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dynamically interact via a fiscal process that effectively allows open access to the aggregate capital stock. In equilibrium, this leads to slow economic growth and a 'voracity effect', by which a shock, such as a terms of trade windfall, perversely generates a more than proportionate increase in fiscal redistribution and reduces growth. We also show that a dilution in the concentration of power leads to faster growth and a less pro-cyclical response to shocks.

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and terms of trade improvements have failed to spur an increase in incomes.

In this paper, we argue that political economy considerations are critical in explaining these anomalies. In many such countries, private property rights are insecure and revenue streams to any individual or group are vulnerable to expropriation by other agents. This expropriation can be mediated via national fiscal policy, via an appropriate system of taxes and transfers. Groups with the effective power to seek transfers can include regional or provincial governments within a federal system; member parties within a coalition; individual ministers within a cabinet; labour unions or industrial conglomerates; and tribal or ethnic leaders. Transfers can only be obtained if a country lacks countervailing institutions that limit discretionary redistribution and it is in countries with a weak socio-political infrastructural framework that we should expect to see such problems arise.

We model such an economy as composed of multiple powerful groups, each possessing the capacity to obtain transfers, via the fiscal process, from all other groups. There are two technologies: one is taxable and subject to expropriation, and so is in effect common property, and the other is private. By assumption, the private asset offers a lower rate of return so there is an incentive to leave some resources invested in the common technology. The multiple groups act non-cooperatively and each period must decide how much to appropriate from the common asset, how much to invest in the private asset and how much to consume. We focus on the Markov perfect interior equilibrium to this differential game.

We show that the growth rate is lower than in the first-best case when there is a representative agent or when groups coordinate or when there are barriers to fiscal redistribution. In the second-best case, however, the growth rate is an inverse function of the number of powerful groups: the greater the number, the more diluted is the effective power of each one and the lower is the equilibrium appropriation rate.

We also show that an increase in the raw rate of return of the taxable, efficient asset leads to a more than proportionate increase in discretionary redistribution. We label this the 'voracity effect': not only does appropriation rise, but it actually increases by more than the size of the shock. We can interpret an increase in the raw rate of return as a positive productivity or terms of trade shock and the implication is that there is a reallocation of endowments or with deep ethnic and tribal divisions have had poor growth performance and that foreign aid transfers are often diverted to non-productive activities.

fall, perversely generates a more than proportionate increase in fiscal redistribution and reduces growth. We also show that a dilution in the concentration of power leads to faster growth and a less procyclical response to shocks. (*JEL* F43, O10, O23, O40)

Two common characteristics of developing countries that have grown slowly in the last several decades are the absence of strong legal and political institutions and the presence of multiple powerful groups in society. In this paper, we analyze a dynamic model of the economic growth process that contains these features. We employ the model to ask three questions. First, why does the combination of a weak institutional structure and fractionalization inside the governing elite generate slow growth? Second, what is the relationship between the concentration of power (the number of powerful groups) and growth? Third, why do such countries not only grow slowly but also frequently respond in a perverse fashion to favorable shocks, by increasing more than proportionally fiscal redistribution and investing in inefficient capital projects?

The importance of weak institutions and fractionalization in explaining poor growth performance has been highlighted in the empirical literature. Furthermore, country studies have recently emphasized these features in explaining procyclical fiscal policies and a decline in the quality of investment in response to favourable shocks. However, a theoretical analysis that explicitly jointly links these perverse responses and the prevalence of low growth to the primitive characteristics of an economy has been lacking.[1] This provides the motivation for our paper.

We focus on the fiscal process as an important arena in which powerful groups interact in a society with a weak legal-political infrastructure and emphasize discretionary fiscal redistribution as a key mechanism by which such groups appropriate national resources for themselves. Examples of powerful groups are provincial governments that extract transfers from the center, strong unions and industrial conglomerates that seek protection, and patronage networks that obtain kickbacks from public works.[2]

We consider a two-sector economy. The formal sector employs the efficient production technology but is subject to taxation; the shadow sector enjoys a less productive technology but is non-taxable. For instance, the shadow sector may represent the domestic informal sector, sectors sheltered from international competition or, if capital is mobile, secret overseas bank accounts that are out of the reach of the domestic fiscal authorities. In each case, it should be clear that the raw rate of return in the inefficient sector is lower than in the formal one, especially in the case of LDCs.

formal sector of the economy are not truly private. Since transfers must be financed by some form of taxation, higher transfers to one group result in higher taxes for the entire formal sector of the economy. In order to protect their profits from arbitrary taxation, agents transfer part of their resources to where they are free from this taxation. Agents can do this by investing in the shadow sector which is out reach of fiscal authorities. Typically these investments yield a lower raw rate of return.

We model the interaction of the powerful groups as an infinite horizon dynamic game. In this game each group has open access, via the fiscal process, to the capital stocks that other groups have in the formal sector. In contrast, capital in the shadow sector is truly private. The solution concept we use is Markov perfect equilibrium, which restrict strategies to be functions of payoff relevant state variables only. History dependent strategies, such as trigger strategies are not permitted.

Our first point is that if there do not exist institutional barriers to discretionary redistribution, the existence of powerful groups reduces the growth rate relative to an economy in which society is composed of a single group or where groups can coordinate. This is because the existence of non-cooperative powerful groups generates a redistributive struggle, and as a result a greater share of resources ends up in non-taxable inefficient activities.

Second, we show that if there exist multiple powerful groups, a reduction in power concentration (an increase in the number of groups) leads to better economic performance. This result is reminiscent of the result that in a market in which firms play Cournot, the outcome approaches the competitive one as the number of firms increases.

Our third point is that if there do not exist institutional barriers to discretionary redistribution, an *increase* in the raw rate of return in the formal sector *reduces* growth.[3] The intuition is as follows. An increase in the raw rate of return in the formal sector unleashes two conflicting effects: a direct effect that increases the profitability of investment in the formal sector, and a voracity effect that leads each group to attempt to grab a greater share of national wealth by demanding more transfers. This is reflected in a higher tax rate in the formal sector, which

Finally, we want to note that our approach is very different from the "Dutch disease" analysis of country adjustment to terms of trade windfalls (see J. Peter Neary and Sweder Van Wijnbergen, 1986). According to that literature, a positive terms of trade windfall leads to a contraction of the non-resource tradables sector, either due to the crowding out effect of an expansion in the natural resource sector or a positive wealth effect that raises demand for nontradables. In contrast, according to our model, the sector experiencing the positive price shock actually shrinks and there is no positive wealth effect: the decline in growth arises from the endogenous increase in distortionary redistributive activity.

Section I provides an overview of the model. Section II contains the model. In section III, we analyze the relationship between power concentration and growth, the voracity effect and welfare. Section IV discusses some related empirical evidence in the context of our model. Finally, in section V, we present our conclusions.

I. Overview of the Model

In this section we make an intuitive presentation of the model. We consider an economy populated by infinitely lived groups and formed by two sectors: a high-return formal sector and a less efficient shadow economy. The shadow economy can be identified with a foreign tax haven or with the domestic informal sector. Taxes can only be levied in the formal sector. If powerful groups exist, each group is able to extract fiscal transfers. The government in turn must finance such transfers by levying taxes on the formal sector. This interaction is repeated for an infinite horizon. We want to stress that this dynamic game is a minimal model to address the issues discussed in the introduction. First, we need a dynamic setup because otherwise groups would just try to appropriate as much as they can and there would be no role for productivity shocks to affect the intensity of rent-seeking activity. Second, we need more than one group to analyze redistribution.

It is straightforward to see that if there is only one powerful group, all powerful groups can coordinate, or there are institution that prevent discretionary fiscal redistribution, then all capital will be allocated in the efficient formal sector and first-best outcome achieved.

If the above is not the case, there are two types of Markov perfect equilibria in the dynamic

Consider the case in which, along the interior equilibrium, capital is transferred from the formal to the shadow sector (the conditions under which this occurs are derived in Section III). In this case each group demands transfers up to the point where the other group is indifferent between investing in the two sectors. That is, each group sets x_i^* so that

$$\alpha - x_i^* = \beta, \qquad i = 1,2 \tag{2}$$

To illustrate the voracity effect consider an increase in the rate of return in the formal sector equal to $\Delta\alpha$. In the interior equilibrium each group increases the transfer it demands up to the point where the net rate of return available to the other group is equal to β. That is, $\Delta x_i = \Delta\alpha$ (by equation (2)). Since both groups behave the same way, the increased redistribution induced by the increase in the raw rate of return is $2\Delta\alpha$. This is the voracity effect. Since the voracity effect dominates the direct effect of the windfall, the rate of accumulation in the formal sector falls. From (1) we can see that $\Delta\frac{\dot{K}}{K} = \Delta\alpha - 2\Delta\alpha < 0$. The counterpart of higher voracity is a shift of capital to the inefficient shadow economy.

