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Abstract. This paper examines choice of occupation between productive activities and rent-seeking in an oil-dominated economy where oil rent is the major source of public revenue. Three regimes can occur: no rent-seeking, coexistence of rent-seeking and of productive activity and full rent-seeking. The economy may get trapped in each regime unless it shocked by a substantial change in exogenous parts of reward structure. In particular in the latter case the extraction and liquidation of oil is the only productive activity. Oil boom in general rewards both productive and unproductive activities unequally and hence affects occupational choice. We identify situations where boom favours misallocation of talent and the extent of diversion that boom induces dominates its income effect. Our model also captures voracity effect where fiscal transfers grow more proportional than the size of windfall itself. Boom may however cause changing of regime from coexistence of both activities to full rent-seeking even when the voracity effect is not operative. In this case boom has a permanent effect and its aftermath persists even when the oil rent returns to its pre-boom level.

Keywords : oil economies, rent-seeking, occupational choice, oil boom, voracity effect
JEL classification: D72 , H59 , J24 , O53, Q33

1 Introduction

This paper examines endogenous allocation of human resources between productive activities and rent-seeking in a natural resource abundant economy where the state has a monopoly right on the extraction and liquidation of natural resource (e.g. the case of oil in Middle East and North African economies) and the income from natural resource liquidation is the major source of public revenue.

Beside direct predation on producers, rent-seekers in oil economies can claim on oil rent via a fiscal process that effectively allows open access to the public revenues. Rent-seeking in this case survives even when there is no production to be grabbed and the economy relies mostly on oil rent.

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In studies concerning the effect of rent-seeking on misallocation of talent, two types of equilibrium are identified namely *good* equilibrium without rent-seeking and coexistence of rent-seeking and of production. We show that when natural resource comes into account, another regime is feasible where there is no productive activity and all agents are rent-seekers.

Further to justification of no-productive equilibrium, another distinction of the present study is that natural resource is state-owned. We assume that fiscal authorities are in charge of the distribution of resource rent. They are influenced however by rent-seekers' lobby. Using this framework, which is close to the political economy of public spending in oil abundant economies (see Amuzegar 1999, p. 14-16), we characterize conditions upon which each type of equilibrium occurs; explore how the extent of rent in each regime is determined and how it depends on the lobbying activities. The paper also addresses how political pressure affects combination of public expenditure and size of transfers.

Although resource boom naturally boosts reward to both productive and unproductive activities, its income effect is not neutral in general in the case of coexistence of two activities. Whether boom favours productive or unproductive activities depends on the characteristics of pre-boom situation. In the latter case where boom pays more to the rent-seekers it is possible that, due to the extent of diversion induced, the overall effect of boom is welfare worsening. Moreover a boom with large enough magnitude is likely to displaces the economy from coexistence of both activities to full rent-seeking. In this case the after effects of boom are irreversible and the economy will be trapped in no-activity equilibrium even when the oil rent returns to its pre-boom level.

In addition to the specific aspects of rent-seeking and occupational choice in oil economies, our results bear some similarities with the earlier contributions on the effect of rent-seeking on allocation of talent and overall performance of a general economy e.g. by Murphy et. al. (1993) and Acemoglu(1995). According to our findings both the allocation of talent and reward to existing activities are jointly determined at equilibrium. There is a scope for multiplicity of equilibria including good equilibrium. This situation is not however feasible unless relative productivity of working is sufficiently high. Finally, we show that producers are under paid except in the case of good equilibrium. Additionally past allocation of human resources in one hand and institutions and policies on the other are two factors that determine in which equilibrium the economy lands. The first element is represented by the inherited allocation of human resources between two activities and the second is addressed by the exogenous aspects of reward structure.

This study captures the main features of voracity effect introduced in Lane and Tornell(1996). We do not explain why redistribution of windfalls exceeds the size of windfall itself, but rationalize how the effect proceeds. In particular our paper elaborates how in the presence of the voracity effect, boom supports diversion and pushes the economy toward full rent-seeking. We also show that change of regime from coexistence of both activities in pre-boom equilibrium to full rent-seeking in post boom era is likely even when voracity effect is not operative.

Our findings are also consistent with those of Baland and Francois(2000) where the effect of resource boom on the extent of rent-seeking depends on the pre-boom situation. In our model however boom may support productive activities when the pre-boom level of rent-seeking intensity is low, but not necessary zero. Having noticed that good equilibrium is an unlikely situation in actual economies, our results seems more consistent with empirical evidence than those of Baland and Francois.

The plan of the paper is as follows. We relate our study to the earlier contributions in next section. In section 3 the formal skeleton of the paper is introduced. Section 4, characterizes the equilibrium of the model with its existence and uniqueness properties. Section 5 analyses the effect of change in the parameters and oil rent on the reward structure and the allocation of human resources. These two sections, obtain most of the important results of the paper. We finally conclude in section 6.

2 Link to the literature

This study supports the original idea of Baumol(1990) who emphasizes the importance of allocation of talent rather than its pure supply on the economic success and the role of relative payoff on this allocation. Our departure point is that here there is a two-sided link between reward structure and the allocation of human resources and so the relative payoff is not exogenous though there are naturally some exogenous elements in the reward structure.

Apart from especial features of rent-seeking in oil economies, our model is closely related to the literature concerning the effect of rent-seeking on the allocation of human resources (e.g. Murphy et. al. 1991,1993, Acemoglu 1995; Acemoglu and Verdier 1998, 2000, Hall and Jones 1999 and Romer 2001, sec. 3.11). This group of studies applies *prey and predator model*[2] where rent-seekers with a predetermined probability appropriate part of producers' income. In our model, the government acts as an intermediary that taxes the producers and extracts the natural resources to finance the productive services and public transfer in favour of producers and rent-seekers respectively. Hence no party plays an explicit predatory role in our model.

Given the appropriation rate and the probability of inspection of producers by rent-seekers, the size of rent in the above mentioned literature is determined in terms of the producers' income. In our model, instead the source of rent is external for individual rent-seekers though it depends on the extent of lobbying. The rent is financed by liquidation of the natural resources. In our setting both producers and rent-seekers benefit from natural resources and the main affected party that pays the cost of rent-seeking is next generation who are absent from our analysis. Government is also neutral with respect to the inefficiencies gen-

[2] Grossman(1998) provides a unified framework for the interation between producers and predators in terms of the resources that they use for defensive and offensive purposes respectively. Baumol(1990) also in a historical approach, shows how unproductive entrepreneurship has been gradually transformed from military activities to less violent forms of rent seeking.

erated by rent-seeking and its budget represents the influence of rent-seekers' lobbying. This is why there is no rent-avoidance activities in our model.

In contrast with the predator-prey models, here the core of rent-seeking lies in the appropriation of natural resource through lobbying. In this view our model is in line with *common pool* and *open access* models (e.g. Tornell and Velasco 1992; Lane and Tornell 1996; Tornell and Lane 1998,1999). In our model rent-seekers, due to their political influence, have the ability to extract transfers from the government that further must balance its budget. So that the transfers result in taxes on production and also depletion of the oil stock which is within easy reach of the fiscal authority. Thus the power to extract transfers gives rent-seekers common access - via the government budget constraint - to the public revenues.

The closest study to ours in question of research is Baland and Francois(2000) which considers the interaction between entrepreneurs and rent-seekers in a developing economy where the former group are manufacturers and the latter hold licence on import. Baland-Francois's model shares with ours in the establishment of full rent-seeking equilibrium. The main message of their study is also very close to ours. The effect of an increase in the value of the economy's endowment of productive resources on the allocation of human resources between productive and unproductive activities depends critically on the nature of the equilibrium where the economy started. The higher the initial proportion of agents engaged in entrepreneurship, the more likely the resource boom is in favour of productive activity.

The measure of entrepreneurship in Baland-Francois model is the number of existing industrial sectors where production by the domestic entrepreneurs takes place. When a goods is produced domestically in a sector, it brings profit to the entrepreneur and destroys the rent of license holder. Rent-seeking is therefore a passive activity that plays the form of residual in manufacturing. Rent-seekers hold the licence on a sector so long as manufacturers replace them. Paradoxically people are better off when the industrialized goods are produced domestically instead of importing from world market.

The present paper also relates with Boyce(1998) who applies Becker(1983)'s political game to natural resource quota allocation. The distinction is that Boyce studies purely the effect of rent-seeking contest on the appropriation of an open access natural resource, while in ours rent-seekers in addition to the competition among themselves, compete with the producers to appropriate natural resources as the prize of the contest.

