ON THE OPTIMAL SIZE OF PUBLIC SECTOR UNDER RENT-SEEKING COMPETITION FROM STATE COFFERS

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Abstract

This paper incorporates competition for fiscal transfers (or, equivalently, rent seeking from state coffers) into a standard general equilibrium model of economic growth and endogenously chosen fiscal policy. The government generates tax revenues, but then each selfinterested individual agent tries to extract, for his own personal benefit, a fraction of these revenues. Extracted tax revenues could alternatively be used to finance economy-wide infrastructure. We look at a Nash equilibrium in individual agents' behavior, and then investigate what the society should do to discourage rent-seeking competition. The focus is on the optimal size of public sector.

Keywords: social conflict, fiscal policy, economic growth.

JEL Code: D74, H3, O40.

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I. INTRODUCTION

Anecdotal and case study evidence across countries shows that politically influential interest groups attempt to appropriate national resources from the rest of society. This is particularly true in countries with "weak institutions".[1] Concurrent theoretical work has shown that non-cooperative behavior can generate a destructive redistributive struggle over wealth that leads to lower economic growth [see, among others, Lane and Tornell (1996), Tornell and Lane (1999) and Mauro (2002)].[2]

Motivated by the above, the present paper incorporates uncoordinated struggle for extra fiscal transfers into a model of growth and fiscal policy. We assume that the government collects tax revenues, but then each self-interested individual agent attempts to extract, for his own personal benefit, a fraction of these revenues. In other words, each individual rent-seeks from state coffers competing with other individuals.[3] We then do two things. First, we provide a simple general equilibrium framework that may be useful to the study of various issues related to atomistic rent-seeking behavior. Second, and more important, we endogenize economic policy and try to understand what the society should do to discourage such a behavior and reduce the associated social loss. Thus, analyzing socially optimal policy (and the associated size of public sector) under rent-seeking competition is the main difference from the literature.

Apparently, once one opens Pandora's box of rent seeking from state coffers, there is a whole range of possibilities depending on the organization and power of private agents versus the organization and power of government.[4] Here, we will focus on a case in which a large number of private agents compete for extra fiscal transfers facing a weak state. For instance, Knack and Keefer

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[1] See e.g. Lane and Tornell (1996) and Tornell and Lane (1999), and the empirical papers cited there. Weak institutions are associated with poor legal systems, insecure property and contract rights, social polarization, ethnic conflicts, low education rates, bureaucratic administrations, etc [see e.g. Knack and Keefer (1997), Rose-Ackerman (1999) and Easterly (2001)]. Then, in countries with weak institutions, special interests (e.g. industrial groups, public sector unions, bureaucrats, politicians, or even single firms) have the power to extract resources from the rest of society.

[2] Tornell and Velasco (1992), Benhabib and Rustichini (1996) and Velasco (1998) also model non-cooperative behavior and competition for redistribution [see Drazen (2000, chapters 10 and 11) for a survey]. Transfers to special interests have always been an important issue [see e.g. Drazen (2000) and Persson and Tabellini (2000)].

[3] The general theory is the theory of rent seeking, which refers to the socially costly pursuit of winning a contestable prize. In our paper, like in Mauro (2002), the prize is the (monopoly) rents that a government generates via coercive taxation. Then, individuals use their private resources to compete for these rents. See e.g. Drazen (2000, chapter 8) for a survey of rent seeking. Note that there is a strong similarity between rent seeking and common property models. That is, government assets can also be thought as a "common pool". Then, individuals, that have access to these assets, attempt to over-fish them for private benefit. See e.g. Drazen (2000, chapters 10 and 11) for a survey of appropriative behavior. Here, we will use the terms "rent seeking", "appropriation" and "extraction" interchangeably.

[4] For instance, Rose-Ackerman (1999, chapter 7) distinguishes four polar cases of corruption: first, the case in which powerful corrupt private agents facing a weak state can extract high private benefits without paying high bribes; second, the opposite extreme case in which a powerful head of government organizes the political system to maximize its rent-extraction possibilities facing a large number of weak private agents; third, a bilateral monopoly case in which powerful private interests face a corrupt ruler; fourth, a case of competitive corruption in which a large number of private agents deal with a large number of corrupt low-level government officials.

(1997, p. 1256) assess the strength of institutions from responses to questions about "claiming government benefits which you are not entitled to" or "cheating on taxes if you have the chance". This is the idea in our model. In turn, given the possibility of rent seeking by self-interested individuals, we ask, "What is the expenditure-tax policy mix that maximizes the economy's growth rate?". That is, we assume that policy decisions are in the hands of a well-meaning government. This is because we want to understand what is optimal from the society's point of view, rather than to study "equilibrium" policy. Nevertheless, our normative results and insights carry over to more general environments in which government officials also rent seek.[5]

To make our results clear, we choose as a benchmark a widely used and simple model. In particular, we choose Barro's (1990) model of economic growth and endogenously chosen fiscal policy, in which government expenditures enhance the productivity of private firms.[6] To this model, we add appropriative or rent-seeking competition for a fraction of collected tax revenues on the part of private agents. We look at a Nash equilibrium in private agents' behavior. This means that, in comparison with Barro's model, when the government chooses tax policy to maximize the economy's growth rate, it also tries to correct the social inefficiencies caused by rent-seeking competition. We then study the properties of optimal policy and its role in growth.