The argument we have made is loose. First, we did not prove that agents will choose linear transfer policies as assumed in equation (1). Also, we should note that equation (2) is valid only when capital flows from the formal to the informal sector. To determine when this is the case we need to solve consumption-savings problems of the n groups and fully characterize the interior equilibrium. We do this in section III. In that section we embed the argument just made in a two-sector growth model, and let the number of groups be arbitrary. We compute the consumption policies and the accumulation paths for both types of capital. We prove the following results. First, if there initially exists multiple powerful groups, a reduction in power concentration (an increase in n) reduces discretionary redistribution and raises the average rate of return in the economy. As the number of powerful groups increases, there are two conflicting effects. On the one hand, there are more groups with the ability to extract subsidies. On the other hand, each group knows that it must ask for a smaller subsidy if the formal sector is to offer a satisfactory

II. The Model

We consider a two-sector growth model. There is an efficient formal sector, and an inefficient shadow sector. Resources in the formal sector are susceptible to taxation whereas, although productivity is lower, resources in the shadow economy are free from taxation. This is a caricature of what goes on in many economies. In the real world, both sectors may be subject to some form of taxation but the formal sector is subject to higher rates and is less able to evade taxation.

An important difference between our model and conventional growth models is that in our model the economy is populated by groups that have power to extract subsidies from the government rather than by atomistic agents that behave competitively. This captures the fact that fiscal policies in many countries are determined by powerful interest groups.

Since we want to analyze the effects of shocks that change the productivity of the formal sector relative to informal one, we shall consider two goods: an exportable and an importable. The exportable is produced in the efficient formal sector and the importable in the inefficient shadow economy. The importable will be the numeraire. In this section we will solve the model for a given price of the exportable. In section 4 we will consider anticipated future shocks.

The objective function of each group is the present value of utility derived from consumption of the importable good

$$\int_t^\infty \frac{\sigma}{\sigma-1} c_i(s)^{\frac{\sigma-1}{\sigma}} e^{-\delta(s-t)} ds, \qquad \delta > 0 \tag{3}$$

Within each instant t the timing is as follows. Each group i enters period t with a stock of capital in the formal sector $k_i(t)$ and a stock of capital in the shadow economy $b_i(t)$. The formal sector capital stock $k_i(t)$ is used to produce the exportable good with a constant returns technology that is sold at a price p in terms of the importable good. The shadow economy capital stock $b_i(t)$ is used to produce the importable good in the shadow economy, again using a linear technology. Next, group i requests a fiscal transfer $r_i(t)$. Lastly, group i pays a tax $T_i(t)$ from its income in the efficient sector, and consumes $c_i(t)$. It follows that the accumulation equations for efficient-taxable capital and for inefficient-nontaxable capital are given by

$$\dot{k}_i(t) = p\alpha k_i(t) - T_i(t) \tag{4}$$

must be equal across groups.

- The fiscal transfer that a group can obtain is bounded by

$$(6) \qquad r_i(t) \leq \overline{x} \sum_{j=1}^{n} k_j(t), \qquad \frac{\alpha p-\beta}{n-1} < \overline{x} < \infty$$

The last restriction precludes each group from appropriating the aggregate capital stock at once. The lower bound on $\overline{x}$ is equal to the appropriation rate in the interior equilibrium (see (18)). The fiscal constitution implies that the tax rate $\tau(t)$ must be adjusted continuously to ensure a balanced budget

$$(7) \qquad T_i(t) = \tau(t)\alpha p k_i(t), \qquad \tau(t) = \frac{\sum_{j=1}^{n} r_j(t)}{\alpha p K(t)}, \qquad K \equiv \sum_{j=1}^{n} k_j$$

This tax rule implies that if group i increases its subsidy by an amount Δr_i, its tax burden increases by only $\Delta r_i \frac{k_i(t)}{K(t)}$. In effect, the subsidy is financed largely by other groups in the economy. In this way, each group's ability to extract subsidies grants it "open access" to the other groups' capital stocks in the formal sector. This implies that the capital held in the formal sector is not truly private. Only capital in the informal sector is truly private in that it enjoys "closed access." Using the terminology of the introduction, we may say that there is no possibility of discretionary fiscal redistribution if there is no open access to the capital stocks in the formal sector. In contrast, if there is open access, fiscal redistribution can occur. To finalize the description of the economy, we list the initial conditions and the restrictions we impose. First, initial conditions are $b_i(0) = 0$ and $k_i(0) = k_{i0} > 0$ for all i. Second, we restrict all capital stocks to be non-negative

$$(8) \qquad k_i(t) \geq 0, \qquad b_i(t) \geq 0, \qquad i = 1, ..., n; t \geq 0$$

Third, the rate of return in the inefficient sector is lower than in the efficient sector

$$(9) \qquad 0 < \beta < \alpha p$$

In this case the setup we described reverts to the standard one-sector representative agent growth model. The solution to this case will be a useful benchmark. The first best allocation obtains in the following cases: (i) if powerful groups can coordinate and act cooperatively; (ii) if there is just one group; or (iii) if there are several groups, but institutional barriers do not permit them to extract any fiscal transfers. The first two cases cover what Mancur Olson (1982) labels encompassing groups.

The allocation in case (i) is the solution to the problem in which a central planner maximizes (3) subject to the accumulation equations (4)-(5), the fiscal constitution (6)-(7) and non-negativity constraint (8). Since fiscal transfers do not generate any externality, net transfers to each group should be zero. Moreover, since the rate of return in the formal sector is higher than in the shadow economy, the central planner would allocate all resources in the formal sector. In terms of our setup this entails setting the consumption of each group $c_i(t)$ equal to the transfer $r_i(t)$ it receives, and making $r_i(t)$ equal to the tax paid by each group $T_i(t)$. This implies that accumulation equations (4)-(5) can be rewritten as

$$\dot{k}_i(t) = \alpha p k_i(t) - c_i(t), \qquad \dot{b}_i(t) = 0 \tag{10}$$

It follows that the optimization problem solved by the central planner is the standard consumption-savings Ramsey problem (see Robert J. Barro and Xavier Sala-i-Martin, 1995). The solution is

$$\begin{aligned} r_i^{fb}(t) &= c_i^{fb}(t) = [\alpha p(1-\sigma) + \delta\sigma]k_i(t) \equiv z(\alpha p)k_i(t) \\ k_i^{fb}(t) &= k_i(s)e^{\sigma\{\alpha p - \delta\}\{t-s\}}, \qquad b_i^{fb}(t) = 0 \end{aligned} \tag{11}$$

where the superscript fb stands for first best. In this case the transversality condition is satisfied if and only if $z(\alpha p) > 0$. The consumption of each group is proportional to its own capital, and in the case of logarithmic utility consumption is equal to the familiar $\delta k_i(t)$.

In the second case, in which there is only one group it is straightforward to see that the optimal allocation is given by (11) replacing $k_i(t)$ by aggregate capital. Lastly, in case (iii) when groups cannot extract transfers, the individual capital that each group owns in the formal sector is truly private. Thus, we may replace the fiscal constitution by the condition $r_i(t) = T_i(t)$. Therefore, in this case we may reinterpret r_i as the amount that group i takes out from the stock, wealth, etcetera. Similarly, in a MPE strategies are just functions of payoff-relevant state variables, not of history (see Eric Maskin and Jean Tirole, 1994). This restriction captures the notion that bygones are bygones. In particular, MPE rules out history-dependent strategies, such as trigger strategies. We consider that MPE is a more appropriate concept than trigger strategies to study the problem at hand for the following reason.

Countries with procyclical government spending or voracity effects are not countries with well established institutional arrangements, such as the congressional committee system in the US, that allow powerful agents to coordinate on specific agreements and to design the threats that support these agreements. Another reason why we consider MPE more appropriate is that it reduces considerably the multiplicity of equibria in dynamic games. As is well known, if the discount rate is sufficiently low, trigger strategies can support virtually any outcome as an equilibrium.