The idea that government transfers are likely to bring about considerable rent-seeking waste is referred to Tullock(1967)'s original paper. Following that, Katz and Rosenberg(1989) in an initial step toward what they called *the macroeconomic effect of rent-seeking* estimate the extent of rent-seeking by calculating the total change in the proportion of government spending. Our paper is close to Katz-Rosenberg idea because we consider rent-seeking in a macro framework either and also trace back the effect of rent-seeking on the combination of public expenditure. The main distinction is that our approach is purely theoretical; we consider both causes and effects of rent-seeking; and finally in our model lobby-

ing channels government expenditures toward rent-seekers and total change in public spending is not our interest.

Another related work to ours is Gradstein(1993) who highlights the non-benevolent behaviour of the government and considers transfer of rent as by-product of the provision of public goods by the government. The novelty in our work is the link between public goods models incorporating rent-seeking and the occupational choice in natural resource economies. Our approach is also related to Chung(1996) in whose paper the rent increases with the total amount of lobbying. The link in our model is however indirect and acts through the political influence of lobbying fiscal authorities. Another relevant study to our paper is Kahana and Nitzan(1999) where the potential beneficiaries of the rents attempt to influence political allocation. The difference is that in the above study, the reason for lobbying is that government is not perfectly credible and thus may not stand behind its commitment and actually make the promised rent. In our paper however, there is no uncertainty of award but there is room for cultivation of treasury's interest to spend higher on public transfer.

3 The model

3.1 Basic elements

Consider an economy consisting of L identical agents, each with some talent that can be employed either in productive activities which broadly defined as working in the product market; or unproductive activities that bring positive return to the individuals but not to the society and thus create negative returns on some other individuals. We call this type of activities, rent-seeking.

The number of rent-seekers is denoted by $N = 0, 1, ..., L$. So there is $L(1-n)$ workers in the model economy where $n \equiv N/L$ is the relative size of rent-seeking. We refer to L as talented individuals or human resources herein. We abstract from considering raw labour believing that choice of occupation between productive and unproductive activities is mostly relevant among talented people rather than unskilled labour.

The final good in this economy is produced by the following technology[3]

$$Y = AL(1-n)G \tag{1}$$

where $A > 0$ is the productivity factor and G is the amount of productive services (e.g. infrastructures) provided by the government (See Barro and Sala-i-Martin 1995, sec. 4.4 on this).

The government, as a typical oil-based state, provides its revenues from two main sources of selling of the extracted oil, Q and raising proportional tax levied on producers' income as

[3] We abstract from capital and other conventional factors of production. This simplification is consistent with an economy where at the steady state growth ceases and capital remains unchanged.

$$T = \tau Y \tag{2}$$

where $\tau \in (0, 1)$ is the exogenous tax rate. We assume that Q is total revenue derived from liquidation of oil out of extraction cost which is referred to herein as oil rent.

The government, apart from productive expenditures, spends rest of its outlays as public transfer, R. This implies

$$T + Q = R + G. \tag{3}$$

By comparing this configuration with a non-oil economy, one concludes that here oil revenues compensates the budget deficit, which is consistent with the stylized facts of public sector in oil-based economies[4]. The income from liquidation of oil helps cutting tax and mitigating its burden in favour of current generation when there is no voice in support of next generations who are also the owners of oil resources[5]. In the next section, we introduce an alternative sector that competes for the human resources with the production sector.

3.2 Rent-seeking contest

Beside working in the product market, individuals can choose to be rent-seeker. This involves two types of activities. Rent-seekers lobby fiscal authority to divert public expenditures to transfer instead of productive spending. They further compete for this prize. We describe the former activity in next section and explain the contest among rent-seekers as follows.

Public transfer is distributed in a lottery fashion. Rent-seekers compete for its appropriation by investment in the rent-seeking contest. More formally the competition can be considered as a one-shot contest among N players for winning of a pre-determined prize whose total value is R. We assume that marginal return to lobbying outlays, in Tullock's winning probability function is equal to one[6]. Along the line of Berry(1993), R can be appropriated by k winners, where $k = 1, ..., N$, and the prize is divisible only to k units.

[4] Amuzegar(1999, p174) reports the share of oil and gas revenues in public income of OPEC countries as follows: "... in the case of Kuwait, Nigeria, Qatar and UAE [,the share] exceeded 80 percent on average. For Iran, Saudi Arabia and Venezuels,... about 70 percent or more. Lybia relied on oil income for nearly 60 percent of its total fiscal receipts. Algeria, Ecuador and Gabon had nearly 50 percent of their fiscal revenues from oil and gas. Only Indonesia managed to keep its need for oil income below 40 percent ".

[5] When oil is the majour source of public revenue and producers as well as rent-seekers benefit from liquidation of natural resources, the opposition of taxpayers to the allocation of public transfer to rent-seekers is negligible and our assumption concerning the politically passive role of workers seems realistic.

[6] There are two main approaches in the analysis of rent-seeking, namely the lottery model in which the probabaility of winning of a given player is proportional to the relative size of his expenditures; and the perfectly discriminating contest model where the player who spends more resources always wins. In the present paper we follow the former approach. For a comprehensive studies of Tullock's rent-seeking contest of the *winner-takes-all* type see Perez-Castrillo and Verdier(1992) and Nitzan(1994).

In a symmetric equilibrium, each player is an active rent-seeker who spends $x = R[(N-k)/N^2]$ into the business with expected payoff of (see appendix)

$$V = kR/N^2 \quad \text{for} \quad N = 1, 2, ..., L \quad \text{and} \quad 0 \quad \text{for} \quad N = 0. \tag{4}$$

The total outlay is then

$$X = R(1 - k/N) \tag{5}$$

>From this, rent dissipation, i.e. X/R for finite N is less than one indicating that rent-seeking is efficient in Tullock's context. In comparison with V which is the *ex-ante* return, the *ex-post* payoff to winners is $R(\frac{1}{k} - \frac{1}{N} + \frac{1}{N^2})$ while the losers[7] gets $-x$. By assuming a *Winner-help-loser mechanism* (see e.g. Baik 1994) within the rent-seeking sector, the income distribution effect of winning is neutralized and so ex-ante and ex-post payoff to the rent-seekers are the same[8] and equal to V.

As one considers, both per-player and total outlay in rent-seeking (respectively x and X) decrease with the number of winners, k . In extreme case when $k = N$, every player is *ex-ante* a winner; there is no need for investing in the contest and the optimum amount of investment is $x = 0$. The overall welfare implication of allowing more winners in the rent-seeking contest is however ambiguous.[9]

3.3 Political pressure and the size of rent

Allocation of human resources between productive and unproductive activities represents their interest toward combination of public spending. Given the amount of public revenues, government allocates its total expenditures between productive spending G, and public transfers R. Workers support higher amount of the former because the higher the value of G, by (1) the more is their productivity. On the other hand, higher share of public transfer in the government expenditure, by (4) leads to higher payoff to rent-seekers.

[7] We implicitly assume that competents are ex-ante wealthy enough to afford the cost of investment in the contest. Since rent dissipation is less than one, the winner-help-loser mechanism justifies this assumption without running into credit difficulties.

[8] Tullock(1980) says " ... we would prefer that there be no rent at all, and, if there must be rent, it does not make much difference to whome it goes" (p.103).

[9] Since X is a measure of total waste, there is a social gain associated with increasing of k. On the other hand, from (4) we have $\partial V/\partial k > 0$, which means that increasing the number of winners favours rent-seekers too. This suggests a *free lunch* by increasing k, because it implies a social gain due to mitigating waste of resources in rent-seeking and also increasing the expected payoff to the rent-seekers. As will be shown in next section however, increasing k amplifies the misallocation of talent in favour of rent-seeking which is not socially desirable.

Rent-seekers thus ex-ante support higher values of k which gives them higher probability to win and higher expected profit from investment in the contest. The winners, who concern only ex-post return, however are not in favour of higher k, because they do not want to share the prize with more contestants.

We assume that a substantial amount of rent is associated with the natural resource[10] where fiscal authority is in charge of distribution of this rent. An enormous amount of money is therefore ready for grab if one can persuade the authority. We suppose that they can be lobbied in an efficient way.

Rent-seekers institute a mechanism to influence fiscal authority for allocating government expenditure to public transfer[11]. Along the line of Becker(1983) this mechanism is introduced using the *influence function* which maps the interests of individuals into the policy outcome. In the present context this function denotes the reduced form of rent-seekers' political pressure on the fiscal authority. A measure of rent-seeking activity (e.g. the relative size of rent-seeking n, or total investment in the context, X) and the amount of oil income, Q as source of the rent are two crucial primitives of the lobbying process which produces the level of fiscal transfers[12].

We deliberately abstract from microfoundations behind the lobbying process and simply assume that rent-seekers are organized and have power to extract fiscal transfers from the government. The function is formally defined as follows:

Definition 1 *An influence function denoted by $R = R(n, Q)$ represents the reduced form of an institutional arrangement by which the rent-seekers whose relative size is n extracts fiscal transfers, R financed by oil rent, Q from the government. The function by assumption satisfies the following properties:*
(i) R is nonnegative;
(ii) It is increasing and differentiable in both n and Q;
(iii) $R(1, Q) = Q$.

