that is equal to or greater than their total costs of production. The game in period $t+1$ is identical to the game in period $t$ except that output is now increased by an amount equal to $\gamma$ because R&D has increased productivity. If the game lasts only two periods, there is a unique equilibrium at the strategies and payoffs (10) which consists of zero planting and no spending on R&D: producers expect the government to act opportunistically, so any investment would be lost.

Once the game is repeated, an infinite number of equilibria are possible. Our concern is to identify the circumstances leading to a pro-growth equilibrium with sustained planting and spending on R&D, assuming that if this is not sustainable players revert to the unique Nash equilibrium of the two period game. For a pro-growth policy to be sustainable, the cost of predatory actions must be greater than their benefits. We must therefore specify what happens when the government does act opportunistically: here we assume that if the government covers only harvesting costs and does not invest in R&D for any one period, farmers revert to the subsistence-farming equilibrium for $k$ periods. Whether this cost is enough to stop the government from acting opportunistically depends on how heavily the government discounts future earnings.
Table 1. Payoffs associated with alternative strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Government</th>
<th>Farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>$(P^w - (s+h)) \times 1 - rd + \beta [(P^w - (s+h))(1 + \gamma) - rd]$</td>
<td>0</td>
</tr>
<tr>
<td>(2)</td>
<td>$(P^w - (s+h)) \times 1 - rd + \beta [(P^w - h)(1 + \gamma) - \alpha s - rd]$</td>
<td>$-\delta (1 + \gamma) s$</td>
</tr>
<tr>
<td>(3)</td>
<td>$(P^w - (s+h)) \times 1 - rd + \beta [(P^w - (s+h))(1 + \gamma)]$</td>
<td>0</td>
</tr>
<tr>
<td>(4)</td>
<td>$(P^w - (s+h)) \times 1 - rd + \beta [(P^w - h)(1 + \gamma) - \alpha s]$</td>
<td>$-\delta (1 + \gamma) s$</td>
</tr>
<tr>
<td>(5)</td>
<td>$(P^w - h) \times 1 - \alpha s - rd$</td>
<td>$-s$</td>
</tr>
<tr>
<td>(6)</td>
<td>$(P^w - (s+h)) \times 1 + \beta [(P^w - (s+h)) - rd]$</td>
<td>0</td>
</tr>
<tr>
<td>(7)</td>
<td>$(P^w - (s+h)) \times 1 + \beta [(P^w - h) - \alpha s - rd]$</td>
<td>$-\delta (1 + \gamma) s$</td>
</tr>
<tr>
<td>(8)</td>
<td>$(P^w - (s+h)) \times 1 + \beta [(P^w - (s+h))]$</td>
<td>0</td>
</tr>
<tr>
<td>(9)</td>
<td>$(P^w - (s+h)) \times 1 + \beta [(P^w - h) - \alpha s]$</td>
<td>$-\delta (1 + \gamma) s$</td>
</tr>
<tr>
<td>(10)</td>
<td>$(P^w - h) \times 1 - \alpha s$</td>
<td>$-s$</td>
</tr>
</tbody>
</table>

Note: Strategy numbers refer to the decision tree in Figure 1.

In the infinitely repeated game, the payoffs associated with a low-tax policy and continued spending on R&D are the following:

\[ [P^w_i - (s + h)] \times 1 - rd + E \sum_{i=1}^{\infty} \beta^i [P^w_{i+1} - (s + h)(1 + \gamma) - rd]. \]

Payoffs from deviating, assuming \( k \) periods of “punishment”, are,

\[ [P^w_i - h - \alpha s] \times 1 + k \text{ periods of zero} + E \sum_{i=1}^{\infty} \beta^{i+k} [P^w_{i+k+1} - (s + h)(1 + \gamma) - rd]. \]
The parameter $\beta$ represents the government’s one-period discount factor, $s$ are sunk costs, $h$ are harvesting costs $P^w_t$ is the world price at time $t$, $rd$ is spending on research and development and $\gamma$ is the increase in output associated with R&D. Subtracting equation (3) from equation (2) gives the conditions under which the high-growth outcome is sustainable, with continued low taxes, efficient production and continued investment in R&D. To simplify the final expression, we assume that $E_t P_{t+k}^w$ is the same for all periods, and that $k$ is infinitely long. This yields the following condition for governments to choose the high-growth strategy:

$$ (4) \quad \text{STC} \ (1-\alpha) < \delta (k) \ [(EPROF-1)(1+\gamma) - \frac{rd}{s+h}]. $$