There are three main results: First, the possibility of extraction reduces economy-wide growth both directly (it reduces resources available for social infrastructure) and indirectly (it distorts the incentives of self-interested individuals by pushing them to appropriative activities). This is as in the literature. Second, for any feasible economic policy, a higher tax rate leads ceteris paribus to a lower fraction of effort allocated to work relative to appropriative activities. This is because individuals do not internalize the adverse effect of their appropriative activities on aggregate output. Hence, whenever the tax rate increases, they get the impression that the contestable prize (here, government tax revenue) also increases, and so attempt to extract a greater share of it by becoming more aggressive (see also Mauro (2002)). This is bad for growth. Third, when economic policy is endogenously chosen, and since a seemingly larger public sector triggers a more aggressive behavior on the part of self-interested individuals, the government finds it optimal to impose a relatively low tax rate (specifically, a tax rate lower than the one in Barro (1990)) so as to correct individuals' disincentives and push them to more socially efficient activities. By doing so, the government reduces (although it cannot eliminate) the deadweight loss arising from extraction.

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[5] Laffont and Tirole (1998), Acemoglu and Verdier (2000) and Sarte (2000) also assume a benevolent central government in problems with private interest groups and corrupt low-level bureaucrats. As Laffont and Tirole (1998, p. 479) point out this "is a first step toward a more general theory of regulatory politics" and "can be straightforwardly applied to cases in which the central government (Congress) does not maximize social welfare but tries to control the regulatory outcome". More discussion of this assumption is later.

Therefore, the new result is that extraction should be associated with lower, rather than higher, tax rates. Even if tax revenues are earmarked for public investment, the size of public sector (measured by the government expenditure-to-output ratio) should be getting smaller and smaller as the possibility of extraction from state coffers increases. This normative result extends the positive results of Tornell and Lane (1999) and Mauro (2002). Note that adding more types of rent-seeking agents would not change our main point. By contrast, it would further call for lower tax rates and smaller public sectors. In other words, to the extent that agents (e.g. private agents, low-level government bureaucrats, top-level government officials, politicians, etc) are self-interested and so attempt to extract from the pool of tax revenues, the socially optimal tax rate, and the associated size of public sector, are relatively low.

The rest of the paper is as follows: Section II describes the model. Section III solves for a decentralized competitive equilibrium. Section IV solves for optimally chosen policy and a general equilibrium. Section V concludes.

II. INFORMAL DESCRIPTION OF THE MODEL

The key features of the model are as follows: (i) We build on Barro's (1990) model. Here, we also assume that individuals can extract from total tax revenues to increase their own personal wealth. In doing so, they compete with other individuals. This appropriative, or rent-seeking, competition is given by a Nash game among individuals. (ii) Appropriation comes at a private cost.[7] Specifically, it requires labor effort.[8] Thus, each individual chooses optimally (in addition to consumption and saving) the allocation of its labor effort to work and appropriative activities. (iii) The amount of public sector income appropriated by each individual is proportional to the effort he, or she, allocates to the appropriative competition relative to the total effort allocated to appropriative competition by all individuals. (iv) This appropriative activity depletes the flow of social resources used as government production services. (v) A government (or perhaps the society) chooses economic policy to maximize the economy's growth rate. (vi) The sequence of events is as follows: Economic policy is chosen first, and in turn each private agent makes his allocation choices non-cooperatively and simultaneously. This means that the government acts as a Stackelberg leader vis-à-vis decentralized private agents. The general equilibrium will be a subgame-perfect Nash

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[6] Del Monte and Papagni (2001), Sarte (2001) and Mauro (2002) also use Barro's model to study rent seeking.

[7] Extracting transfers and favors from the government, cheating on taxes, bribing, lobbying, etc, are costly activities. In general, rent seeking (i.e. winning a contestable prize) requires the expenditure of private resources (time and effort).

[8] We could assume that extraction also requires private capital. This is not important.

equilibrium in private decisions and the chosen policy. (vii) We assume infinite-time horizons, continuous time, certainty and commitment technology on the part of government.[9]

III. DECENTRALIZED COMPETITIVE EQUILIBRIUM

We will work with backward induction. Thus, this section solves for a decentralized competitive equilibrium for any feasible economic policy. Economic policy will be chosen in the next section.

Firms' behavior

Firms are indexed by $i \in I$ and are modeled as in Barro (1990).[10] Each individual firm i maximizes profits, π^i:

$$\pi^i = (1-\tau)y^i - rk^i - wl^i \quad (1)$$

where $0 < \tau < 1$ is the output tax rate;[11] y^i is output produced by firm i; k^i and l^i are capital and labor used by firm i; and r and w are the interest rate and wage rate.