The first property means that in this economy, transfers do not act as redistribution of resources from one group to another. In other words people do not provide the source of transfers. They receive it as a gift provided by nature.

In the second property, continuity of R in n is required to examine the existence and uniqueness of the equilibrium. Moreover one needs to ensure that a small change in the relative size of rent-seeking or a small perturbation in the level of oil rent has a relatively small effect on the level of fiscal transfers and hence combination of public expenditure. We need also differentiability of R to examine the marginal productivity of lobbying for further investigation.

In addition, the higher the relative size of rent-seekers, the more powerful and influential is their lobby and so the more effective is the political pressure for diversion of oil income toward public transfers[13]. In addition, the higher Q

[10] Weitzeman(1999) estimates the amount of rent associated with crude petrolum which is chiefly distributed among few oil producers equal to some b$170 for 1994.

[11] According to Tullock(1967) "Generally governments do not transfer the rent of resource by their own. They have to be lobbied or pressured into doing so by the expenditure of resources (or the effort supplied) in political activity."(p. ?).

[12] The process described here though seems like an aggregate production function, but due to its nature of *collective action* can not be disaggregated into the efforts that rent-seekers supply seperately.

[13] To rationalize this effect, one can interprete total contribution of rent-seekers, X as an index of political capital that affects the policy outcome in lobbying process. Lobbying can

the bigger is the size of cake and hence, *ceteris paribus*, the more valuable is the prize to the rent-seekers.

The last property states that in full rent-seeking, all of the resource rent is devoted to transfers. From (1), nothing is produced in this economy when all are rent-seekers. It does not make sense therefore to assume that a portion of public resource is allocated to productive services for producing nothing. From Eqs. (1) - (3) we obtain $G(1) = Q - R(1, Q)$. The last property of R is therefore equal $G(1) = 0$ meaning that at full rent-seeking the government does not deliver productive services. It is also plausible to assume that the magnitude of claim does not exceed the oil rent itself, i.e. $R(n, Q) \leq Q$.

What we have assumed here is the minimum constraints required to link the allocation of talent to the fiscal transfers[14].

The budgetary process is a convenient and effective mechanism in this economy by which rent-seekers can appropriate resources from the rest of society. The *fiscal constitution* of our model is set as follows:

- The fiscal budget has to be balanced. This is addressed in (3).
- Only proportional tax on producers' income can be levied which is showed in (2).
- The fiscal transfer that rent-seekers can obtain is determined by influence function defined above.

In our model rent-seekers have power to extract fiscal transfers from the government, but government in turn does not impose tax to finance these transfers. The transfers instead are financed by oil rent that otherwise is allocated to public productive spending that enhances the level of income and raises the productivity of workers.

To avoid ambiguities, we clarify that here the level of fiscal transfers claimed or attempted to extract by rent-seekers is what they actually get. Since we abstract from the lobbying process in details and ignore the deadweight loss associated with redistribution of resources, we assume that the level of appropriation of resources by rent-seekers is exactly what is enforced by influence function. Having assumed this simplification, we use the terms claim, transfers and appropriation interchangeably where we refer to the mechanism by which rent-seekers extract oil rent from the government.

According to Lahiri and Raimoudos-Moller(2000)'s argument "*...if everyone in the economy lobbies, lobbying has no impact on the equilibrium ... one needs the existence of at least one group of individuals who are politically passive.*" (p.C67). In the above influence function, it is implicitly assumed that workers

also be taken as a process in which rent-seekers invest their time to affect policy which is the combination of public expenditures in our model.

[14] According to some literature, e.g. Murphy et. al. (1993), lobbying is expected to be convex in the level of rent-seekers' efforts because political pressure involves some costs that increase less than proportional with the level of lobbying. These include legal expenses, hiring of experts, establishment of relation with authorities and cultivation of their interests, extraction of information, etc. We do not impose such condition on R.

are politically passive and only rent-seekers create political pressure[15]. Since politicians here are assumed mainly to transmit the pressure of active groups and producers are passive, we do not determine the political equilibrium in our model.

The particular modeling adopted in the influence function is somewhat *ad hoc*, but nevertheless provides a useful framework for the analysis of a realistic political process by which public decisions are made. Rent-seekers by lobbying increase the size of available pie, R. On the other hand, by lowering the share of public goods in government spending G, they cut marginal product of working and so the producers' income. This decreases the pay in the alternative occupation and makes the rent-seeking more attractive. Hence rent-seeking amplifies itself.

3.4 Distribution of oil rent

In this section we show that oil income is the key variable that determines the pattern of changes in the economy. From Eqs. (4) and (5) we have $R = NV + X$. This using balance budget (3) results

$$Q = (G - T) + NV + X \tag{6}$$

indicating that there are three channels for spending oil revenue: net transfer to the producers, $G - T$; net transfer to the rent-seekers, NV; and waste of resources by investment in rent-seeking, X.

The larger the size of rent-seeking sector, the lesser is the first component and the larger is the second and third. As one considers from (3) since by assumption $R'(n) > 0$, the amount of subsidy to producers, i.e. $G - T$, is declining with the extent of rent-seeking. Hence although all agents receive transfers, the size of rent-seeking intensity has a distributional effect on the direction of subsidy from producers to rent-seekers.

Eq. (6) refers to an important task of bureaucracy in oil-based economies. Beside extraction and liquidation of oil, the allocation of oil rent among interest groups justifies the bulk of bureaucracy in these economies. Distributive task by itself rationalizes the establishment of institutions for such a purpose. Further to inefficiency arises from these institutions, the nature of political (outside market) allocation of resources encourages pressure groups to claim on fiscal transfers. The distributional task of bureaucracy is amplified during oil-boom period when higher amount of oil revenue allows the government to undertake its promises and serve national objectives.

Eq. (6) states also another aspect of the economies in question. In contrast with the conventional models of political competition among pressure groups (e.g. Becker 1983), here due to the oil revenue, pressure groups play a positive-sum game to appropriate their desired share from oil rent. Workers, although

[15] In the political game designed by Becker(1983), aggregate influence is zero which means that increased influence of some groups decreases the influence of others by equal amounts.

receive less due to the rent-seeking, do not provide subsidy for other party, i.e. rent-seekers. In other words source of the prize to the winner is not transfer from the losers.

Now let $t(n) \equiv \tau AL(1-n)$ be the contribution of tax revenue in finance of public productive spending. This gives $t'(n) < 0$, indicating that the higher the size of rent-seeking, the lesser is the role of tax revenue in public finance and the more dependent is the economy on the oil income. We assume $T < G$ for the possible levels of rent-seeking intensity[16]:

Assumption 1 $t(0) = \tau AL < 1$.

Plugging from Eq. (2) into (3), one derives the role of oil revenue in the public productive expenditures as

$$G(n) = \frac{Q - R(n,Q)}{1 - t(n)} \tag{7}$$

The effect of Q on T can be easily obtained from $T = t(n).G$. The effect of rent-seeking intensity on fiscal variables is summarized in the following statement:

Proposition 1 *Misallocation of talent causes underprovision of productive services by government, i.e.* $G'(n) < 0$. *The higher the extent of diversion of human resources, the extent of diversion of public spending away from productive services toward fiscal transfers is higher. Moreover tax income reduces with rent-seeking intensity.*

Proof. See appendix. ■

The evolution of fiscal variables as functions of the extent of rent-seeking, for the case where $R(0,Q) = 0$ and R is convex in n is depicted in figure 1. The findings is consistent with the evidence from oil-based economies whose total governments revenue fluctuates with volatility of their oil income.

The uncommon feature of this analysis is that size of government, i.e. $T+Q$ declines with the extent of rent-seeking. Since we take Q and τ as exogenous, the endogenous part of tax base declines with rent-seeking. One may consider an alternative situation where rent-seekers influence authorities to extract more oil to meet their desires. In this case, the voracity of rent-seekers compensate their side effect on cutting tax base and the government expenditures increases along the extent of rent-seeking as we expect.

In this economy GDP has two components, the amount of good that is produced by workers Y , and the flow of oil that is extracted from the ground Q. We have implicitly assumed that the latter is convertible without cost to the former[17], implying $GDP = Y + Q$.

[16] In extreme for $n = 1$, we have $T = G = 0$.

[17] In another interpretation, oil flow is sold to a foreign entity and its equilvalent is imported such that the current account is always balanced.