The left-hand side of inequality (4) is the ratio of sunk costs to total costs and represents the short-run gain from acting opportunistically. The right hand side of inequality (4) is the present discounted cost of doing so. With an infinitely long $k$, farmers taxed by an opportunistic government are expected to retreat from the market forever, so the government loses the present discounted value of all future tax revenue. Equation (4) allows us to test the theory empirically, as each of its variables has an implication for the level of taxation and investment in R&D. They are discussed in turn below.

**Ratio of Sunk Costs to Total Costs (STC)**

The set of parameters for which the first-best 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). 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.
Discount Factor \((\delta (k))\)
The set of parameters for which the first-best policy is sustainable is greater the more the government values future revenue. Thus, deviations from the first-best 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, and the role of political institutions in imposing collective discipline. For our empirical work we will use the government’s probability of remaining in power, to measure just one major influence on its discount rate.

Expected Future Profits (EPROF)
The set of parameters for which the first-best 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. Expectations may be formed in various ways; for our empirical work we use a simple average of past profits.

Weight on Producer Surplus \((\alpha)\)
The set of parameters for which the first-best 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. Since we have no empirical counterpart to this variable, we leave it unobserved.

Net Benefit of R&D \([\delta (k) (\gamma f - rd/(s+h))]\)
The set of parameters for which the first-best policy is sustainable is greater the greater is the expected productivity increase due to R&D spending, \(\gamma f\). This is because the government has more to lose in the future by heavily taxing today and not investing in R&D the greater is \(\gamma f\). On the other hand, the set of parameters for which the first-best policy is sustainable is greater the lower the cost of R&D relative to total costs. The greater \(rd/(s+h)\), the less the government has to lose in the future by heavily taxing today and not investing in R&D. The
important point here is that the benefits of R&D spending are delayed and hence, although spending on R&D could provide the government with more revenue and society with greater welfare in the long run, R&D policy is subject to a time consistency problem.

III. Data and Results

The data used to estimate the growth equations and test our political-economy model come from several sources. First, we replicate the work of Sachs and Warner (1997) using their data. Then, we identify the key role of policy choices in explaining intra-African variation using data on primary-export taxation from Deaton and Miller (1995) and Jaeger (1992), plus data on R&D investments from Pardey, Alston and Rosenboom (1998). Finally we test the policy-choice model using data on the structure of production costs from Martin (1991). Complete documentation of the data sources, along with some additional results not reported here, are provided in McMillan (1998).

Can Agricultural Policy Explain Growth?

The regression results presented in Table 1, Column 1, show that five of the nine variables used by Sachs and Warner to explain sources of slow growth in Africa relative to the rest of the world do a poor job of explaining growth within Africa. Two of the key Sachs-Warner variables, tropical climate and open trade regime, have very little variance in the African subsample: out of 23 countries, 20 are entirely tropical and 17 are classified as completely closed. Three other Sachs-Warner variables, landlockedness, natural-resource exports, and institutional quality, also lose their significance in a within-Africa regression.

Column 2 of Table 1 presents estimates with the same data when the insignificant variables are dropped, showing that the variables providing robust explanation of growth within Africa are initial income, life expectancy, government savings and relative growth in the economically active population. Initial income captures the idea of conditional convergence, consistent with diminishing marginal returns on reproducible capital. Life expectancy captures the impact of health and human capital on both total savings and total factor productivity. Government savings affect growth through the total savings rate, and
perhaps also through the efficiency of investment. Relative growth in the economically active population affects growth via the dependency ratio and its influence on total factor productivity.