At the firm's level, the production function is:

$$y^i = AG^{1-\alpha}(k^i)^{\alpha}(l^i)^{1-\alpha} \quad (2)$$

where G is public production services, $A > 0$ and $0 < \alpha < 1$.

Each firm i acts competitively by taking market prices (r, w) and economic policy (τ, G) as given. When firm i chooses k^i and l^i, the first-order conditions are:

[9] The models closest to ours are those by Lane and Tornell (1996), Tornell and Lane (1999) and Mauro (2002). As said above, the key difference of our analysis is that here we endogenize economic policy. Then, the government has a non-trivial role to play: to internalize production externalities and individuals' atomistic incentives. There are also modeling differences (although this is less important). For instance, our model differs from that by Lane and Tornell (1996) and Tornell and Lane (1999) because in their work factor returns are exogenous and the common pool is the economy's capital stock rather than government tax revenue. Also, they focus on different issues. They show that an increase in the raw rate of return can reduce economic growth, because an increase in the raw rate of return leads self-interested groups to attempt to extract a greater share of national wealth. Demand for transfers is then reflected in higher tax rates (especially, in the formal sector) that reduce economy-wide growth. Mauro's (2002) model is similar to ours. For instance, like in our paper, the common pool is government tax revenue so that redistribution takes explicitly via government policy. On the other hand, he models rent seeking in a different way so as to focus on the role of strategic complementarities in generating multiple equilibria. Here, we use the rent seeking technology used by the literature on natural resources (see equation (5) below).

[10] We could assume that firms, like households, also extract public revenues; this is not important.

$$r = (1-\tau)\alpha \frac{y^i}{k^i} \qquad (3a)$$

$$w = (1-\tau)(1-\alpha)\frac{y^i}{l^i}$$

(3b)

Households' behavior

Households are also indexed by $i \in I$. Each individual household i maximizes intertemporal utility:

$$\int_0^\infty \log(c^i) e^{-\rho t}$$

(4)

where c is private consumption and $\rho > 0$ is the discount factor.

The flow budget constraint of household i is:

$$\dot{k}^i + c^i = rk^i + \eta^i h^i w + \frac{(1-\eta^i)h^i}{\sum_{i=1}^{I}(1-\eta^i)h^i}\delta T \qquad (5)$$

where $0 < \eta^i \leq 1$ and $0 \leq (1-\eta^i) < 1$ are respectively the fractions of effort, h^i, that i allocates to work and appropriative competition; T is total government income; and $0 \leq \delta < 1$ is the degree of economy-wide extraction (see below). That is, it is assumed that δT can be stolen from the government, and then each i attempts to extract a fraction of δT, where this fraction depends on the amount of effort that agent i allocates to the appropriative competition relative to all agents. In other words, we borrow the extraction technology used extensively by the literature on natural resources; see e.g. Dasgupta and Heal (1979). Grossman (2000) also uses this technology in a property rights model. Note that a positive δ presupposes weak institutions.

Each household i acts competitively by taking market prices (r, w), economic policy (T) and aggregate activity ($\delta, \sum_{i=1}^{I}(1-\eta^i)h^i$) as given.[12] Household i chooses the paths of c^i, k^i, η^i, h^i.

[11] Since the model is AK at social level (see below), the type of distortionary taxation assumed is not important.

[12] Each i takes the degree of economy-wide extraction, δ, as given. In equilibrium, δ will be endogenous and a function of the total rent-seeking activity in the economy (see (8a) below). This is standard modeling. Note that we

Without loss of generality, we assume $h^i \equiv 1$, i.e. total effort is equal to one in each time period.[13] The first-order conditions for consumption, saving and extraction, c^i, k^i, η^i, imply:

$$\dot{c}^i = c^i(r-\rho) \tag{6a}$$

$$w = \frac{\delta T}{\sum_{i=1}^{I}(1-\eta^i)} \tag{6b}$$

where (6a) is a standard Euler equation and (6b) implies that net returns from work and appropriative competition should be equal for the agent to be in equilibrium.

Government budget constraint

Assuming a balanced budget at each instant, the government's budget constraint is:

$$G + \delta T = T \tag{7}$$

where $T = \tau \sum_{i=1}^{I} y^i$ is total tax revenues. In other words, total tax revenues, T, finance public services, G, and total transfers, δT. Equivalently, only a part $0 < (1-\delta) \leq 1$ of public sector income is used for public services because rent-seeking individuals capture the rest.[14]

Decentralized competitive equilibrium

We now solve for a Decentralized Competitive Equilibrium (DCE). This is defined to be a Nash equilibrium in individuals' decisions in which: (i) each individual firm maximizes its own profits; (ii) each individual household maximizes its own utility; (iii) all constraints are satisfied and all markets clear.[15] A DCE holds for any feasible economic policy, where here policy is summarized by the tax rate, $0 < \tau < 1$. Obviously, a DCE is inefficient because private agents have ignored

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could assume that each i internalizes the effects of his/her own actions on aggregate outcomes. This is not important. What is important is that each i takes the actions of other individuals $j \neq i$ as given.