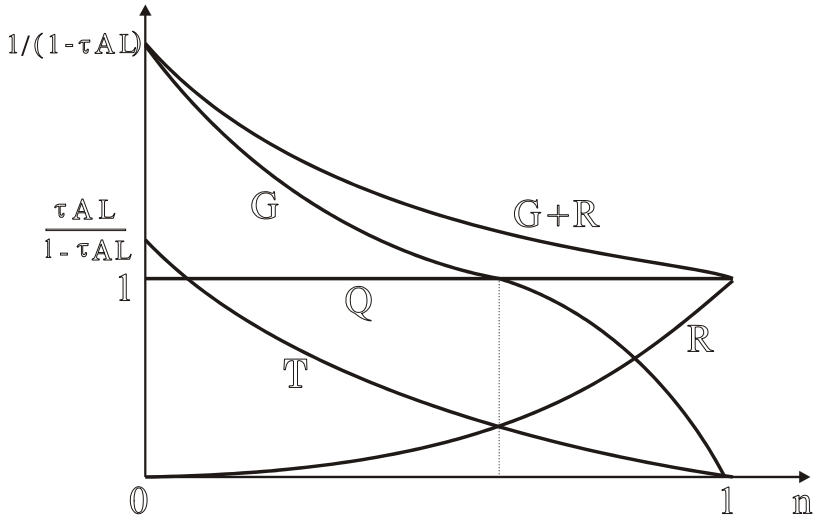

Figure 1: The effect of occupational choice on fiscal variables. The vertical axis is in Q units. It is assumed that $0.5 < \tau AL < 1$.

We would like now to measure the welfare loss of rent-seeking by comparing the percentage forgone production with the benchmark case where there is no rent-seeking and workers enjoy their highest productivity. For this purpose we introduce

$$\frac{\Delta Y}{Y} \equiv \frac{Y(0) - Y(n)}{Y(0)} = 1 - \frac{(1-n)(1-\tau AL)}{1-\tau AL(1-n)}\left[1 - \frac{R(n,Q)}{Q}\right]$$

According to assumption 1 and properties of R, this measure is strictly increasing in n and bounded between $R(0,Q)/Q$ and one. It assigns to the size of rent-seeking n, the percentage of production that the economy loses relative to its potential level for two reasons. Firstly, a fraction of potential producers are rent-seekers and have no contribution in production. Secondly, rent-seekers by diverting public expenditures from productive goods prevent producers from access to the potential productive inputs that they could use if there was no rent-seeking.

3.5 Reward structure

We assume that the market for final product is competitive and workers receive their marginal product. Considering (1) and (2), the after tax wage rate is then $W = A(1-\tau)G(n)$.

Rent-seekers do not pay tax and only workers by assumption act as *tax base*. Limited liability constraint dictates that the government can not tax more than revenue of workers which means $T \leq WL(1-n)$. This implies $\tau \leq 0.5$.

By reward structure we mean pair of functions:

$$V,\ W : [0,1] \times \Re^{+} \longrightarrow \Re^{+}$$

where

$$V(n,Q) = \frac{k}{L^2 n^2} R(n,Q) \qquad \text{for} \quad n > 0 \qquad \text{and} \qquad V(0,Q) = 0, \tag{8}$$

and

$$W(n,Q) = \frac{(1-\tau)A}{1-\tau AL(1-n)} \left[Q - R(n,Q)\right] \tag{9}$$

denote reward to rent-seekers and producers for given level of rent-seeking and oil rent respectively. Dependence of W and V on n means that what everybody receives in this economy not only depends on the occupation that s/he chooses but also on how human resources has been allocated between current occupations. The following statement establishes the properties of reward structure.

Lemma 1 *Reward structure has the following properties:*

(i) W *and* V *are continuous in* n *on* $[0,1]$ *and* $(0,1]$ *respectively and differentiable in* Q*;*

(ii) W *is decreasing in* n*;*

(iii) $W(0,Q) > V(0,Q) = 0$*;*

(iv) $0 = W(1,Q) < V(1,Q)$*.*

Proof. These properties are easily obtained from assumption 1, properties of R and definitions of V and W in (8) and (9) respectively. ■

The fact that wage rate is decreasing in n refers to a negative externality from rent-seeking on production via the role of former on lowering the share of productive public spending. In other words more rent-seeking in the society reduces the return to producing.

Two forces affect marginal returns to rent-seeking, $V'(n)$. New comers reduce the probability of winning of established contestants. On the other hand and ignoring free-riding, they increase rent-seekers' power to claim on oil rent. In early stage of rent-seeking, the first effect dominates. When rent-seeking become popular however, the second effect may dominate. In general, we suppose that V is U-shaped in n. Reward to producers and rent-seekers as functions of n is illustrated in figure 2.

Considering the policy variables τ and k, and the exogenous variables Q, L and A agents by comparing V and W decide to be producer or rent-seeker. So the reward structure (indicated by V and W) determines the allocation of talent. On the other hand, the allocation of human resources, through influence function, indirectly affects the reward structure itself.

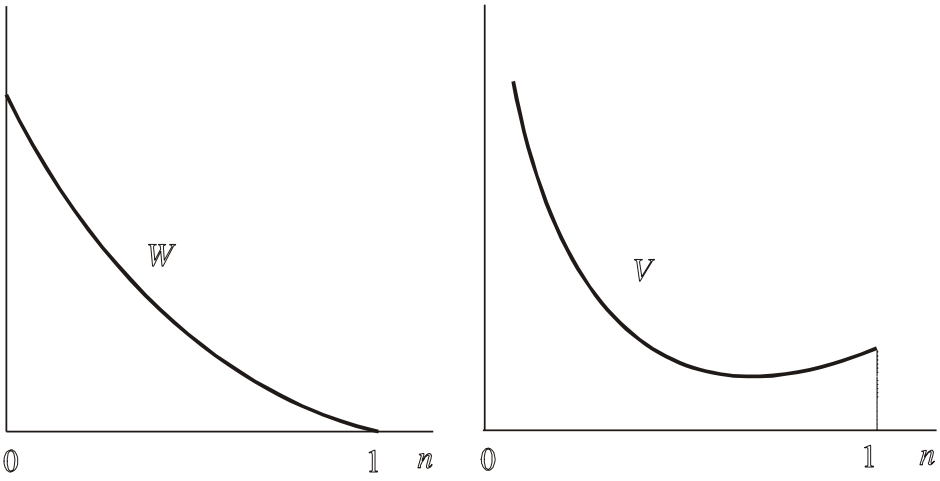

Figure 2: Reward to productive activities, W and rent-seeking, V as functions of rent-seeking intensity, n.

3.6 Sequence of events

We can now describe how the model works. The sequence of events in this model economy is as follows:

1. Nature selects the allocation of talent between two existing activities. This determines the level of rent-seeking intensity, n.
2. Given the available level of oil rent, Q rent-seekers' lobby claim on fiscal transfers, $R = R(n, Q)$.
3. Having decided the level of public transfers:
   (a) The fiscal authority sets the level of productive services according to $G = (Q - R)/[1 - t(n)]$.
   (b) Producers produce final products $Y = AL(1 - n)G$; They pay tax: $T = \tau Y$, and receive their after-tax wage $W(n, Q)$.
   (c) Rent-seekers receive their net payoff, $V(n, Q)$.
4. People compare V and W and choose the activity that pays more. This determines the allocation of talent which gives the equilibrium level of all endogenous variables.
5. If a substantial change in one of the exogenous parts of reward structure displaces the economy from equilibrium, allocation of human resources change such that the arbitrage between two activities disappears.

4 Equilibrium

People choose occupation that relatively rewards more, if they are free to do so. This gives us the allocation of human resources between two existing activities according to their returns. The extent of rent-seeking further affects combination of public expenditure and hence reward structure. A two-sided link therefore exists between reward structure and the allocation of talent. Both are endogenous and jointly determined at equilibrium.

In this section, we define types of equilibrium in this economy and consider their existence and uniqueness.

4.1 The existence and Uniqueness

Given reward structure for working and rent-seeking, an equilibrium in this economy is a situation where individuals have no incentive to leave their current occupation. More formally we have:

Definition 2 *Let $\delta > (1/L)$ be small enough, then*

(i) $n = 0$ is a corner equilibrium (called good equilibrium) if $W(\delta) > V(\delta)$.

(ii) $n = 1$ is another corner equilibrium (called no-activity equilibrium or full rent-seeking) if $W(1-\delta) < V(1-\delta)$.

(iii) $n \in (0,1)$ is an interior equilibrium if $W(n) = V(n)$, $W(n-\delta) < V(n-\delta)$ and $W(n+\delta) > V(n+\delta)$.

Two facts are worth noting here. First, we do not know how many interior equilibrium(s) exist. W and V are continuous in n. The former is decreasing and the latter in general is U-shaped. They can therefore intersect at several points. We identify however conditions for the existence of such equilibria.