For Column 3 of Table 1, we use the same data but expand the sample size to all 32 African countries for which the five retained variables are available. Expanding the sample slightly raises the coefficient and significance of life expectancy, and slightly lowers the coefficient without changing the significance of growth in economically active population, but otherwise has little effect on the regression results.

Columns 4-9 present results from regressions that include taxation of primary exports, and the regressions in columns 7-9 include investment in agricultural R&D as well. Each variable is tested with three equations, corresponding to three different measures of taxation. Columns 4-5 and 7-8 use a dummy variable constructed by Deaton and Miller (1995) to indicate whether a country pays producers a relatively low proportion of the world price, for a weighted average of the country’s most important exports. Columns 4 and 7 use the Deaton and Miller dummy for the period 1970-1975, while columns 5 and 8 use a similar variable for the period 1970-1979. Finally, columns 6 and 9 use a continuous measure, the nominal protection coefficient (NPC), or ratio of domestic producer prices to world prices. Note that the signs of the two types of measures are reversed: a positive dummy indicates more taxation, whereas a larger NPC indicates less taxation.

The effect of taxation is significant in all but one of the six regressions. The magnitude of effect is quite large: moving between the low-tax and high-tax categories is associated with a change of about one percent in annual real GDP growth, and changing the NPC of 0.1 is associated with a change in the growth rate of 0.2 percent per year. Furthermore, the effect of taxation on growth is largely independent of the other variables’ explanatory power, as their estimated coefficients and significance are little affected.
### Table 1. Results of Growth Regressions

Dependent variable: Growth of per capita PPP-adjusted GDP, 1965-90

<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>-1.76</td>
<td>-1.19</td>
<td>-1.39</td>
<td>-1.47</td>
<td>-1.48</td>
<td>-1.53</td>
<td>-2.24</td>
<td>-2.02</td>
<td>-2.12</td>
</tr>
<tr>
<td></td>
<td>(3.74)</td>
<td>(3.59)</td>
<td>(4.63)</td>
<td>(5.78)</td>
<td>(5.02)</td>
<td>(3.56)</td>
<td>(7.47)</td>
<td>(6.09)</td>
<td>(4.03)</td>
</tr>
<tr>
<td>Openness</td>
<td>26.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.51)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open*initial</td>
<td>-4.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.59)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landlocked</td>
<td>.84</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.34)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life Expectancy</td>
<td>.13</td>
<td>.11</td>
<td>.15</td>
<td>.16</td>
<td>.14</td>
<td>.13</td>
<td>.15</td>
<td>.14</td>
<td>.16</td>
</tr>
<tr>
<td></td>
<td>(2.74)</td>
<td>(2.13)</td>
<td>(3.97)</td>
<td>(4.37)</td>
<td>(3.68)</td>
<td>(2.31)</td>
<td>(3.66)</td>
<td>(4.08)</td>
<td>(2.31)</td>
</tr>
<tr>
<td></td>
<td>(5.48)</td>
<td>(7.73)</td>
<td>(6.26)</td>
<td>(8.83)</td>
<td>(7.49)</td>
<td>(3.01)</td>
<td>(2.15)</td>
<td>(3.05)</td>
<td>(2.78)</td>
</tr>
<tr>
<td>Tropical Climate</td>
<td>.82</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.08)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional Quality Index</td>
<td>.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.89)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural Resource Exports/GDP</td>
<td>.59</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.34)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Growth in e.a. population</td>
<td>4.2</td>
<td>2.73</td>
<td>2.03</td>
<td>1.28</td>
<td>1.82</td>
<td>2.21</td>
<td>2.06</td>
<td>2.28</td>
<td>3.28</td>
</tr>
<tr>
<td></td>
<td>(3.23)</td>
<td>(2.39)</td>
<td>(2.36)</td>
<td>(2.09)</td>
<td>(2.34)</td>
<td>(1.47)</td>
<td>(2.61)</td>
<td>(2.72)</td>
<td>(2.09)</td>
</tr>
<tr>
<td>Taxation</td>
<td>-1.03</td>
<td>-.73</td>
<td>2.34</td>
<td>-1.01</td>
<td>-.86</td>
<td>1.96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.19)</td>
<td>(1.96)</td>
<td>(2.43)</td>
<td>(2.92)</td>
<td>(1.86)</td>
<td>(0.66)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&amp;D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.21</td>
<td>0.11</td>
<td>0.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.51)</td>
<td>(1.34)</td>
<td>(0.12)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>.87</td>
<td>.81</td>
<td>.76</td>
<td>.84</td>
<td>.81</td>
<td>.69</td>
<td>.95</td>
<td>.93</td>
<td>.91</td>
</tr>
<tr>
<td>No. of Countries</td>
<td>23</td>
<td>23</td>
<td>32</td>
<td>32</td>
<td>32</td>
<td>24</td>
<td>17</td>
<td>17</td>
<td>11</td>
</tr>
</tbody>
</table>