[13] This justifies why labor effort was not included in the utility function (4) above.

[14] Our modeling in (5) and (7) is consistent with evidence. As e.g. *The Economist*, October 26th, 2002, p. 42, reports in an article about corruption: "Nothing shocks Angolans. It's normal, said one, referring to the disappearance of $4.3 billion from state coffers in the past five years". For another motivation of (5) and (7), see the real-world examples provided by Mauro (2002, p. 7).

[15] Market clearing in the labor markets requires $L = \eta h$, where $h \equiv 1$.

externalities. We will focus on a symmetric DCE, i.e. in equilibrium all firms and households are alike.[16] Thus, from now on, the superscript i will be omitted. Also, for notational simplicity, we set $I = 1$, i.e. there is one firm and one household.

To close the model, we have to specify the degree of economy-wide extraction (δ). We assume that in equilibrium:

$$\delta \equiv f\left(\sum_{i=1}^{I}(1-\eta^{i})h^{i}\right) = f(1-\eta) \tag{8a}$$

where $f'(.) > 0, f''(.) \leq 0$.[17] That is, in equilibrium, δ is a positive function of the total time spent in extraction activities.[18] Specifically, to keep in line with the linear AK structure of the model, we assume - without loss of generality - a linear function for δ:[19]

$$\delta \equiv \delta_0 + \delta_1(1-\eta) \tag{8b}$$

where the constant term $\delta_0 \geq 0$ reflects the idea that, in countries with weak institutions, there is a possibility of extra transfers independently of the effort each individual allocates to rent seeking, and the technology parameter $\delta_1 \geq 0$ translates rent-seeking effort into extraction from state coffers. Notice that it must always be $0 \leq \delta < 1$.

We can now solve for a DCE. It is easy to show that equations (1)-(8) give:

$$\dot{c} = c\left((1-\tau)\alpha A^{\frac{1}{\alpha}}[(1-[\delta_0+\delta_1(1-\eta)])\tau\eta]^{\frac{1-\alpha}{\alpha}} - \rho\right) \tag{9a}$$

$$\dot{k} = [1-\tau(1-[\delta_0+\delta_1(1-\eta)])]A^{\frac{1}{\alpha}}[(1-[\delta_0+\delta_1(1-\eta)])\tau\eta]^{\frac{1-\alpha}{\alpha}}k - c \tag{9b}$$

$$\eta = \frac{(1-\alpha)(1-\tau)}{(1-\alpha)(1-\tau)+[\delta_0+\delta_1(1-\eta)]\tau} \tag{9c}$$

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[16] Solving for symmetric equilibria is not restrictive for what we do here. That is, we can still capture effects on incentives and therefore show how non-cooperative (Nash) and cooperative equilibria differ (see e.g. Cooper and John (1988) for the properties of symmetric Nash and cooperative equilibria). A simple way to get a cooperative equilibrium is to assume ex ante symmetricity in the optimization problem (4)-(5) above. Then, it is optimal to set η at its highest possible value, i.e. $\eta = 1$. Thus, when economic agents do not compete for extra transfers, all effort goes to work.

[17] Recall that, in equilibrium, all agents are alike and there is one agent. Also, $h \equiv 1$.

[18] See also e.g. Zak and Knack (2001) and Mauro (2002).

[19] We have experimented with richer functional forms and the main results do not change.

where (9a)-(9c) give the paths of (c,k,η). This is for any feasible economic policy, $0<\tau<1$.

Therefore, we have:

Proposition 1: *Given economic policy* $0<\tau<1$*, there is a unique Decentralized Competitive Equilibrium (DCE), which is summarized by equations (9a)-(9c). In this equilibrium, there is rent-seeking behavior,* $0<\eta<1$.

Proof: See Appendix A.

To understand the logic of the model, we present comparative static results in a DCE. Since analytical results are not possible in general,[20] we resort to numerical simulations. Table 1 below reports the effects of a changing tax rate, τ, on the fraction of effort that each individual allocates to work relative to rent seeking, η, the degree of economy-wide extraction, δ, the economy's consumption growth rate, $\gamma \equiv \frac{\dot{c}}{c}$, and the consumption-to-capital ratio, c/k. The results show that a higher τ leads monotonically to lower η and higher δ, while there is [as in Barro (1990)] a Laffer-curve type effect from τ to γ and c/k.[21]

Table 1 here

The main result is $\frac{\partial \eta}{\partial \tau}<0$. That is, other things equal, a higher tax rate leads to a lower fraction of labor effort allocated to work relative to appropriative activities. This happens because private agents do not internalize the adverse effect of their appropriative activities on aggregate output, or equivalently the tax base, y. Hence, whenever the tax rate, τ, increases, they get the impression that the contestable prize, $\delta T=\delta\tau y$, also increases and so attempt to extract a greater share of it by demanding more transfers. This aggressive behavior is at the cost of time allocated to work, η [see also Mauro (2002)]. In turn, as (9a) implies, this is at the society's expense (a lower η leads to lower growth in a DCE).