Secondly, the above definition rules out unstable equilibrium(s). We assume that both W and V are *common knowledge* and hence at each situation people *know* how much they will get if deviate from current situation. According to this assumption, unstable points of equality of of W and V can no longer be called equilibrium because at those points attaining higher returns is possible by changing the type of activity.

When W crosses V from above, people are equally paid in both occupations. They however realize that by leaving rent-seeking and joining the productive activity they will be rewarded more. Such points do not serve as equilibrium because of the existence of incentive for deviation.

In similar models, e.g. Acemoglu(1995), equilibrium is defined where the reward to both activities are the same. This includes both stable and unstable equilibria because so long as people are rewarded equally they have no incentive to change their career. In our model we assume that individuals know the entire profile of W and V meaning that the returns to both careers are commonly known for each potential value of n. This piece of "information" stimulates people to deviate in case of unstable equilibrium because they know that they would be better off if they leave rent-seeking and join productive activity. For

this reason unstable equilibria in conventional models of occupational choice no longer serve as equilibrium in our setting.

Agents choose their professions by comparing their corresponding payoff[18]. Free-entry implies that by entering into or leaving these two careers, they offset the arbitrage between W and V which implies

$$\frac{A(1-\tau)}{1-\tau AL(1-n)}(Q-R)=\frac{k}{L^2n^2}R \tag{10}$$

where the LHS and RHS are wage rate and payoff to rent-seekers respectively. This implicitly defines interior equilibrium(s) that refers to the coexistence of productive and unproductive activities for $0<n<1$. To study equilibrium we consider the payoffs to production and rent-seeking as function of n, the ratio of people engaged in rent-seeking where the exogenous parts of reward structure are given.

According to (10), producers join rent-seeking till the expected marginal reward of rent-seeking is equal with the opportunity cost of leaving the production sector. In conventional rent-seeking contests, the number of participants are either constant or determined by free entry into the contest. In our model, there is no barrier to prevent participation in the contest, but wage rate as the opportunity cost of being unproductive provides an indicator for agents to decide whether join the rent-seeking or not.

For net wage rate one finds $W(n)=W(0)-A(1-\tau)[G(0)-G(n)]$, which states that due to diversion of public spending to public transfer, the workers are underpaid and rent-seeking acts like an extra tax on output[19]. Hence although rent-seekers do not play an explicit predatory role, by channeling the public spending toward unproductive activity, they act as a tax burden on the production.

In the following statement we establish the existence and uniqueness of equilibria.

Proposition 2 ***Existence and Uniqueness:***

(i) If $V(1/L)<W(1/L)$, $n=0$ *is an equilibrium;*

[18] If one takes morality into account, amoral agents choose their careers based purely on the corresponding payoff but moral agents for being rent-seekers and living by appropriating the income of the producers must incur a moral cost. The model analysed in the present paper implicitly assumes that moral cost of being rent-seeker is zero and everybody is potentially a rent-seeker. Baumol(1990) says :" If entrepreneurs are ... ingenious and creative in finding ways that add to their own wealth, power, and prestige, then it is to be expected that not all of them will be overly concerned with whether an activity that achieves these goals adds much or little to the social product or ... even ... it is an actual impediment to production." (p: 897 - 8). It has also been assumed that there is no social or institutional control over the diversion of talent from production.

[19] Murphy et. al. (1991) address the effect of this hidden tax on the diversion of talent as : " In some countries entrepreneurs ... avoid the tax from rent seekers by becoming rent seekers themselves. "

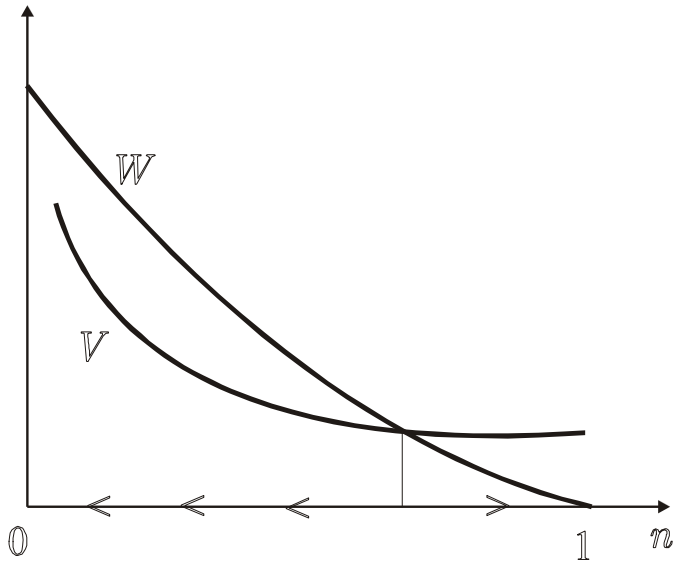

Figure 3: *Case (i)*: Beside full rent-seeking ($n = 1$), good equilibrium ($n = 0$) is feasible.

(ii) Otherwise if $W(n) < V(n)\ \forall\ n \in (0,1)$*, then* $n = 1$ *is the only equilibrium.*

(iii) Otherwise, at least one interior equilibrium exists.

Proof. The proof follows from (10) and figure 2 indicating that both W and V are continuous in n. From Eqs. (7), (8) and (9) we have $W(0) = (1-\tau)A[Q - R(0,Q)]/[1 - \tau AL] > V(0) = 0$, and $V(1) = kQ/L^2 > W(1) = 0$. On the other hand V has a discontinuity at the origin. While $V(0) = 0$, $V(1/L) = kR(1/L, Q) > 0$. ■

Conclusion 1 *Full rent-seeking* ($n = 1$) *is always an equilibrium.*

Case (i) refers to the situation where "*rent-seekers have a strength in numbers*" (Murphy et. al. 1993). Rent-seeking is not attractive unless a certain number of people being involved in the rent-seeking activity. In other words in this situation, the society is not secure from rent-seeking unless the relative productivity of working is sufficiently high; figure 3.

In case (ii), reward structure encourages rent-seeking. The extreme value of $n = 1$ is the only equilibrium. There is no room for interior equilibria. Reward structure favours diversion and the economy ends up with no-activity regime where individuals are all rent-seekers; figure 4.

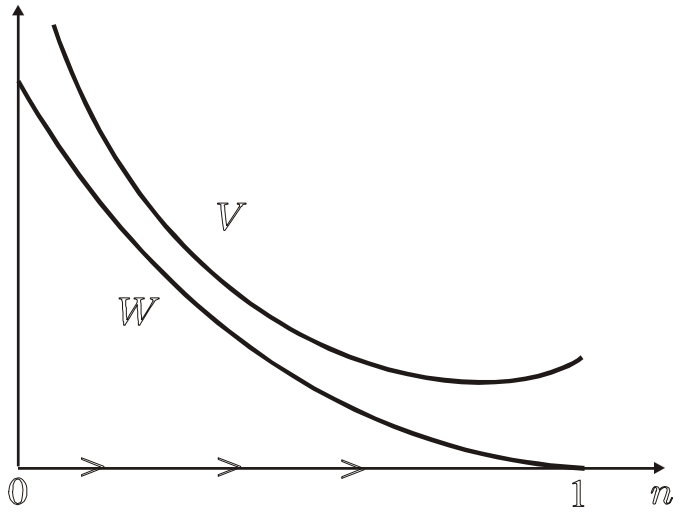

Figure 4: *Case (ii)*: Only full rent-seeking ($n = 1$) is feasible.

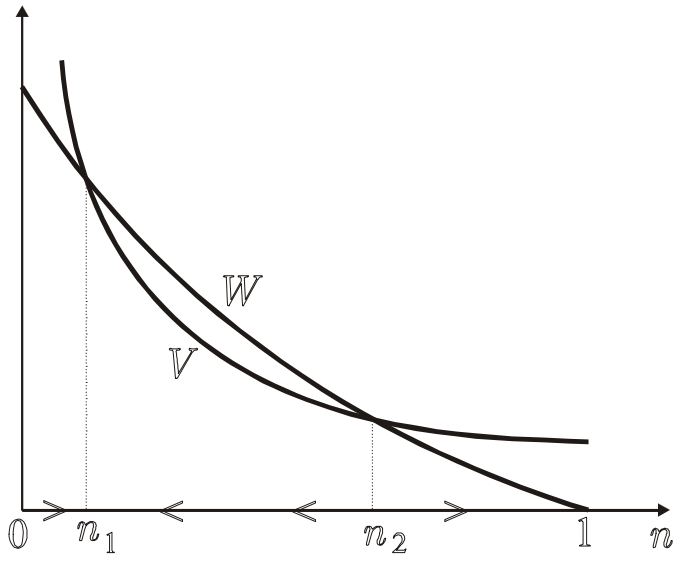

Figure 5: *Case (iii)*: Apart from full rent-seeking ($n = 1$), at least one interior equilibrium ($n = n_1$) exists.