In this model the payoff-relevant variables for group i are the aggregate capital stock in the formal sector $K(t)$ and group i's closed-access capital stock b_i. To see why $K(t)$, and not $k_i(t)$, is payoff-relevant for group i note that although the efficient capital stocks of the other $n-1$ groups are nominally private, group i has open access to them via the fiscal process. Since the transfer appropriated by group i, r_i, is financed by taxing income in the formal sector of all groups (not only that of i), it follows that by demanding r_i group i appropriates $r_i(1-\frac{k_i}{K})$ from the formal capital stocks of the other groups. This is because the fiscal constitution implies that the tax paid by i only has to finance a proportion $\frac{k_i}{K}$ of the transfer it receives. Hence, the consumption possibilities of group i (and its payoff) depend on $K(t)$ and not on $k_i(t)$. To obtain the accumulation equation for aggregate capital we substitute (7) in (4)

$$\dot{K}(t) = p\alpha K(t) - \sum_{j=1}^{n} r_j(t) \tag{12}$$

To see why any $b_j(t)$ $j \neq i$ is not payoff-relevant for group i note that since none of the capital stocks groups hold in the shadow economy are subject to taxation, they are truly private. Therefore group i does not have open access to them.

where * denotes equilibrium value, $\Phi^*_{-i} = (\phi^*_1, ..., \phi^*_{i-1}, \phi^*_{i+1}, ...\phi^*_n)$, and $J(.,.)$ is the value taken by payoff function (3). In order to be able to use optimal control methods we will allow groups to choose transfer policies from the class of differentiable functions of the payoff-relevant state variables. That is

$$(14) \qquad r_i(t) = r_i(K(t), b_i(t)), \qquad c_i(t) = c_i(K(t), b_i(t))$$

We will derive the equilibria of this game in three steps. First, we let each group choose its consumption and transfer policies taking as given the strategies of the other $n-1$ groups. Second, we find a set of n transfer policies that are best responses to each other. Last, using the equilibrium transfer policies we derive the equilibrium paths of the capital stocks in the formal and informal sectors and the consumption policies. During each instant s, group i solves the following problem:

Problem $(\mathbf{P}_i(\mathbf{s}))$. Choose a consumption policy $\{c_i(t)\}_{t=s}^{\infty}$ and a transfer policy $\{r_i(t)\}_{t=s}^{\infty}$ in order to maximize payoff function (3) subject to accumulation equations (5) and (12), restrictions (6) and (8), and the transfer policies of the other groups (14).

The present value Hamiltonian associated with i's problem is

$$(15) \quad H_i = \nu_i U(c_i) + \lambda_i \left[p\alpha K - r_i - \sum_{j \neq i} r_j(K, b_j) \right] + \zeta_i \left[\beta b_i + r_i - c_i\right] + \xi_i \left[\overline{x} K - r_i\right] + \mu_i b_i$$

where $U(c_i) = \frac{\sigma-1}{\sigma} c_i^{\frac{\sigma-1}{\sigma}}$. The second and third terms correspond to accumulation equations (12) and (5); the fourth term to restriction (6); and the last term to the second constraint in (8). We have disregarded the first constraint in (8). It turns that it is not binding in equilibrium. Notice that in deriving the first order conditions for group i, r_i and c_i are treated as control variables, while the other $n-1$ transfers $r_j^*(K, b_j)$ are treated as functions of the state. In fact, these functions are the equilibrium policies derived from analogous control problems. To find an MPE, it is necessary to find n transfer policies $r_j^*(K, b_j)$, $j = 1, ..., n$ that simultaneously solve n Hamiltonian problems like (15). There are two types of Markov perfect equilibria in the game we are considering: interior and extreme. In an interior equilibrium, the transfers demanded by all groups are within the bounds defined in (6) at all times. This is not true in an extreme equilibrium.

from the efficient formal sector.

Along an extreme equilibrium any productivity shock does not have any effect on the transfer policies because groups extract the highest possible transfer $\bar{x}\,K$ regardless of the returns in the formal and informal sectors. Therefore, in order to make interesting the analysis of extreme equilibria one would require a theory that explains the level of the appropriation bound ($\bar{x}$). In this paper, instead, we will focus on the interior equilibrium.

D. Interior Equilibrium

In this subsection we will characterize the interior equilibrium and show that it is stable against unilateral deviations for a wide range of parameter values.[5] There are two cases to consider depending on the number of powerful groups n. Define $\widetilde{n}$ as

$$\widetilde{n} \equiv 1 + \frac{\alpha p - \beta}{z(\beta)} \tag{16}$$

where $z(\beta)$ is defined in (17) below. If $1 < n \leq \widetilde{n}$, capital is continuously transferred from the efficient to the inefficient sector and the stock of inefficient capital $b_i(t)$ is increasing. Meanwhile, if $n > \widetilde{n}$, all the capital stock is allocated to the efficient sector and $b_i(t)$ is always zero. The following Proposition characterizes the strategies that support the interior equilibrium for the case $n \leq \widetilde{n}$. Proposition 2 covers the case $n > \widetilde{n}$.

Proposition 1 *In the case $1 < n \leq \widetilde{n}$ there exists an interior MPE if and only if*

$$z(\beta) \equiv \beta(1-\sigma) + \delta\sigma > 0 \tag{17}$$

This equilibrium is unique within the class of differentiable strategies defined in (14). The equilibrium consumption and transfer policies are

$$r_i^*(K, b_i) = \frac{\alpha p - \beta}{n-1} K, \qquad c_i^*(K, b_i) = z(\beta)[K + b_i] \tag{18}$$

The intuition behind (18) is as follows. During each instant, group i must decide how to allocate its capital between the efficient and inefficient sectors $K(t)$ and $b_i(t)$. Given the tax rule (7), it can do this by choosing its desired transfer $r_i(t)$. To illustrate suppose that the transfer to each of the other groups is $r_j(t) = x_j(t)K(t)$, with $x_j(t)$ being an undetermined coefficient. It follows that i's post-appropriation rate of return in the formal sector is $\alpha p - \Sigma_{j\neq i} x_j(t)$. For i to find it optimal to set $r_i(t)$ within the admissable bounds given by (6), it is necessary that the rate of return on i's closed-access capital β be equal to its rate of return on the open-access capital after redistribution to other groups has taken place. This implies that the following condition must hold for any group i in an interior equilibrium: $\beta = \alpha p - \Sigma_{j\neq i} x_j(t)$. The unique solution of this system of n simultaneous linear equations is that all x_j's be equal to $\frac{\alpha p - \beta}{n-1}$ as shown in (18).

Next, note that the consumption policy in (18) has the some form as in the standard representative agent models. That is, at all times i's consumption is a fixed proportion of i's wealth, which in this case consists of i's private capital in the informal sector b_i plus aggregate capital in the formal sector K, not only $k_i(t)$. Note also that the consumption policy can be rewritten as $c_i^*(t) = z(\beta)[K(s)+b_i(s)]e^{\sigma[\beta-\delta][t-s]}$ This implies that regardless of the value of αp, consumption grows at the constant rate $\sigma[\beta-\delta]$ as in the standard representative agent model with CRRA utility, elasticity of intertemporal substitution σ, discount rate δ and rate of return β (see Barro and Sala-i-Martin, 1995). The reason for this is that regardless of how each group distributes its resources between the efficient and the inefficient sectors, it faces a rate of return β in equilibrium. Substituting (18) in accumulation equations (5) and (12) it follows that (see the appendix)

(19) $$K^*(t; n \leq \widetilde{n}) = K(s) exp\left(\frac{n\beta - \alpha p}{n-1}(t-s)\right)$$

(20) $$b_i^*(t; n \leq \widetilde{n}) = [K(s) + b_i(s)]e^{\sigma[\beta-\delta][t-s]} - K^*(t)$$

The following proposition characterizes the interior equilibrium for the case $n > \widetilde{n}$.

Proposition 2 *In the case $n > \widetilde{n}$ there exists an interior MPE if and only if*

(21) $$\sigma > \frac{n}{n-1} \qquad \text{and} \qquad z(\alpha p) \equiv \alpha p(1-\sigma) + \delta\sigma < 0$$

The equilibrium strategies are

(22) $$r_i^*(K, b_i; n > \widetilde{n}) = c_i^*(K, b_i; n > \widetilde{n}) = \frac{z(\alpha p)}{n - \sigma(n-1)} K$$

the post-redistribution rate of return obtained by group i in the formal sector $\alpha p - \Sigma_{j\neq i}x_j$. Combining these two equations we obtain n linear simultaneous equations in the x_j's. The solution is given by (22). Substituting $r_j^*(t)$ in accumulation equations (5) and (12) it follows that the capital stocks are given by

$$(23) \qquad K^*(t;n>\tilde{n}) = K(s)exp\left(\frac{\sigma[\alpha p - n\delta]}{n-\sigma[n-1]}[t-s]\right), \qquad b_i^*(t;n>\tilde{n}) = 0$$

A comparison with the first best allocation reveals the inefficiencies introduced by having groups with power to extract transfers from the rest of society. First, when groups are powerful and do not coordinate, they consume "too much" in the sense that consumption is a function of aggregate capital in the formal sector, not only of individual capital as in the first best. That is i's consumption is proportional to $K(t) + b_i(t)$, not just to the capital nominally owned by group i : $k_i(t) + b_i(t)$. Second, with the existence of powerful groups, capital may be invested in a socially inefficient way. That is, a low return technology in the shadow economy may be used. As a result of these inefficiencies, the growth rate of efficient capital is lower than under the first best.