[20] Equation (9c) implies $\frac{\partial \eta}{\partial \tau}=\frac{-[(1-\alpha)(1-\eta)+f(1-\eta)\eta]}{\left[(1-\alpha)(1-\tau)+\tau f(1-\eta)-\tau f'(1-\eta)\eta\right]}$, whose sign is ambiguous. Only if we set $\delta_1=0$ so that $f'(.)=0$ in (8a)-(8b), this sign is unambiguously negative.

[21] The growth rate, γ, can easily become positive if we set the productivity parameter, A, higher than one. Since this is not important, we just set $A=1$ in all numerical examples.

Table 2 below reports the effects of a changing δ_0 (see (8b) above). A higher δ_0 leads monotonically to lower η, higher δ, and lower γ and c/k. Table 3 reports similar effects of a changing δ_1 (again see (8b) above). In other words, higher δ_0 and δ_1 (and hence higher δ) reduce economy-wide economic growth both directly (see (9a)) and indirectly (via a decrease in η; see (9c)). The direct effect arises simply because there are less social resources available to finance public infrastructure. The indirect effect arises because the possibility of extraction distorts individuals' incentives and pushes them to appropriative activities, which are socially harmful. Therefore, we get the standard result of the literature; namely, rent seeking is detrimental to growth.

Tables 2 and 3 here

IV. ENDOGENOUSLY CHOSEN POLICY AND GENERAL EQUILIBRIUM

We now endogenize the choice of economic policy, as summarized by the tax rate, $0 < \tau < 1$. Following Barro (1990) and most of the endogenous growth literature, we assume that τ is chosen by a well-meaning government, whose objective is to maximize the economy's consumption growth rate. In doing so, the government takes into account the DCE derived above, and thus solves a second-best policy problem.

Note that the objective of a well-meaning government could alternatively be to maximize households' lifetime utility as in the standard optimal tax Ramsey problem. Whether the government maximizes economy-wide growth, or households' utility, does not matter for our qualitative results. What does matter is the assumption that the central authority does not rent seek itself. As said in the Introduction above, we make this assumption because here we want to address the question of the optimal size of public sector from the society's viewpoint. That is, as Laffont and Tirole (1998, p. 475) point out, we follow the "public interest" theory of policy emphasizing the government's role in correcting imperfections (here, in the form of production externalities and appropriative competition for fiscal transfers).

Socially optimal policy

The planner chooses the tax rate, τ, to maximize the consumption growth rate in (9a). The solution to this optimization problem gives:

Proposition 2: *There is an optimal tax rate, τ^*, that maximizes the economy-wide consumption growth rate. This tax rate is a solution to:*

$$0 < \tau^* = \frac{(1-\alpha)(1+\varepsilon)}{(1-\alpha)(1+\varepsilon)+\alpha} < 1-\alpha < 1 \qquad (10)$$

where $\varepsilon \equiv \frac{\partial \eta}{\partial \tau}\frac{\tau}{\eta}\left(1+\frac{f'(1-\eta)\eta}{(1-f(1-\eta))}\right)$ *and* $\frac{\partial \eta}{\partial \tau} = \frac{-[(1-\alpha)(1-\eta)+f(1-\eta)\eta]}{\left[(1-\alpha)(1-\tau)+\tau f(1-\eta)-\tau f'(1-\eta)\eta\right]}$.

Proof: See Appendix B.

A general equilibrium is summarized by (9a)-(9c) and (10). We can first solve (9c) and (10) simultaneously for η and τ.[22] In turn, (9a) gives the so-called balanced growth path, $\gamma \equiv \frac{\dot{c}}{c} = \frac{\dot{k}}{k}$, i.e. the common constant rate at which c and k can grow positively. Finally, (9b) can give the consumption-to-capital ratio, c/k.[23]

Proposition 2 shows that τ^* lies in the region $0 < \tau < 1-\alpha$. That is, the chosen tax rate (and the associated size of public sector)[24] are smaller than the productivity of government expenditures, $(1-\alpha)$, which is Barro's popular result. Intuitively, since a higher tax rate gives a wrong signal to individuals that the pie (total tax revenues) gets larger, the government finds it optimal to impose a relatively low tax rate to correct individuals' disincentives. By doing so, the government aims to discourage self-interested individuals from going for extraction and thereby push them to use their private resources more efficiently.