In case (iii), according to the intermediate value theorem, the number of crossing points of W and V are even. They are respectively stable and unstable from left to right. We have already ruled out the latter points because so long as reward structure is common knowledge, unstable roots do not serve as equilibrium. In the simplest case suppose there exist n_1 and n_2 such that $0 < n_1 < n_2 < 1$ and $W(n) = V(n)$ for $n = n_1$ and $n = n_2$. Apart from extreme regime of common rent-seeking, there is now room for the coexistence of productive activity and rent-seeking. In particular n_1 is an interior equilibrium.

Suppose we are in case (iii). Moreover suppose W and V only cross at n_1 and n_2 where $0 < n_1 < n_2 < 1$. This is illustrated in figure 5. In this case we have $W(n) > V(n)$ for $n_1 < n < n_2$ and $W(n) < V(n)$ for $n \in (0, n_1) \cup (n_2, 1]$. In this case $n = n_1$ and $n = 1$ are two equilibria. At $n = n_2$ rent-seekers are better off by changing their occupation while at $n = 0$ the other way round. For a given allocation of talent, determined by history, the economy lands either in $n = n_1$ or $n = 1$. The final outcome depends on whether the inherited allocation of talent is in the basin of attraction of the former or the latter equilibrium which is defined as $[0, n_2)$ and $(n_2, 1]$ respectively. We conclude then:

Conclusion 2 *Suppose W and V cross only at n_1 and n_2 where $0 < n_1 < n_2 < 1$. Then*

(i) Two equilibria exist: coexistence of two activities at $n = n_1$ and no-activity equilibrium at $n = 1$.

(ii) For an inherited allocation of talent between two activities defined by n, the probability of falling in two above equilibria are n_2 and $1 - n_2$ respectively. In other words $\Pr\{n = n_1\} = n_2$ and $\Pr\{n = 1\} = 1 - n_2$.

When $n = 1$, rent-seeking is self-sustained and the economy is trapped in the no-activity equilibrium. The lower n_2, the likelihood of being trapped is higher. One should learn that the social and political costs of pushing the economy out of this equilibrium could be high. For low values of n_2 which indicates the high probability of falling in no-activity trap, the findings of this paper are consistent with what is called *political vicious circle*, *bad equilibrium*, *underdevelopment trap* or *persistent corruption* in Krueger(1974), Murphy et. al. (1993), Acemoglu(1995) and Tirole(1996) respectively.

In no-activity regime, all believe that rent seeking is the only route to gain, and entrepreneurs would devote all their resources to capturing windfall rents. The only productive activity in this situation is extraction and liquidation of oil resources to finance rent-seeking activity. In predator-prey type models of rent-seeking, no-activity equilibrium does not exist because a minimum amount of production is required to be fallen as the target of rent-seeking. In our model, rent-seekers instead of appropriation of the producers' income, have common access through their political influence to the oil rent. So rent-seekers survive as long as poorly defined property right does not prevent them from usage of oil revenue to cover their activities.

According to the empirical evidence, we expect that everything being equal, there should be a positive correlation between the level of rent-seeking intensity

and the degree of natural resource abundance. The following statements help us to identify under what circumstances this can happen.

Lemma 2 *Let*

$$\phi(n) \equiv \left[1 + \frac{1 - \tau AL(1-n)}{(1-\tau)AL} \cdot \frac{k/L}{n^2}\right]^{-1}$$

then:
(i) ϕ is increasing and differentiable in n and positive for $n \in (0,1]$;
(ii) $\lim_{n \to 0} \phi(n) = 0$;
(iii) $\phi(1) = [(1-\tau)AL]/[(1-\tau)AL + k/L] < 1$;
(iv) $\phi'(0) = +\infty$, and $0 < \phi'(1) < +\infty$.

Proof. Assumption 1 is a sufficient condition for $\phi > 0$ when $n \in (0,1]$. Moreover we have

$$\phi'(n) = \frac{\tau AL + 2(1 - \tau AL)/n}{n^2 + (k/L)[1 - \tau AL(1-n)]/[(1-\tau)AL]},$$

which is positive. ■

Based on this lemma, we can now reduce the problem of payoff comparison to the one of comparison of the average productivity of lobbying R/Q and ϕ as defined above.

Lemma 3 *For $n \in [0,1]$ and $Q > 0$, $W \lesseqgtr V$ if and only if $R(n,Q)/Q \gtreqless \phi(n)$.*

Proof. See appendix. ■

This helps us to identify a sufficient condition for the case where the level of oil income does not affect the allocation of talent.

Proposition 3 *An interior equilibrium level of rent-seeking intensity is independent from Q if R is linear in Q. In this case, oil rent rewards both activities equally and does not affect choice of occupation.*

Proof. Let $R(n,Q) = f(n).Q$ be linear in Q. Properties of R imply $0 \leq f(n) \leq 1$, $f(1) = 1$, and $f'(n) > 0$. Moreover in this case, average and marginal productivity of lobbying coincide and we have $R_Q = R/Q = f(n)$. By definition of interior equilibrium and using lemma 3, an interior equilibrium is defined as $n = \arg\{R(n,Q)/Q = \phi(n)\}$ which in this case is reduced to point(s) where $f(n) = \phi(n)$ which is independent from Q. ■

4.2 Cost of rent-seeking

The fact that rent-seeking sector employs agents who would otherwise be productive, introduces the direct cost of rent-seeking. There is also an indirect cost caused by negative externality of rent-seeking on productivity of workers. Notice that since the size of rent is endogenous in this model, the extent of rent

dissipation, according to Nitzan(1994), is only a partial and in general, unsatisfactory measure of the inefficiency created by rent-seeking. By attempting to channel the government expenditures to public transfer, rent-seekers introduce another source of inefficiency in the economy.

In our model we have implicitly assumed that occupational choice is reversible. Individual change their careers without cost and given the inherited allocation of talent, the model economy jumps instantaneously to the equilibrium situation where there is no arbitrage between two existing activities. By this assumption we deliberately abstract from dynamics of the economy when it converges to the equilibrium. Acemoglu(1995) in his dynamic setting, assumes that occupational choice is not reversible. By taking a constant and common rate of birth and death, he makes a room for skill accumulation where the current holders of the inferior profession gradually die and the new comers choose activity that pays more. This defines a constant rate of adjustment for the economy and convergence toward its equilibrium.

The underlying structure can support some of the dynamic features of diversion of the human resources and their implied costs. Following the seminal work of Tullock(1967), income transfers lead people to employ resources in attempting to obtain such transfers. This encourages individuals to learn and accumulate skills that are essential for rent-seeking. The environment where individuals accumulate skills is, according to Hall and Jones(1997), an important part of the explanation of the large differences in economic levels across countries. So when the reward structure favours diversion, the types of skills that individuals accumulate would be those that maximize their productivity in rent-seeking, instead of skills that would increase the productive capacity of the economy. Following Hall and Jones in these situations: " ... *investment in capital, skills and new ideas is reduced by the threat of diversion. Moreover, some of the investment that does take place is devoted to increasing the effectiveness of diversion instead of the effectiveness of production*" (p. 175). This is why some countries invest so much less than others.

Total cost of rent seeking should be measured in terms of the efforts to persuade fiscal authorities to authorize the transfer by the unsuccessful as well as successful. In an economy where entrepreneurship is not attractive and rent seeking is common and profitable, individuals learn skill that are essential for the latter. The existence of vast resource revenue in the hands of bureaucrats and the incentive for appropriation among rent seekers when combined with poor property right and the common access problem, provides the essential requirements for transfer of resource rent to fiscal claimants. The success of rent-seekers in appropriation of public revenue encourages others to join them implying that rent seeking stimulates itself. Another side effect of rent-seeking, which is not followed here, is its effect on the people's perception about the function of markets[20].

[20] Krueger(1974) argues: " ... the existence of rent seeking surely affects prople's perception of the economic system. If income distribution is viewed as the outcome of a lottery where wealthy individuals are successful (or lucky) rent seekers, whereas the poor are those precluded from or unsuccessful in rent seeking, the market mechanism is bound to be suspect..."(p. 302).

5 The effect of external shocks

Productivity parameter A, Tax rate τ, size of the economy represented by the total population L, rule of the game in the rent-seeking contest represented here by the number of winners k and finally the size of oil rent Q, constitute the exogenous aspects of the reward structure. We discuss now the effect on the reward to both activities and the implied choice of occupation of any change in the parameters firstly in section 5.1.We then discuss these issues about the effect of oil boom with more details in section 5.2.

5.1 Exogenous parts of reward structure

Productivity parameter In Eq. (1) A can be interpreted as the relative productivity of working to rent-seeking. Excluding the no-activity equilibrium, a rise in A is associated with the rise in income in both interior equilibria and the good equilibrium. In case (iii), an increase in A also decreases the level of rent-seeking in the case of its coexistence with production.