E. Stability of the Interior Equilibrium

Here we show that the interior equilibrium is stable in the sense that if one group deviates by setting its appropriation policy different from $r^*(t)$ in (18) the other $n-1$ groups will not respond by changing their appropriation rates in the same direction as the deviant. Thus, a deviation by one group will not induce convergence to an extreme equilibrium. Consider first the case $1 < n \leq \tilde{n}$. Let $r_j(t) = x_j K(t)$ and suppose that the n^{th} group deviates by setting its appropriation rate equal to $x^d \neq x^* = \frac{\alpha p - \beta}{n-1}$, and that the other $n-1$ groups play the game defined by (3)-(12) taking as given that $x^d \neq x^*$. Following the same steps as before we have that the best responses to this deviation $\hat{x}_j(x^d)$ must satisfy the following conditions: $\beta = \alpha p(t) - x^d - \sum_{j\neq\{i,n\}} \hat{x}_j(x^d)$, for $i = 1, ..., n-1$. The unique solution to this system of linear

Now we consider the case $n > \tilde{n}$. Following the same steps as before we have that the best response of each of the $n-1$ groups that did not deviate originally is given by (22) replacing the rate of return αp by $\alpha p - x^d$ and the number of groups n by $n-1$

$$\hat{x}(x^d) = \frac{[\alpha p - x^d][1-\sigma]+\delta\sigma}{n-1-\sigma[n-2]} \qquad \text{if } n > \tilde{n} \tag{25}$$

It follows that $\hat{x}(x^d = x^*) = x^*$ and $\frac{\partial \hat{x}(x^d)}{\partial x^d} = \frac{\sigma - 1}{n-1-\sigma[n-2]}$. Since in the case $n > \tilde{n}$ an interior equilibrium exists only if $\sigma > \frac{n}{n-1}$ (see (21)), the numerator of the derivative is positive. Thus, the interior equilibrium is stable if and only if the denominator is negative. That is, when $n > 2$ and $\sigma > \frac{n-1}{n-2}$. Since when the interior equilibrium exists σ must be greater than $\frac{n}{n-1}$, the region of instability is $\sigma \in \left(\frac{n}{n-1}, \frac{n-1}{n-2}\right]$. Note that this instability interval is quite small and that it shrinks very fast as n grows. For $n = 3$ it is $\sigma \in (1.5, 2)$ and for $n = 4$ it is $\sigma \in (1.3, 1.5)$.

Lastly, we note that the deviant does not gain by deviating even if it can appropriate the entire aggregate capital stock. To see this let us make the extreme assumption that the upper bound on the appropriation rate $\overline{x}$ is infinity, so that the deviant can appropriate the entire aggregate capital stock in the efficient sector and invest it in the inefficient sector ($b_d(0) = K(0)$). The deviant would then maximize (3) subject to accumulation equation (5). As in any standard representative agent model its consumption would be $c_d(t) = z(\beta)b_d(t)$, and $b_d(t) = K(0)e^{\sigma(\beta-\delta)t}$. Therefore, its payoff would be $U_d = \frac{\sigma}{\sigma-1}K(0)^{\frac{\sigma-1}{\sigma}}z(\beta)^{-\frac{1}{\sigma}}$, which is the same as the payoff it gets in the interior equilibrium if $n \leq \tilde{n}$, while it is lower if $n > \tilde{n}$ (see (30)). For future reference we summarize the results of this subsection in the following proposition

Proposition 3 *The interior MPE is stable against unilateral deviations if and only if*

- $n > 2$ when $n \leq \tilde{n}$ (where $\tilde{n}$ is defined by (16)).
- $n \geq 2$ and $\sigma > \frac{n-1}{n-2}$ when $n > \tilde{n}$.

III. Power Concentration and Voracity

In this section we use the model of section 3 to analyze both the relationship between power concentration and growth and the voracity effect in response to productivity or terms of trade shocks.

In this subsection, we consider the former effect (in the next subsection we consider the latter effect). To check that the growth rate in the formal sector falls as an economy moves away from perfect power concentration, we compare the path of efficient capital in the first best (11) with the path along the interior equilibrium (19). It is easy to show that[7]

$$g_K^{fb} - g_K^{\bullet}(\widetilde{n} \geq n > 1) = \sigma[\alpha p - \delta] - \frac{n\beta - \alpha p}{n-1} > 0$$

Next, we show that starting with less than perfect power concentration ($n > 1$), the growth rate increases as power becomes less concentrated. First, note that within each of the regions $n \leq \widetilde{n}$ and $n > \widetilde{n}$ the growth rate is increasing in n. Treating n as a continuous variable, we have from (19) and (23) that

$$\frac{\partial g_K^{\bullet}(n; n \leq \widetilde{n})}{\partial n} = \frac{\alpha p - \beta}{(n-1)^2} > 0, \qquad \frac{\partial g_K^{\bullet}(n; n > \widetilde{n})}{\partial n} = -\frac{\sigma z(\alpha p)}{[(n-1)\sigma - n]^2} > 0$$

The signs follow from (9) and (21). Second, note that the growth rate is higher for any $n > \widetilde{n}$ than for any $1 < n \leq \widetilde{n}$. This is because: (i) at $n = \widetilde{n}$ the growth rates in both regions coincide,[8] and (ii) within each region $n \leq \widetilde{n}$ and $n > \widetilde{n}$ the growth rate is increasing in n.

As n increases, each group, in the interior equilibrium, has to reduce the subsidy it demands. On the other hand, there are more groups whose demands for subsidies must be satisfied. In equilibrium, the subsidy each group demands falls at a faster rate than n increases for $n > 1$. As a result, the growth rate of the formal sector increases.

Proposition 4 *Consider an economy in which groups do not act in a coordinated manner and institutional barriers to discretionary redistribution are absent, then there is a non-monotonic relationship between power concentration and the growth rate of the efficient sector:*

i *A shift away from the $n = 1$ case to $n > 1$ reduces the growth rate.*

ii *Starting at $n > 1$, a further reduction in power concentration increases the growth rate.*

outcomes. In a static setup the argument commonly made is that the greater the number of groups, the smaller is the share of the costs of a "bad action" that are imposed on any individual group, and thus the more of the bad action any group undertakes. Conversely, in the small-n case, each group would internalize more of the costs of its bad action and hence better outcomes would be generated.[9]

In a dynamic setup the argument that higher n leads to bad outcomes is based on the idea that the smaller n, the easier is for groups to cooperate and implement a low appropriation high growth equilibrium (Olson 1982, 1993). Jakob Svensson (1996) considers a similar setup to ours, but analyzes trigger strategy equilibria. He finds that higher n is likely to reduce economic performance. He considers equilibria where groups agree to have low transfers. These equilibria are supported by the threat of a reversion to high transfers in case someone deviates. As n grows it becomes more difficult to support low appropriation equilibria because the temptation to deviate increases faster than the punishment. Therefore, the greater n, the more rent seeking and the lower growth. This holds true in our model when we go from $n = 1$ to $n > 1$, but is not true starting at starting any $n > 1$.[10]

Why this difference in predictions? The literature addresses the issue of when is it more likely that cooperation will emerge. We address a different issue: given that groups do not cooperate, what happens when n goes up. Since in our model each group has an outside option, in the interior equilibrium every group must receive a rate of return which is no lower than that of the outside option. As with Cournot competition, when n grows each group must reduce its appropriation rate to make sure the preceding condition is satisfied. As a result, the aggregate growth rate increases.

B. The Voracity Effect

In this subsection we rationalize the phenomenon that countries with powerful groups respond to a positive productivity or terms of trade shock by an increase in discretionary redistribution and slower growth. We will argue that this response is caused by the voracity effect, which we define next

Definition 1 *The "voracity effect" is a more than proportional increase in discretionary redis-*

This surprising result is caused by the *voracity effect,* which counteracts the standard effect that an increase in the raw rate of return increases the return on investment and the growth rate. The intuition for (26) is the following. The higher p leads to an increase in the pre-tax rate of return in the formal sector. Recall that, along the interior equilibrium, each group must perceive a post-redistribution rate of return on capital in the formal sector which is not lower than β, the rate of return in the non-taxable informal sector. Thus, with higher p, each group can afford to demand a higher transfer. How much higher? To answer this note that a particular group (call it i) will still be willing to participate in the interior equilibrium, if the other $n-1$ groups, as a whole, increase their appropriation rate by the same amount as the increase in p. Since, by an analogous argument, group i also increases its transfer rate, it must be true that the increase in the aggregate transfer rate of the n groups must be greater than the increase in the raw rate of return along the interior MPE. Thus, ex-post, the higher terms of trade reduces the growth rate of the efficient sector.