Tables 4 and 5 below report numerical results in general equilibrium.[25] Table 4 shows the effects of the autonomous part of extraction, δ_0, on all endogenous variables including the optimally chosen tax rate, τ^*. As δ_0 increases, the tax rate, τ^*, falls monotonically, while the total degree of extraction, δ, increases monotonically. The idea is that the government chooses a smaller and smaller tax rate in order to counterbalance the adverse effects of a rising δ_0. Nevertheless, the policy control is less than perfect because, although τ^* falls to correct individuals' disincentives, the direct effect dominates so that the overall degree of extraction, δ, increases (see (8b) above).

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[22] In our setup, it is optimal to keep tax policy, τ, and the allocation of work effort, η, flat over time. In other words, τ and η are not state-contingent. See Drazen (2000, chapter 11) for a survey of state-independent and state-dependent behavior in models with extraction.

[23] When c and k grow at the same rate along the long-run balanced growth path, equations (9a)-(9b) give $\frac{c}{k} = \rho + [(1-\alpha)(1-\tau)+\delta\tau]A^{\frac{1}{\alpha}}\left((1-\delta)\eta\tau\right)^{\frac{1-\alpha}{\alpha}} > 0$. Then, it is easy to see that the eigenvalues are unstable so that, with forward-looking variables, the economy jumps to its long-run equilibrium and there are no transitional dynamics as in the basic AK model. See Park and Philippopoulos (2002) for details.

[24] As (7) shows, the tax rate equals the government expenditure-to-output ratio.

[25] Notice that τ^* is always less than $(1-\alpha) = 0.6$, which is Barro's (1990) tax rate. This is as in Proposition 2.

As a result, γ and c/k fall monotonically. This less-than-perfect control is also shown by the fact that, although policy is optimally chosen, the growth rate (γ) is always lower than in the benchmark case in which $\delta = 0$ (in this Barro-case, as the first row of Table 4 reports, $\tau = 0.6, \gamma = 0.0544$ and $c/k = 0.0632$). Finally, notice in Table 4 that the effect of δ_0 upon η is U-shaped. Intuitively, as the opportunities of extraction increase, the fraction of effort that each individual allocates to work relative to rent seeking falls initially, but then it starts increasing as the size of the pie (government tax revenue) gets smaller and smaller. It is worth pointing out that this general equilibrium effect of δ_0 upon η differs from the one in a DCE analyzed in the previous section. Specifically, in Table 2 above, a higher δ_0 led monotonically to lower η; this was for given policy. Now, where policy is endogenously chosen, the government can stop the fall in η by choosing a small enough public sector (and so mitigate the adverse effects of a rising δ_0). Table 5 reports that the effects of δ_1 are qualitatively similar to those of δ_0.

Tables 4 and 5 here

Therefore, the main results are: (a) from a social welfare point of view, the intensity of extraction and the size of the public sector should move in opposite directions;[26] (b) the government cannot fully correct the distortion arising from the possibility of extraction, simply because it does not have enough policy instruments at its disposal.

Special cases ($\delta_0 = 0$ *or* $\delta_1 = 0$*)*

It is interesting to discuss two special cases. First, when $\delta_0 = 0$ in (8b) above. That is, the degree of economy-wide extraction is determined entirely by the total time spent in extraction activities. This is studied in Appendix C. In this case, there can be two DCE: a good equilibrium without rent seeking, $\eta_1 = 1$; and a bad equilibrium with rent seeking, $\eta_2 < 1$, if the tax rate (or equivalently the size of public sector) is large enough. Intuitively, in the absence of an institutionally given extraction (δ_0) that unambiguously makes rent seeking the dominant behavior, there can be an expectations coordination problem. Atomistic individuals can coordinate their actions to an outcome without rent seeking, but it is equally possible that rent seeking becomes their self-

[26] When the government also rent seeks (i.e. it is not benevolent), δ and τ might move in the same direction, especially when there are connections between policymakers and private interest groups sharing the extra rents. In our model, this can be shown by assuming that the government chooses tax policy so as to maximize a weighted sum of the economy's growth rate and extracted resources enjoyed by private interest groups.

fulfilling belief.[27] In turn, when the government chooses policy, it sets $\tau^* = 1-\alpha$ so that $\eta = 1$. In other words, the benevolent government uses its policy instrument to select the good equilibrium and lead the economy to Barro's second-best solution.

Second, when $\delta_1 = 0$ in (8b) above. That is, now the degree of economy-wide extraction is institutionally given, $\delta = \delta_0 > 0$. In this case, all results of the general case hold. In addition, as Appendix D shows, we can get an analytical solution and there is a unique tax rate in Proposition 2.

V. CONCLUDING REMARKS AND EXTENSIONS

This paper considered an economy where self-interested individuals competed for national wealth. Specifically, we extended Barro's (1990) model. In this model, on the one hand, government services enhance the productivity of private firms; on the other hand, the provision of government services requires distorting taxes. This produces a tradeoff in fiscal policy that can determine the optimal tax rate and the associated optimal size of public sector. Here, to this tradeoff, we added rent-seeking competition for a fraction of collected tax revenues.