Tax rate Tax rate has two effects on reward to producers while its effect on rent-seekers' income is neutral. By rising τ, workers have less income to appropriate. It also provides more resources for the government to spend on productive input. The overall effect depends on the level of rent-seeking. More explicitly we have $\partial W/\partial\tau \lesseqgtr 0$ iff $n \lesseqgtr 1 - 1/AL$.

Size of the economy By growing size of the economy denoted here by L, while keeping the prize and the number of winners constant the marginal profit of being a rent-seeker decreases and V falls more than proportionally. On the other hand, reward to producers rises and in overall the allocation of talent changes in favour of production.

One may interpret Q/L as an indicator for natural resource intensity in this economy. Having accepted this indicator, our analysis shows that a decline in the natural resource dependence mitigates the degree of rent-seeking tolerance in this economy and decreases the likelihood of diversion.

Another issue that is worth considering is the effect of L on the standard of living in the bad equilibrium where all human resources are devoted to rent-seeking. At this situation we have $V(1) = (k/L)(Q/L)$. The first term in the RHS is the number of winners out of population and the second term addresses per capita income derived from the only source of income in that situation. Obviously for a natural resource economy with a high degree of resource intensity whose output from resource sector is limited, higher population associated with lower level of living standard.

The number of winners Increasing the number of winners k, leaves the wage rate intact. Its effect on reward to the rent-seekers is in the same direction as the size of the economy. The only difference is that V is proportional with k and hence the effect of change in k on V is less severe relative to L.

5.2 Oil boom

The purpose of this section is to analyze the effect of oil windfall on the allocation of human resources. The equilibrium condition (10) gives the relative size of rent-seeking as a function of the level of oil income, $n(Q)$. The functional form however is not explicitly specified. In the case of existence of the interior equilibria, n does not exhibit a monotonic pattern with respect to Q either.

5.2.1 Income and Allocation Effects

In general oil revenue has two different effects in our model economy. During the boom, size of oil rent and the amount of fiscal transfers both grow where the extent of change in the latter is determined by influence function. Boom therefore changes the available resource and directly affects the reward structure. This is called the *income effect*. The windfall has also an indirect effect which is called here the *allocation effect*. This, operates when boom pays unequally to the existing activities and motivates people to change their current occupations. The allocation effect may reinforce or offset the income effect.

According to the production function (1), rent-seeking intensity adversely affects the level of income. Hence when boom discourages rent-seeking, it has a positive level effect while in case that the windfall is in favour of rent-seekers, it reduces the level of production[21]. The higher the size of boom, the stronger is the income effect.

We show that in the corner equilibria only income effect operates and the boom has not any allocation effect. In the interior equilibria however, both effects are in general operative. In this case, an equilibrium level of rent-seeking before boom is no longer an equilibrium after boom because boom encourages one of the activity and creates incentive for deviation. Throughout this section we assume that the economy stays at equilibrium when boom occurs.

In the following statement we identify situations where boom has no allocation effect and only the income effect is operative.

Proposition 4 *Boom does not induce any change in the allocation of human resources if*

(i) R is linear in Q; or

(ii) The economy stays at corner equilibrium in pre-boom era.

Proof. According to proposition 10, a pre-boom equilibrium is still an equilibrium in post-boom era if R is linear in Q. This establishes the first part. For the second part, we consult lemma 9 by which if for a constant value of oil rent, say $\overline{Q}$ we have $V(1/L, \overline{Q}) < W(1/L, \overline{Q})$ or $W(1, \overline{Q}) < V(1, \overline{Q})$ then $\forall \Delta Q > 0$ these inequalities hold for $Q = \overline{Q} + \Delta Q$ too. This shows that if the economy stays at either $n = 0$ or $n = 1$ in pre-boom period, it will be there in post-boom era too. ■

[21] In this case, boom changes structure of GDP by reducing the share of non-oil part that is produced in the *genuine* production process.

When the allocation effect is operative and strong enough, it may induce change of regime. In the following statement we show that this is however only the case when the economy stays at an interior equilibrium.

Conclusion 3 *Boom does not cause a change of regime if the pre-boom level of rent-seeking is too low or too high. At both good equilibrium and no-activity equilibrium, boom raises returns to producers and rent-seekers respectively and leaves the reward to other activity intact. It therefore has no effect on the occupational choice in corner equilibria.*

5.2.2 Voracity Effect

The concept of voracity effect is firstly introduced in Lane and Tornell(1996) and then the idea was extended in Tornell and Lane(1998, 99). These studies elaborate the interaction among several rent-seekers who have the power to extract fiscal transfers and claim independently on a commonly accessible pool of asset, say physical capital. Fiscal claimants only care their own private asset and the social infrastructure does not prevent them to appropriate the common pool of asset. As a result, when the value of the asset, by say resource boom increases the fiscal claimants each redistributes part of the windfall to its own private area and as a result, the size of claim grows more proportional than the size of windfall itself. Tornell and Lane then successfully rationalize the main failures of booming economies, like negative rate of growth, public debt and current account deficit by using the voracity effect.

Our study though does not explain why the voracity effect operates, rationalizes how it operates and proceeds during boom. For doing so we firstly consider the effect of resource boom on the reward to both activities separately, by considering the size of marginal productivity of lobbying with respect to the size of oil rent, R_Q.

Lemma 4 *$V_Q > 0$ if $R_Q > 0$ and $W_Q > 0$ if $R_Q < 1$.*

Proof. Partial differentiation from (8) and (9) with respect to Q and considering assumption 1, gives the results. ■

The voracity effect is operative in this economy when the increment in size of fiscal transfers, ΔR exceeds the size of windfall, ΔQ itself. This is simply captured in our setting when the size of marginal productivity of lobbying exceeds one, i.e. $R_Q > 1$. The following statement explains the effect of resource boom on the allocation of human resources and economic success in the presence of voracity effect.

Proposition 5 ***Voracity effect:*** *When size of claim grows more proportional than the windfall, i.e. $R_Q > 1$, boom favours misallocation of talent. The higher the size of boom, ceteris paribus, the diversion of human resources into rent-seeking is more severe.*

In particular, a resource boom with high enough magnitude induces change of regime from coexistence of both activities to full rent-seeking.

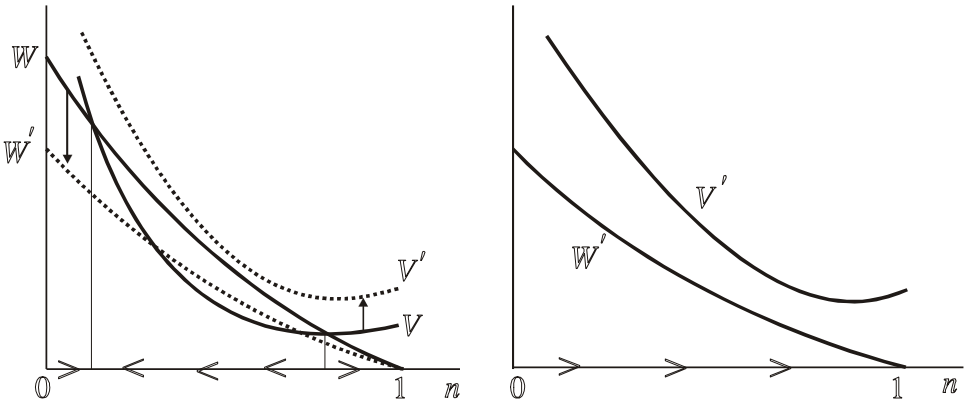

Figure 6: In the presence of voracity effect, boom may lead to change of regime from coexitence of productive and unproductive activities ($n = n_1$ in the left panel) to full rent-seeking ($n = 1$ in the right panel).

Proof. >From lemma 13, when $R_Q > 1$, we have $W_Q < 0 < V_Q$. This implies that oil boom pushes the reward to producers and rent-seekers downward and upward respectively. This has no effect on exterior equilibria, but displaces the interior equilibrium(s) rightward which is equivalent with misallocation of talent in favour of rent-seeking.

For a large enough upward and downward displacement in reward to rent-seeking and production respectively, there is no room for interior equilibrium and the economy ends up with full rent-seeking; This is illustrated in figure 6. ■

5.2.3 Normal Situations

In the reminder we concentrate on more general cases where income effect for both activities is positive. This requires $0 < R_Q < 1$. Moreover we interested in the case where apart from income effect, allocation effect is also operative. For having this situation we need $n \in (0, 1)$ and R not being linear in Q, therefore both income and allocation effect are operative.

To analyze the problem more concretely, consider $V - W$ as the bonus that the economy pays to the rent-seeking. The sign of $\partial(V - W)/\partial Q$ determines whether the boom encourages rent-seeking or it pays more to the producers.