Note: Absolute t-statistics are in parentheses.
Columns 7-9 of Table 1 test for the correlation between agricultural R&D spending and growth, using data on total expenditure from Pardey, Alston and Roseboom (1998), expressed as a percentage of agricultural GDP for the period 1961-1991. The three columns differ only in the measure of taxation used. Including both R&D and taxation in the same equation causes the t-statistics to differ according to the measure of taxation used, perhaps due to differences in the degree of collinearity between R&D and different measures of taxation. The strongest result is obtained under specification 7, using Deaton and Miller's measure of taxation for the 1970-75 period only. The estimated parameter is large and significant: it implies that increasing the share of agricultural GDP re-invested in agricultural R&D by one percent (from 3 to 4 percent, for example) is associated with a rise in annual per-capita GDP growth of over 0.2 percent (e.g. from 3 to 3.2 percent per year).

Can economic structure explain policy choice?

We have seen that primary-export taxation and agricultural R&D are strong determinants of growth. This is interesting but unless we also understand what determines policy choice, we still won't know what institutional changes could influence policies and hence increase economic growth. In this section we test our repeated-game model of the interaction between government and farmers. The model predicts that three structural factors, the variables STC, $\delta(k)$ and EPROF, will help explain policy outcomes. Table 2 presents regression results estimating the strength of the correlations between those variables and four measures of policy choice: Taxdum1 (the Deaton and Miller measure for individual crops), Taxdum2 (the same measure aggregated to the country level), NPC (the continuous measure of taxation), and R&D intensity (which matters in itself, and may also be correlated with unobserved other features of good governments).

Columns 1 and 3 present the results of crop-specific regressions, with a sample size of 128 crops and countries. By far the largest and most significant coefficient is on the STC variable, which is of the expected sign and is of surprisingly large magnitude: a one-unit change in the level of STC is associated with a five percent increase in the probability of adopting predatory policies towards that crop. Changes in the $\delta(k)$ variable are also significant, and also have a relatively large magnitude: a one-unit change in $\delta(k)$ is associated with a 0.1-unit change in the probability that government will adopt predatory
policies. The level of EPROF is not significant in these regressions, perhaps because it is very poorly measured as we use average historical profitability to proxy expected future profits.

To explain R&D intensity, which we observe at the country level and not for individual crops, we must turn to a country-level regression with a smaller sample size. Results are shown in column 4, and for comparison we present a similar regression to explain taxation levels in column 2. Since each crop has different structural characteristics (STCs and EPROF), we construct an aggregate measure for each country of the incentives for government to commit to a pro-growth strategy, and forego predatory policies. This commit index is calculated as the following weighted average over all crops \((j)\) in each country \((i)\):

\[
commit_{country \ i} = \sum_{crops} \delta (k)(PROF_{crop \ j}^c - 1) \frac{\text{revenue crop } j}{\text{revenue all crops}}
\]

A higher level of commit corresponds to larger relative benefits of sustaining the pro-growth policy package, so we hypothesize that it will be correlated with lower taxation and higher R&D intensity. In our empirical test, regression coefficients are indeed of the expected sign, and significantly so. The adjusted \(R^2\) is under 10 percent, indicating that the commit index explains a relatively small fraction of the variance in taxation or R&D intensity, with even that level of explanatory power is unexpectedly high for such a sparse model using cross-sectional data.
### Table 2. Determinants of Tax Regime and R&D Spending for Agriculture