Since our results have been written in the Introduction, here we only discuss two extensions. First, we focused on rent seeking by private actors ignoring rent seeking by government officials. It is known that low-level government bureaucrats and top-level government officials also rent seek at the citizens' expense. As argued above, to the extent that the key human motivator is the same (i.e. self-interest), so that people get more aggressive as the contestable prize increases, our main normative result is not expected to change. Nevertheless, it would still be interesting to model the interaction between corrupt private actors and corrupt government officials in a general equilibrium model of growth and endogenously chosen policy. Second, here we took weak institutions as given, i.e. we assumed that extraction is possible, and then studied its implications. That is, we focused on the demand side of rent seeking. While this is as in most of the literature, an interesting extension could be to explain how the possibility of extraction arises in the first place (i.e. why δ is positive in equation (5)). In other words, as Laffont (2000) points out, it is also important to open the black box of the supply side of rent seeking. We leave these extensions for future research.

[27] Mauro (2002) also gets multiple DCE. However, this is due to strategic complementarities in his paper.

APPENDIX

A. Proof of Proposition 1

Eq. (9c) gives a quadratic equation in η, $\eta^2 - \left(\frac{(1-\alpha)(1-\tau)+(\delta_0+\delta_1)\tau}{\delta_1\tau}\right)\eta + \frac{(1-\alpha)(1-\tau)}{\delta_1\tau} = 0$.

Say that there are two real roots, denoted as η_1 and η_2. Since $0<\alpha<1$ and $0<\tau<1$, both roots are positive. Also, $(\eta_1-1)(\eta_2-1)=\frac{-\delta_0}{\delta_1}<0$. Hence, one root is higher than one, while the other root is positive but less than one. Only the latter is acceptable, so there is a unique solution $0<\eta<1$. In turn, (9a) and (9b) give a unique solution for the other endogenous variables (for details, see below Proposition 2 in the main text).

B. Proof of Proposition 2

Maximizing $\frac{\dot{c}}{c}$ in (9a) with respect to τ gives $(1-\alpha)(1-\tau)(1+\varepsilon)=\alpha\tau$, or $\tau^* = \frac{(1-\alpha)(1+\varepsilon)}{(1-\alpha)(1+\varepsilon)+\alpha}$, where $\varepsilon \equiv \frac{\partial\eta}{\partial\tau}\frac{\tau}{\eta}\left(1+\frac{f'(1-\eta)\eta}{(1-f(1-\eta))}\right)$, $\frac{\partial\eta}{\partial\tau} = \frac{-[(1-\alpha)(1-\eta)+f(1-\eta)\eta]}{\left[(1-\alpha)(1-\tau)+\tau f(1-\eta)-\tau f'(1-\eta)\eta\right]}$ and the function $f(.)$ is as in (8a). For this equation to hold, $(1+\varepsilon)>0$ so that $0<\tau^*<1$. Also, if $\frac{\partial\eta}{\partial\tau}<0$ (which is what Table 1 shows) and hence $-1<\varepsilon<0$, we have $\tau^*<1-\alpha$. Notice that we cannot exclude the possibility of multiple solutions for τ^*. See Park and Philippopoulos (2003) for a more general growth model that shows the possibility of multiple general equilibria (optimal tax Ramsey equilibria), even when there is a unique competitive equilibrium for given policy.

C. The special case $\delta_0 = 0$

Let us go back to Appendix A. Then, if $\delta_0=0$, $(\eta_1-1)(\eta_2-1)=0$. Hence, one root is equal to one; say $\eta_1=1$. But then $\eta_2=\frac{(1-\alpha)(1-\tau)}{\delta_1\tau}$, which is less than one if $\tau>\frac{(1-\alpha)}{(1-\alpha+\delta_1)}$. Therefore, it is possible to have two solutions in a DCE: one without rent seeking, $\eta_1=1$; and one with rent seeking, $\eta_2<1$, if the tax rate is high enough. Next, let us go back to Appendix B, which studies general equilibrium. Then, if $\delta_0=0$, it is easy to show that $\varepsilon=0$ so that $\tau^*=1-\alpha$ and $\eta=1$.

D. The special case $\delta_1 = 0$

We again have $(1-\alpha)(1-\tau)(1+\varepsilon) = \alpha\tau$ as in Appendix B above, but now $\varepsilon \equiv \frac{\partial\eta}{\partial\tau}\frac{\tau}{\eta} = \frac{-\delta\tau}{(1-\tau)[(1-\alpha)(1-\tau)+\delta\tau]} < 0$. Thus, we get a quadratic equation in τ, $(1-\alpha-\delta)\tau^2 - (1-\alpha)(2-\alpha)\tau + (1-\alpha)^2 = 0$. Say that there are two real roots, τ_1 and τ_2. It is convenient to distinguish two cases: (a) when $(1-\alpha-\delta) < 0$ and (b) when $(1-\alpha-\delta) > 0$. In either case, if we check the sign of $(\tau_1 - 1)(\tau_2 - 1)$, it follows that there is only one solution in the right region, namely between 0 and 1. In particular, in case (a), it must be $0 < \tau_1 < 0$ and $\tau_2 < 0$; while, in case (b), it must be $0 < \tau_1 < 0$ and $\tau_2 > 1$. Therefore, there is a unique solution, $0 < \tau^* < 1-\alpha$.