The mechanism by which this perverse outcome occurs is as follows. Note that the raw [i.e. pre-redistribution] rate of return goes up by $\alpha\Delta p$. This increase in the raw rate of return represents an opportunity for some group to increase redistribution to itself without reducing below β the post-redistribution rate of return perceived by other groups. In equilibrium, every group increases the redistribution rate to itself by an amount $\frac{1}{n-1}\alpha\Delta p$ following this reasoning. This lack of coordination implies that the aggregate redistribution rate increases by $\frac{n}{n-1}\alpha\Delta p$ which is greater than $\alpha\Delta p$. As a result the growth rate of the efficient sector falls: $\Delta\dot{K}/K = \alpha\Delta p - \alpha\Delta pn/[n-1] = -\alpha\Delta p/[n-1]$. The counterpart of this is an increase in the rate of growth of the shadow economy. This reallocation of resources toward more inefficient activities is the cause of lower growth.

In the case in which power is diffused among a large number of groups ($n > \widetilde{n}$) the growth rate of the formal sector also responds negatively to a productivity shock. From (23) we have that

$$\frac{\partial g^{*}_{K}(n>\widetilde{n})}{\partial p} = \frac{\alpha\sigma}{n-\sigma(n-1)} < 0 \tag{27}$$

This is because the growth in the terms of trade increases the rate of return to investment, as in standard models. For future reference, we state these results in the following proposition.

Proposition 5 *In the presence of multiple powerful groups, along the interior equilibrium a positive shock to the productivity of the efficient sector leads to:*

- *A more than proportional increase in the fiscal transfers demanded, a fall in the growth rate of the (taxable) efficient sector and a reallocation of resources toward the (non-taxable) inefficient sector, if there are no institutional barriers to discretionary redistribution.*
- *An improvement in the growth rate of the efficient sector if there are barriers to discretionary redistribution, or groups act in a coordinated manner.*

Note that the squeezing of the sector that experiences the terms of trade improvement is in fact opposite to the predictions of the Dutch disease literature and is explained by endogenously higher redistribution.

Lastly, we analyze the relation between the degree of power concentration and the strength of the voracity effect. Within the regions $1<n \leq \tilde{n}$ and $n > \tilde{n}$ the voracity effect is decreasing in n. That is, higher n diminishes the negative effect on the growth rate of a positive shock to the terms of trade. Using (26) and (27) we have that the sign of the second equation follows from (21)

$$(29) \qquad \frac{\partial^2 g_K^{\bullet}(\tilde{n} \geq n > 1)}{\partial p \partial n} = \frac{\alpha}{(n-1)^2} > 0, \qquad \frac{\partial^2 g_K^{\bullet}(n \geq \tilde{n})}{\partial p \partial n} = \frac{\alpha\sigma(\sigma-1)}{[n-(n-1)\sigma]^2} > 0$$

C. Welfare

We again analyze the two cases of uncoordinated powerful groups and the first best. In the first case, the improvement in the terms of trade does not generate any welfare gains for the powerful groups. By substituting (18) and (22) in (3), we have that for any level of the terms of trade that satisfies (9), the payoff of group i along the interior equilibrium path is given by

$$(30) \quad J_i(K(0)+b_i(0)) = \begin{cases} \frac{\sigma}{\sigma-1}[K(0)+b_i(0)]^{\frac{\sigma-1}{\sigma}} z(\beta)^{-\frac{1}{\sigma}} & if \quad 1 < n \leq \tilde{n} \\ \\ \frac{\sigma}{\sigma-1}[K(0)+b_i(0)]^{\frac{\sigma-1}{\sigma}} \left[\frac{z(\alpha p)}{n-\sigma(n-1)}\right]^{-\frac{1}{\sigma}} & if \quad n > \tilde{n} \end{cases}$$

it also increases fiscal redistribution more than proportionally and hence a lower proportion of resources ends up allocated to the formal sector. As a result, there is a reduction of average productivity in the economy. Along the interior equilibrium both effects cancel out. To see this add up (19) and (20) to get $K^*(t)+b_i^*(t) = [K(0)+b_i(0)]e^{\sigma[\beta-\delta]t}$, and note that it is independent of p.

In the case $n > \widetilde{n}$ resources are not allocated to the informal sector in equilibrium. Thus, the more than proportional increase in fiscal redistribution induced by an increase in p is reflected one for one in higher consumption and a lower growth rate of capital in the formal sector. As a result the growth rate of consumption falls as well as the welfare of each group. In the case of no discretionary redistribution, the payoff of each group is obtained by substituting the first best consumption policy (11) into (3)

$$J_i^{fb}(k_i(0)+b_i(0)) = \frac{\sigma}{\sigma-1}[k_i(0)+b_i(0)]^{\frac{\sigma-1}{\sigma}} z(\alpha p)^{-\frac{1}{\sigma}} \tag{31}$$

This expression is unambiguously increasing in p. Thus, an improvement in the terms of trade is sure to raise welfare in this case. We summarize the results of this subsection in the following proposition

Proposition 6 *A productivity improvement in the efficient sector fails to lead to an increase in welfare when there are powerful groups and no institutional barriers to discretionary redistribution. In contrast, when groups are powerless, act in a coordinated manner or when there are barriers to redistribution, a productivity improvement raises welfare.*

D. Anticipated Shocks

To show that the voracity effect is operative when the presence of shocks is explicitly taken into account, we consider the case where at time 0 there is an anouncement that the terms of trade will increase from $p_t = p$ on $[0,T)$ to $p_t = p+\epsilon$ on $[T,\infty)$.[12] The optimality conditions are the ones we derived for the case of no shocks (A.1)-(A.7), replacing p by p_t, plus the following transversality

This condition just determines consumption at T. As in the no shock case, transfer policies are determined independently of consumption, and they must equalize, for each group, the post-redistribution rate of return in the formal sector to the one in the informal sector: $\alpha p_t - \sum_{j\neq i} \partial r_{jt}/\partial K = \beta$. The unique solution to this system of n equations is

$$r_i(K, b_i, p_t; n \leq \widetilde{n}) = \tfrac{\alpha p_t - \beta}{n-1} K \tag{33}$$

This transfer policy is the same as the one we derived in the previous case replacing p by p_t. Replacing (33) in accumulation equation (12) we have that the growth rate of the formal sector is $g_t(n < \widetilde{n}) = \frac{n\beta - \alpha p_t}{n-1}$. Therefore, the voracity effect is still operative: $\frac{\partial g_t}{\partial p_t} = \frac{-1}{n-1} < 0$. That is, a productivity improvement reduces the growth rate contemporaneously. Note that the fact that a shock is fully anticipated does not smooth the effects of the shock on the growth rate of the formal sector. We show in the appendix that on $[0, \infty)$ the consumption policy is given by

$$c_i^*(K, b_i, p_t; n \leq \widetilde{n}) = z(\beta)[K + b_i] \tag{34}$$

A remarkable property of (34) is that consumption is not affected by an anticipated future shock to p. This can be seen more clearly by rewriting it as $c_i^*(t) = z(\beta)[K(0) + b_i(0)]e^{\sigma[\beta-\delta]t}$. Moreover, comparing (34) with (18) we can see that the consumption policy is identical to the one in the no-shock case if $1 < n \leq \widetilde{n}$.