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>Taxdum1</th>
<th>Taxdum2</th>
<th>NPC</th>
<th>R&amp;D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanatory variables</td>
<td>probit</td>
<td>ols</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STC</td>
<td>5.02</td>
<td>-1.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.87)</td>
<td>(4.18)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>δ(k)</td>
<td>-.19</td>
<td>.004</td>
<td>.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.01)</td>
<td>(1.19)</td>
<td>(3.64)</td>
<td></td>
</tr>
<tr>
<td>PROF&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-.12</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.47)</td>
<td>(0.77)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>commit</td>
<td>-.51</td>
<td>-.41</td>
<td>.13</td>
<td>.13</td>
</tr>
<tr>
<td></td>
<td>(3.73)</td>
<td>(2.01)</td>
<td>(2.55)</td>
<td>(2.59)</td>
</tr>
<tr>
<td>likelihood ratio</td>
<td>33.2</td>
<td>16.91</td>
<td>4.28</td>
<td></td>
</tr>
<tr>
<td>adjusted R&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td>.23</td>
<td>.05</td>
<td>.17</td>
</tr>
<tr>
<td>No. Observations</td>
<td>128</td>
<td>128</td>
<td>32</td>
<td>128</td>
</tr>
</tbody>
</table>

absolute t-statistics in parentheses
IV. Conclusion

This paper presents a model of policy choice aimed at explaining why so many African governments adopt self-defeating predatory policies towards the private sector, when pro-growth reforms would yield greater incomes for both government and the private sector.

First we adapt a standard growth-regression model to demonstrate that two kinds of policy, taxation of primary exports and investment in agricultural R&D, significantly explain economywide growth. Then we derive a political-economy model in which the government sets the level of these two policy instruments in a strategic game with domestic producers. One equilibrium has the government commit to low taxes with investment in R&D, so as to elicit high levels of production and economic growth. Another possible equilibrium involves high tax rates and no investment, to which the economy responds with low production and economic growth.

In a repeated game, the government can credibly commit to the high-growth strategy only under certain conditions. We derive an equation linking policy choice to potentially observable characteristics of the sector, notably the share of sunk costs in total costs (and hence the potential payoff to exploitation by a rent-seeking government), the government’s discount rate and the product’s expected future profitability (and hence the cost of opportunistically exploiting producers, who would then withdraw from the market). Our empirical test finds considerable support for the model. Our preliminary conclusion is that African countries have been trapped in a low-growth equilibrium of opportunistic policies and low investment, so that reforms enabling governments to make credible pro-growth commitments are likely to have a high payoff.
References cited


Figure 1
Timing of Interactions between Government’s Pricing Policy & Decision of Whether to Invest in R&D and Farmer’s Decision whether to Plant

- Government decides to invest in R&D
- Farmers decide whether to plant
- Farmers decide whether to harvest
- Government pays farmers for output
- Farmers harvest output

$R&D \equiv$ research and development expenditures

$P^f \equiv$ actual farmgate price (paid by government to farmers)

$TC \equiv$ farmers’ total costs of production per unit of output

$HC \equiv$ farmers’ harvesting costs per unit of output

(1) - (10) are strategies considered as equilibrium candidates, payoffs associated with these strategies are listed on the following page
TUFTS UNIVERSITY
ECONOMICS DEPARTMENT

DISCUSSION PAPERS SERIES 1999

99-03 Margaret S. MCMILLAN and William A. MASTERS; A Political Economy Model of Agricultural Taxation, R&D, and Growth in Africa.

99-02 MASTERS, William A. and Margaret S. MCMILLAN; Ethnolinguistic Diversity, Government Expenditure and Economic Growth Across Countries.

99-01 MCMILLAN, Margaret S.; Foreign Direct Investment: Leader or Follower?

Discussion Papers are available on-line at

http://www.tufts.edu/as/econ/papers/papers.html