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TABLES

Table 1: effects of τ in DCE

τ	η	δ	γ	c/k
0.10	0.9633	0.2071	-0.0124	0.0310
0.20	0.9173	0.2165	-0.0026	0.0448
0.30	0.8603	0.2276	0.0049	0.0550
0.40	0.7880	0.2424	0.0080	0.0599
0.50	0.6976	0.2602	0.0062	0.0593
0.60	0.5877	0.2812	0.0004	0.0543
0.70	0.4534	0.3093	-0.0077	0.0458

Note: $\alpha = 0.4, \quad A = 1, \quad \rho = 0.04, \quad \delta_0 = 0.20, \quad \delta_1 = 0.20$.

Table 2: effects of δ_0 in DCE

δ_0	δ	η	γ	c/k
0	0	1	0.0260	0.0702
0.10	0.1152	0.9242	0.0140	0.0625
0.20	0.2276	0.8603	0.0049	0.0550
0.30	0.3389	0.8054	-0.0021	0.0479
0.40	0.4485	0.7575	-0.0076	0.0414
0.50	0.5568	0.7156	-0.0118	0.0355
0.60	0.6643	0.6783	-0.0150	0.0302
0.70	0.7709	0.6451	-0.0174	0.0258
0.80	0.8767	0.6153	-0.0190	0.0223
0.90	0.9824	0.5879	-0.0200	0.0201

Note: $\alpha = 0.4, \quad A = 1, \quad \rho = 0.04, \quad \tau = 0.30, \quad \delta_1 = 0.20$.

Table 3: effects of δ_1 in DCE

δ_1	δ	η	γ	c/k
0	0.2000	0.8750	0.0069	0.0568
0.10	0.2128	0.8683	0.0060	0.0560
0.20	0.2276	0.8603	0.0049	0.0550
0.30	0.2447	0.8513	0.0037	0.0539
0.40	0.2633	0.8420	0.0025	0.0527
0.50	0.2832	0.8331	0.0012	0.0514
0.60	0.3081	0.8197	-0.0003	0.0499
0.70	0.3352	0.8068	-0.0019	0.0482
0.80	0.3655	0.7932	-0.0036	0.0463
0.90	0.3951	0.7822	-0.0051	0.0445
1.00	0.4334	0.7660	-0.0069	0.0422

Note: $\alpha = 0.4, \quad A = 1, \quad \rho = 0.04, \quad \tau = 0.30, \quad \delta_0 = 0.20$.

Table 4: effects of δ_0 in general equilibrium

δ_0	δ	η	τ	γ	c/k
0	0	1	0.6000	0.0544	0.0632
0.10	0.1306	0.8441	0.4597	0.0223	0.0688
0.20	0.2443	0.7778	0.4126	0.0081	0.0601
0.30	0.3530	0.7348	0.3804	-0.0009	0.0513
0.40	0.4591	0.7044	0.3542	-0.0072	0.0432
0.50	0.5631	0.6837	0.3301	-0.0117	0.0362
0.60	0.6654	0.6725	0.3050	-0.0150	0.0303
0.70	0.7649	0.6747	0.2743	-0.0174	0.0256
0.80	0.8591	0.7040	0.2270	-0.0190	0.0222
0.90	0.9393	0.7954	0.1410	-0.0198	0.0204

Note: $\alpha = 0.4$, $A = 1$, $\rho = 0.04$, $\delta_1 = 0.20$.

Table 5: effects of δ_1 in general equilibrium

δ_1	δ	η	τ	γ	c/k
0	0.1999	0.7754	0.4651	0.0132	0.0640
0.05	0.2108	0.7754	0.4522	0.0119	0.0632
0.10	0.2222	0.7754	0.4391	0.0106	0.0622
0.15	0.2335	0.7762	0.4258	0.0093	0.0612
0.20	0.2442	0.7779	0.4125	0.0081	0.0601
0.25	0.2549	0.7798	0.3994	0.0069	0.0590
0.30	0.2652	0.7821	0.3865	0.0057	0.0577
0.35	0.2750	0.7853	0.3737	0.0046	0.0565
0.40	0.2844	0.7887	0.3612	0.0035	0.0553
0.45	0.2932	0.7924	0.3491	0.0025	0.0540
0.50	0.3017	0.7962	0.3374	0.0015	0.0528
0.55	0.3093	0.8008	0.3261	0.0006	0.0516

Note: $\alpha = 0.4$, $A = 1$, $\rho = 0.04$, $\delta_0 = 0.20$.

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