Now we consider the case $n > \widetilde{n}$. In this case consumption and transfers are equal. Thus, we should expect that through the consumption smoothing channel anticipated shocks will have an effect on the consumption path.To obtain the equilibrium transfer functions we follow the same steps we used in the previous section. However, since there is an anticipated shock, we need to consider non-stationary transfer policies. Let $r_i(t) = c_i(t) = x(t)K(t)$, where $x(t)$ is an undetermined function of time. This implies that $\frac{\dot{r}_i}{r_i} = \frac{\dot{x}}{x} + \frac{\dot{K}}{K}$. Since the rate of return perceived by i is $\alpha p - [n-1]x(t)$, its Euler equation is $\frac{\dot{r}_i}{r_i} = \sigma[\alpha p - \delta - [n-1]x(t)]$. Combining both equations for $\frac{\dot{r}_i}{r_i}$ we have that consumption must satisfy $\dot{x}(t) = [n - \sigma[n-1]]x^2(t) - z(\alpha p)x(t)$ (recall that $z(\alpha p) = \alpha p[1-\sigma] + \delta\sigma$). The general solution of this differential equation is $x(t) = z(\alpha p)\left[n - \sigma[n-1] + Az(\alpha p)e^{z(\alpha p)t}\right]^{-1}$. In order to determine the constant A, we use the transversality condition

$$c_i(T)^{-1/\sigma} = \left[\tfrac{z(\alpha[p+\epsilon])K(T)}{n-\sigma[n-1]}\right]^{-1/\sigma} \tag{35}$$

$$\alpha[p+\epsilon] - n\frac{z(\alpha p)+\epsilon\alpha[1-\sigma]}{n-\sigma[n-1]} \qquad \text{for } t \geq T$$

In contrast to the $n \leq \tilde{n}$ case, the voracity effect manifests itself immediately after the announcement of a future positive shock is made. At $t = 0$ the growth rate falls relative to a no-shock economy. Afterwards, it follows an increasing path and when the shock occurs, at time T, it experiences an upward jump.[13] This is because although transfer rates evolve smoothly, the raw return on the formal sector jumps at T. Note that the fact that the growth rate increases when the positive shock occurs does not mean that the voracity effect is not operative. Since $\frac{\partial g}{\partial \epsilon} = \frac{\alpha\sigma}{n-\sigma[n-1]} < 0$ (because $\sigma > n/n-1$), we have that (i) the post-shock growth rate is smaller than the growth rate before the announcement takes place; and (ii) at a given point in time economies with greater shocks have lower growth rates. We summarize the results of this subsection in the following proposition

Proposition 7 *The voracity effect is operational in the presence of anticipated productivity shocks. When a positive future shock is announced*

- *If $1 < n \leq \tilde{n}$, the growth rate of the formal sector remains unchanged until the time of the shock. At the time of the shock it falls.*
- *If $n > \tilde{n}$, the growth rate falls at impact, and follows an increasing path until the shock takes place. At that time it experiences an upward jump, but remains below its preannouncement level.*

IV. Empirical Discussion

In this section, we discuss some recent empirical evidence on country responses to windfalls such as terms of trade shocks, foreign aid transfers and natural resource endowments, as well as on the relationship between fractionalization and economic growth. The model we have presented can be used to rationalize how, in some of these episodes, apparently perverse collective permanently raised oil prices, which enjoyed a further temporary surge during 1980-82, but a sharp persistent decline in oil prices subsequently occurred in 1986. For our purposes, and following our theoretical model, the fiscal accounts are of particular relevance as the proximate domestic recipient of oil revenues is typically the national government and the budgetary process is a convenient mechanism by which powerful groups can appropriate resources from the rest of society. Our theoretical approach predicts a more than proportional increase in fiscal spending in response to a positive revenue shock. In contrast, such a procyclical response would not be predicted from a neoclassical smoothing model of fiscal policy, especially with respect to government consumption and transfers.

[Insert Table 1]

The table presents ratios of different components of government spending to GDP. Thus an increase in a ratio indicates that that category of government spending rose by more than the increase in GDP during the windfall period. For capital expenditure one could give the countries the benefit of the doubt and argue that if the shocks were considered permanent, an increase in public investment might be justified. However, it is more difficult to rationalize a more than proportionate increase in government consumption and transfers.

In each case, as can be seen in Table 1, government spending rose sharply in response to the improvement in the terms of trade and peaked at the crest of the oil boom in 1980-82.[15] A startling example is Nigeria: the average ratio of government expenditure (net of interest payments) to GDP doubled from 0.2 in 1970/73 to 0.399 in 1980/82 before reverting to 0.198 after 1986. Especially interesting is the increase in transfer payments, with central government resources being distributed to state-owned and private enterprises, local governments and the banking sector. Moreover, these data seriously understate the increase in public expenditure in Nigeria, as much of the oil revenues were diverted into extra-budgetary secret accounts (see Abdul-Ganiya Garba, 1996). In Figure 1, we plot the terms of trade and total government expenditure (net of interest payments) for Mexico: again, the sensitivity of government spending to the terms of trade is clearly evident. A positive fiscal response to terms of trade shocks has also been recorded by Ludger Schuknecht (1995) who calculated, in a study of 17 beverage booms, n average increase in government spending of 2.2 percentage points of GDP.

[Insert Figure 1]

nation. In Table 3, we present data that shows the coffee windfall similarly unleashed a more than proportionate expansion in government consumption in three major coffee exporters: Costa Rica, Cote d'Ivoire and Kenya.[16] When the boom was over, government spending fell back.

[Insert Table 2]

Other researchers have also investigated the apparently perverse responses of some countries to exogenous endowment shocks. Gelb (1988) and Little at al. (1993) present detailed country studies that show a recurrent pattern of developing countries failing to take advantage of the sharp terms of trade improvements of the 1970s. Peter Boone (1996) and Svensson (1996) have recently studied countries that are recipients of foreign aid transfers, which are another type of windfall income. Boone (1996) finds, in a panel of developing countries, that foreign aid fails to raise the investment rate in recipient countries, being mostly consumed. Svensson (1996) shows that, in countries suffering from ethno-lingual fractionalization and weak political institutions, injections of foreign aid generate increases in corruption, indicating that such windfall income is dissipated in rent-seeking. This response would be predicted by our model: the receipt of foreign aid induces powerful groups to increase their appropriation rates, leading to a dissipation of the revenues and no gain in welfare.

Jeffrey D. Sachs and Andrew M. Warner (1995) have recently presented evidence that countries with high endowments of natural resources have had significantly worse growth performance than other countries. In line with our model, the explanation for this result may lie in the distributive struggle in these countries, as groups attempt to appropriate the rents generated by these natural resource endowments. Barro (1996) similarly suggests such an explanation of the findings of Sachs and Warner.

The other empirical regularity that can be rationalized by our model is the chronic low growth of countries that suffer from socio-political divisions and weak institutions. This evidence is comprehensively documented by Easterly and Levine (1996). These authors argue the root cause of the inferior growth performance of African countries is the combined effect of deep shows that countries with greater linguistic heterogeneity typically grow more slowly.[17] Our analysis provides a formal mechanism that explains why, in the absence of countervailing institutions, fractionalization can lead to lower growth and hence rationalizes this empirical evidence.

V. Conclusion

In this paper, we endogenize the extent of discretionary fiscal redistribution to more fundamental characteristics of a country, namely the existence of powerful groups, physical rates of return, and institutional barriers to discretionary redistribution. We show that an economy in which there are powerful groups grows more slowly than one in which groups are powerless or act in a coordinated manner. Moreover, in the case of powerful groups, growth is lower when power is concentrated among only a few groups than when power is diffused across many groups.

We also explain the anomaly described in the case study literature that a number of countries respond perversely to terms of trade windfalls by experiencing a decline in growth performance. The voracity effect – a more than proportional increase in redistribution in response to a windfall – generates in equilibrium a negative relationship between improvements in raw rates of return and growth, in the case of powerful groups.

Our findings are relevant in evaluating the growth prospects of developing nations that are undergoing democratization. According to our view, the effect on growth of a switch from autocracy to democracy will depend on the effect that the shift has on the ability of powerful groups to extract transfers. If the collapse of an autocracy relaxes restrictions on the behavior of the powerful groups in a society, democratization may actually intensify the redistribution struggle in these countries. From our analysis, this will lead to lower growth and poorer adjustment to windfalls. In contrast, if the shift to democracy brings with it the destruction of entrenched interest groups, and power becomes more diffused, then growth performance and adjustment to windfalls will improve. It also follows that pro-competition policies – for example, making easier market entry or exposing domestic behemoths to foreign competition – may be as important in terms of altering a country's propensity to arbitrarily appropriate private wealth as in their direct impact on efficiency.

(A.5) $$\mu_i(t) b_i^*(t) = 0, \qquad \mu_i(t) \geq 0, \qquad b_i^*(t) \geq 0$$

(A.6) $$\lim_{t\to\infty} K(t)^* \lambda_i(t) e^{-\delta t} = 0, \qquad \lim_{t\to\infty} b_i^*(t) \zeta_i(t) e^{-\delta t} = 0$$

(A.7) $$\nu_i = \{0, 1\}, \qquad \{\nu_i, \lambda_i(t), \zeta_i(t)\} \neq \{0,0,0\} \text{ for all } t$$

To find an equilibrium candidate we need to find n pairs $\{c_i(t), r_i(t)\}$ that simultaneously solve n sets of equations (A.1)-(A.7), one for each group i. Then we need to check that this equilibrium candidate is admissible in the sense that it satisfies constraints (6) and (8), and that it satisfies the second order conditions. In what follows we will derive the interior equilibrium. First, since by definition $r_i^*(t) < \overline{x} K(t)$ at all times, $\xi_i(t) = 0$. Second, the constant ν_i cannot be zero. If $\nu_i = 0$, (A.1) would imply $\zeta_i(t) = \infty$ for all t, and (A.6) would be violated. Third, the multiplier $\mu_i(t)$ will be equal to or different from zero depending on the value n takes.

Case i. $1 < n \leq \widetilde{n} = 1 + \frac{\alpha p - \beta}{z(\beta)}$

We will set $\mu_i(t) = 0$ and show that in this case $b_i^*(t) \geq 0$ for all t, so that (A.5) is satisfied. Since $\mu_i(t) = 0$, it ollows from (A.2)-(A.4) that along the interior equilibrium it is necessary that for each i, $\alpha p - \beta = \sum_{j \neq i} \partial r_i^*(K, b_j)/\partial K$. This set of n linear equations has a unique solution, which is given by $\partial r_i^*(K, b_j)/\partial K = [ap - \beta]/[n-1]$. Integrating with respect to K we get $r_i^* = A + K(t)[ap - \beta]/[n-1]$. Since $r_i^*(0, b_j) = 0$, the constant A is zero, and we obtain equation (18) in the text. Note that r_i^* lies within the bounds given in (6). Consumption policy (18) is derived as follows. From (A.1) and (A.3) we have that consumption grows at the constant rate $\sigma[\beta - \delta]$. Thus

(A.8) $$c_i(t) = c_i(s) e^{\sigma[\beta-\delta][t-s]}, \qquad \forall t, s$$

To obtain initial consumption we first solve for the stock of inefficient capital $b_i(t)$ by substituting (A.8), (18) and (19) into accumulation equation (5), and solving the differential equation, it follows that for all t and s

(A.9) $$b_i(t) = e^{\beta[t-s]} \left\{ b_i(s) + K(s) \left[1 - e^{-x[t-s]}\right] - \left[1 - e^{-z(\beta)[t-s]}\right] c_i(s)/z(\beta) \right\}$$

second row of (A.10) would be infinite unless $c_i(0) = 0$. But $c_i(0) = 0$ implies that the first term is infinite. Thus, (A.10) would not be satisfied. Similarly, if $z(\beta) = 0$ and $c_i(0) > (<)0$, the first term would be $-\infty$ and the second $+(-)\infty$. Given that $z(\beta) > 0$, (A.10) is satisfied if and only if $c_i(0) = z(\beta)[b_i(0) + K(0)]$ which corresponds to equation (18) in the text. To derive (20) we simply substitute this expression for $c_i(0)$ in (A.9) and replace $K(s)e^{(\beta-x)(t-s)}$ by $K(s)\exp\left(\frac{n\beta-\alpha p}{n-1}\right)(t-s) = K^*(t)$.

To verify our initial supposition that $\mu_i(t) = 0$ and $b_i^*(t) > 0$ note first that $n < \widetilde{n}$ is equivalent to $\sigma(\beta-\delta) > [n\beta - \alpha p]/[n-1]$ (see (16)). Second, note that since $b_i(0) = 0$, (19) and (20) imply that $\dot{b}_i(t) > 0$ if and only if $\sigma(\beta-\delta) > [n\beta - \alpha p]/[n-1]$. Lastly, since both conditions are identical and since $b_i(0) = 0$, it follows that $b_i(t) > 0$ for all t. Next, we check that the first transversality condition in (A.6) is satisfied. Noting that (A.2) and (A.3) imply that $\lambda(t) = \lambda(0)e^{(\delta-\beta)t}$, and using (19) it follows that

$$\lim_{t\to\infty} K^*(t)\lambda(t)e^{-\delta t} = \lim_{t\to\infty} K(0)\lambda(0)e^{\frac{n\beta-\alpha p}{n-1}t}e^{(\delta-\beta)t}e^{-\delta t} = \lim_{t\to\infty} K(0)\lambda(0)e^{\frac{\beta-\alpha p}{n-1}t} = 0$$

We have shown that the set of n strategies given by (18) and the associated paths of the state variables (19) and (20) satisfy the n sets of optimality conditions (A.1)-(A.7) and the constraints (6) and (8). To check that these strategies constitute a MPE (i.e., satisfy condition (13)) note that taking as given that the strategies of the other groups are $\Phi_{-i}(t) = \{\phi^*(K(t), b_j(t))\}_{j\neq i}$, by construction group i will find it optimal to set $\phi_i(t)=\phi^*(K(t), b_i(t))$. This is because $\phi^*(K(t), b_i(t))$ satisfies all the necessary conditions for an optimum of i's control problem, and because the Hamiltonian of group i evaluated at the optimum is concave in (K, b_i) (Theorem 2.3 of Alexander Mehlman, 1988).[18] Since $r_i^*(K, b_i)$ is the unique solution of the system of n equations formed by (A.2)-(A.4), it follows that (18)-(20) is the unique interior MPE within the class of differentiable functions of K and b_i.

Lastly, we verify that $n \leq \widetilde{n}$ and $z(\beta) > 0$ are mutually consistent. In the case $\beta > \delta$ we can rewrite these inequalities as $\frac{n\beta-\alpha p}{(n-1)(\beta-\delta)} \leq \sigma < \frac{\beta}{\beta-\delta}$. These inequalities hold if and only if $n\beta - \alpha p < \beta(n-1) \quad \Leftrightarrow \quad \alpha p > \beta$. The last inequality holds because the rate of return in the formal sector is higher than in the informal sector. In the case $\beta < \delta$, we can rewrite $n \leq \widetilde{n}$ and $z(\beta) > 0$ as $\frac{n\beta-\alpha p}{(n-1)(\beta-\delta)} > \sigma > \frac{\beta}{\beta-\delta}$, which holds if and only if $\alpha p > \beta$.

Case ii. $n > \widetilde{n}$

To find a solution to this set of equations we try $r_j^*(K,0) = xK$, where x is an undetermined coefficient. It follows that x is given by (22). Next, we verify that condition (A.5) is satisfied, i.e. that $\mu_i(t) \geq 0$. From (A.2)-(A.4) we have that $\frac{\mu_i}{\zeta_i} = \delta - \beta - \frac{\dot{\lambda}_i}{\lambda_i}$. Replacing (22) in $\frac{\dot{\lambda}_i}{\lambda_i}$ it follows that $\frac{\mu_i}{\zeta_i} = \frac{\alpha p - n\beta + \sigma(n-1)(\beta-\delta)}{n-\sigma(n-1)}$. The ratio $\frac{\mu_i}{\zeta_i}$ must be non-negative because ζ_i is a costate variable and μ_i is the multiplier associated with the restriction $b_i \geq 0$. Since $n > \tilde{n}$ implies that the numerator of $\frac{\mu_i}{\zeta_i}$ is negative, the denominator must be negative. Thus, we must impose $\sigma > n/(n-1)$, which is condition (21). Now we verify that transversality conditions (A.6) are satisfied. Since $b_i^*(t) = 0$, the second condition is trivially satisfied. The first condition is

$$0 = \lim_{t\to\infty} K^*(t)\lambda_i(t)e^{-\delta t} = \lim_{t\to\infty} K^*(t)[K^*(t)x]^{-\frac{1}{\sigma}}e^{-\delta t} =$$

(A.12)

$$\lim_{t\to\infty} [x]^{-\frac{1}{\sigma}} \left[K(0)\exp\left(\frac{\sigma(n\delta-\alpha p)}{\sigma(n-1)-n}t\right)\right]^{\frac{\sigma-1}{\sigma}} e^{-\delta t} = \lim_{t\to\infty} [x]^{-\frac{1}{\sigma}} K(0)^{\frac{\sigma-1}{\sigma}} \exp\left(\frac{z(\alpha p)}{\sigma(n-1)-n}t\right)^{\frac{\sigma-1}{\sigma}}$$

where $x = \frac{z(\alpha p)}{n-\sigma[n-1]}$. The second equality follows from (14), (A.1) and (A.2), the third equality follows from (23), and the last equality uses $z(\alpha p) = \alpha p[1-\sigma] = \delta\sigma$. Since $\sigma > n/[n-1]$ implies that the denominator inside the exponential in (A.12) is positive and since x is non-zero, this transversality condition is satisfied if and only if $z(\alpha p) < 0$, which is condition (21). Lastly, we verify that the restrictions on parameters in (21) –necessary for the first order conditions to be satisfied– are mutually consistent in this case. Since $n > \tilde{n}$ can be rewritten as $\sigma < \frac{n\beta-\alpha}{(n-1)(\beta-\delta)}$, it follows that $\sigma > n/(n-1)$ can hold in this case if and only if

(A.13) $$\frac{n}{n-1} < \frac{n\beta-\alpha}{(n-1)(\beta-\delta)} \iff 0 < (n-1)(n\delta-\alpha p) > 0 \iff n\delta > \alpha p$$

and the condition $z(\alpha p) < 0$ can hold in this case if and only if

(A.14) $$\frac{\alpha p}{\alpha p - \delta} < \frac{n\beta-\alpha}{(n-1)(\beta-\delta)} \iff (\alpha p - \beta)(n\delta - \alpha p) > 0 \iff n\delta > \alpha p$$

Comparing (A.13) and (A.14) it follows that both conditions in (21) can be simultaneously satisfied in this case.

Derivation of (34)

where $\Delta = T - t$, $x = \frac{\alpha p - \beta}{n-1}$ and $z(\beta) = \beta[1-\sigma] + \delta\sigma$. Simplifying we obtain $c_i^*(t) = z(\beta)[K(t) + b_i(t)]$, which is equation (34).

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useful comments. All errors are our own.

1. On the growth evidence, see Stephen Knack and Philip Keefer (1995) and William Easterly and Ross Levine (1996). Collections of case studies include Alan Gelb (1988) and Ian Little, Richard N. Cooper, W. Max Corden and Sarath Rajapatirana (1993). Theoretical papers on the relationship between insecure property rights and growth include Jess Benhabib and Roy Radner (1992), Jess Benhabib and Aldo Rustichini (1996), Tornell and Andres Velasco (1992), and Tornell (1997a).

2. See Ekaiser (1994), de Pozuelo, et. al. (1994) and Max Royko (1971) for examples of contemporary Spain and Daley's Chicago. Andrei Shleifer and Robert W. Vishny (1994) model explicitly a patronage network.

3. Of course, there are other mechanisms by which an increase in the terms of trade can depress growth (e.g. taking more leisure when a windfall occurs). We want to focus on a mechanism that emphasises the role of the security of property rights because it is the mechanism most clearly identified in the case study literature.

4. This result cannot be deduced from equations (1)-(2) which apply just for the case $n = 2$.

5. It is worth noting that the interior equilibrium is not specific to continuous time. Tornell (1997b) shows that it also exists in the discrete time version of the model where the accumulation equations are: $K(t+1) = [1+\alpha p]K(t) - \sum_{i=1}^{n} r_i(t)$ and $b(t+1) = [1+\beta]b(t) + r_i(t) - c_i(t)$. Furthermore, the continuous time equilibrium strategies in (18) correspond exactly with the discrete time strategies.

6. $D(n)$ is positive for any $n > \widetilde{n}$ because: (i) evaluating $D(n)$ at $\widetilde{n} = 1 + \frac{\alpha p - \beta}{z(\beta)}$ it follows that $D(\widetilde{n})[\widetilde{n} - \sigma(\widetilde{n} - 1)] = \left[\left(1 + \frac{\alpha p - \beta}{z(\beta)}\right) - 1\right] z(\beta) + \beta - \alpha p = 0$; and (ii) condition (21) implies that $D'(n) > 0$.

7. Since $\frac{n\beta - \alpha p}{n-1}$ attains its maximum at $\widetilde{n} = 1 + \frac{\alpha p - \beta}{z(\beta)}$, it follows that $\sigma[\alpha p - \delta] - \frac{n\beta - \alpha p}{n-1} > 0$ if and only if $\alpha p > \beta$, which is condition (9).

8. That is $\lim_{n \to \widetilde{n}} g_K^*(n; n > \widetilde{n}) = g_K^*(\widetilde{n}; n \leq \widetilde{n})$. To see this note that

$$\lim_{n \to \widetilde{n}} g_K^*(n; n > \widetilde{n}) - g_K^*(\widetilde{n}; n > \widetilde{n}) = \frac{\sigma(\widetilde{n}\delta - \alpha p)}{\widetilde{n}(\sigma-1) - \sigma} - \frac{\widetilde{n}\beta - \alpha p}{\widetilde{n}-1} = \frac{\sigma(\widetilde{n}\delta - \alpha p)(\widetilde{n}-1) - (\widetilde{n}\beta - \alpha p)(\widetilde{n}(\sigma-1) - \sigma)}{(\widetilde{n}(\sigma-1) - \sigma)(\widetilde{n}-1)}$$

11. To check this recall that if $n > n$, necessary conditions for the existence of an interior equilibrium are $\sigma > \frac{n}{n-1} > 1$ and $z(\alpha p) < 0$ (see (21)). The derivative of (30) with respect to p is

$$\frac{-1}{\sigma - 1}[K(0) + b_i(0)]^{\frac{\sigma-1}{\sigma}} \left[\frac{z(\alpha p)}{n - \sigma(n-1)}\right]^{-1-\frac{1}{\sigma}} \left[\frac{\alpha(1-\sigma)}{n - \sigma(n-1)}\right] < 0$$

The negative sign follows directly from the conditions listed above.

12. The solution method we use in this subsection is similar to the one in Tornell (1997a).

13. To see this note that $\lim_{t \to T} g(t < T) - g(t \geq T) = -\alpha\epsilon < 0$.

14. Lane and Tornell (1996) provide more details on some of the country experiences. Michael Gavin (1993) studies the Nigerian case.

15. Although overall government spending fell in Venezuela after 1986, in line with our model, this was not the case for one subcomponent, government transfers.

16. We present data only for government consumption as other data for Cote d'Ivoire were not reported until the late 1970s and some data for Kenya only began in the mid-1970s.

17. Tamura explains his result by the restricted scope for human capital spillovers in a heterogeneous society, which is a complementary mechanism to ours.

18. Substituting (18) in (15) and taking derivatives we find that

$$H^*_{KK} = H^*_{Kb_i} = H^*_{b_i b_i} = -[K + b_i]^{\frac{-\sigma-1}{\sigma}} z(\beta)^{\frac{-1}{\sigma}} < 0$$

This implies that the associated Hessian is negative semidefinite. Therefore, the Hamiltonian is concave.

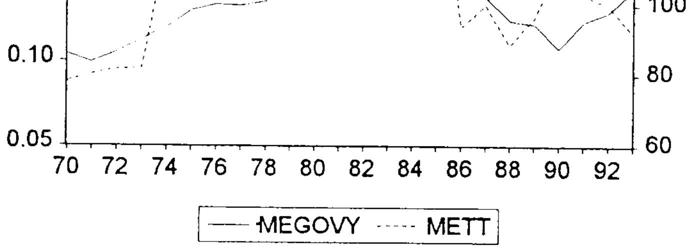
	TT	GTOTY	CONY	CAPY	TRANY	INTY
Nigeria						
1970	34.2	0.217	0.056	0.037	0.062	0.023
1981/82	195.7	0.359	0.103	0.106	0.13	0.045
1970/90	111.5	0.27	0.072	0.074	0.101	0.03
Venezuela						
1970	41.9	0.194	0.099	0.027	0.044	0.004
1981/82	196.6	0.257	0.104	0.03	0.093	0.019
1970/90	111.6	0.218	0.091	0.025	0.086	0.016
Mexico						
1970	78.1	0.114	0.046	0.017	0.041	0.01
1981/82	161.4	0.262	0.079	0.043	0.102	0.038
1970/90	114.7	0.203	0.061	0.023	0.061	0.06

TT is terms of trade index (1987=100). GTOTY is total government expenditure; CONY is government consumption; CAPY is government investment; TRANY is government transfers; INTY are government debt interest payments. All are expressed as ratios to GDP. Sources: TT and GDP data for Venezuela and Mexico are from World Tables; fiscal data for Venezuela and Mexico are from Roberto Perotti (1997); GDP and fiscal data for Nigeria are from Central Bank of Nigeria Annual Report 1994.

Predicted growth rate computed from 78 country cross-sectional growth regression 1970-90, with initial income per capita, average investment rate and average black market premium as regressors. Human capital data are lacking for Nigeria. Source: Barro and Lee (1994) data set.

Costa Rica		
1973/75	119.2	0.163
1976/80	127.7	0.194
1981/85	106.2	0.177
Cote d'Ivoire		
1973/75	93.8	0.193
1976/80	139.5	0.225
1981/85	107.9	0.187
Kenya		
1973/75	115.4	0.207
1976/80	140.3	0.252
1981/85	124.1	0.221

TT is terms of trade index (1987=100). GOVY is ratio of government consumption to GDP.
Source: World Tables.


0.10
0.05
100
80
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72
74
76
78
80
82
84
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88
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92
MEGOVY
METT