Lemma 5 *For $n \in (0, 1]$, $V_Q(n, Q) \lesseqgtr W_Q(n, Q)$ if and only if $R_Q(n, Q) \lesseqgtr \phi(n)$.*

Now consider the following interesting case:

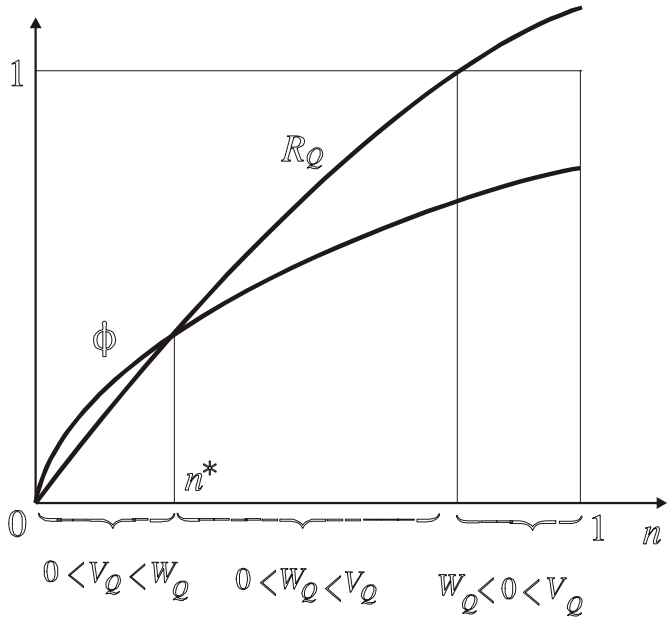

Figure 7: If R_Q is monotone and crosses ϕ from below and also $R_Q(0, Q) = 0$, then the extent of diversion that boom induces, depends directly on the level of rent-seeking intensity.

Proposition 6 *Suppose the marginal productivity of lobbying has the following properties:*

(i) $R_Q(0, Q) = 0$ *and* $R_Q(1, Q) > \phi(1)$*;*

(ii) $R_Q(n, Q)$ *is monotonous in* n*;*

(iii) $R_{Qn}(0, Q)$ *is finite.*

Then there exists a unique cut-off value of rent-seeking intensity defined by

$$n^* = \arg\{R_Q(n, Q) = \phi(n)\}$$

such that if the pre-boom equilibrium level of rent-seeking is higher than n^**, the boom rewards rent-seekers more and supports diversion. Otherwise it reduces the extent of misallocation of talent.*

Proof. See appendix. ■

Hence for $n > n^*$, oil boom encourages rent-seeking while for $n < n^*$ it pays more to the producers and has a positive level effect. In Baland and Francois(2000), resource boom favours rent-seeking along $(0, 1]$ interval. In our model this is the case on a shorter region, i.e. $(n^*, 1]$ where $n^* > 0$. Moreover in our study, the bonus that boom pays to rent-seekers is continuous and strictly increasing in the level of rent-seeking intensity.

We consider the interaction of income and allocation effects where production and rent-seeking coexist. This refers to the case (iii) in proposition 2. In this case W and V cross at n_1 and n_2 $(0 < n_1 < n_2 < 1)$ and n_1 is an interior equilibrium. Considering whether n^* is on the right or left of the interior equilibrium we distinguish two cases.

Case 1 $n_1 < n^* < 1$

Case 2 $0 < n^* < n_1$

In case 1, $V_Q(n_1) < W_Q(n_1)$ meaning that when the economy starts at n_1, boom rewards both producers and rent-seekers but pays the former group more. As a result, after boom n_1 is no longer an equilibrium. The boom stimulates rent-seekers to join production until the incentive for deviation disappears at n_1' where $0 < n_1' < n_1$. The new equilibrium Pareto dominates the old one and the boom is therefore welfare enhancing. The effect of boom in this case is depicted in the upper panel of figure 8.

In case 2 we have $V_Q(n_1) > W_Q(n_1)$ and boom favours rent-seekers more when the economy starts at n_1. Boom therefore induces diversion from production to rent-seeking implying that the allocation of human resources ends up with a new equilibrium at n_1' where $n_1 < n_1' < 1$. The allocation effect counteracts the income effect in this case. The welfare implication of boom is ambiguous and depends on whether the new equilibrium level of returns to both activities (at n_1') is higher or lower than its pre-boom level (at n_1). In the latter case, the adverse level effect of rent-seeking, generated by producers who have switched to unproductive activity, offsets the income effect of boom. The occurrence of this situation depends on the pre-boom equilibrium that the economy starts with (n_1), the magnitude of boom (ΔQ) and the extent of change implied by rent-seeking on reward structure (W_n and V_n). This case is illustrated in the middle panel of figure 8.

Case 2 also reveals a possibility for changing of regime induced by oil boom. In this case $0 < n^* < n_1 < n_2$. Since boom rewards rent-seeking relatively more, the points of intersection of W and V become closer after the boom. The higher the magnitude of boom, *ceteris paribus*, n_1' and n_2' are closer. Given parameters of the model, there exists a threshold level of oil rent, say $\overline{Q}$, for which n_1' and n_2' coincides and V touches W only once. For $Q > \overline{Q}$ therefore, there is no room for interior equilibria and only the no-activity equilibrium is feasible. In this case the economy switches from coexistence of productive and unproductive activities in pre-boom period to the no-activity regime in post-boom era. This is illustrated in the lower panel of figure 8.

Having noticed that rent-seeking is self-sustained in the latter regime, one can conclude the following statement:

Conclusion 4 *Suppose W crosses V at n_1 and $n_2 \in (0,1)$ and $n^* < n_1 < n_2$. Also the economy stays at n_1 when an oil boom takes place. Then*

(i) The misallocation of talent induced by boom may totally offset its income effect such that overall, boom favours diversion of human resources.

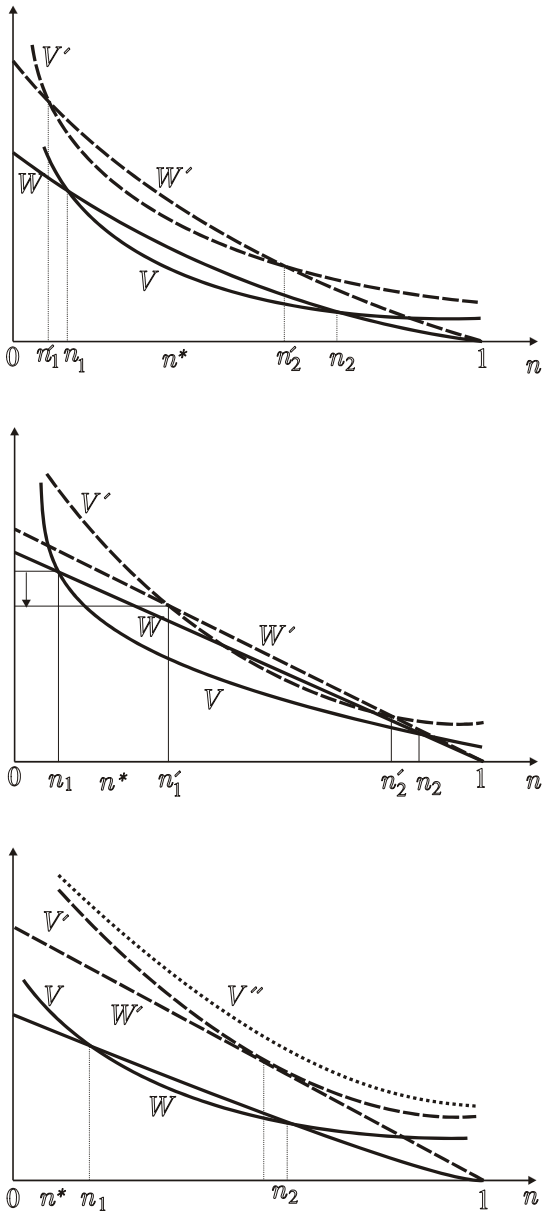

Figure 8: The effect of oil boom on the occupational choice where both income and allocation effects are operative. When $n_1 < n^* < n_2$, boom is welfare enhancing (upper panel). If $n^* < n_1 < n_2$, boom can be welfare worsening (middle panel). When the magnitude of boom is high enough, the interior equilibrium disappears and the economy switches to full rent-seeking regime (lower panel).

(ii) A boom with large enough magnitude governs the economy to full rent-seeking. In this case temporary shock has a permanent effect and the economy stays at no-activity equilibrium even when the level of oil income returns back to its pre-boom level.

The above analysis refers to a situation where oil boom which is naturally expected to brings about a boost in income and economic prosperity, induces a major change in the allocation of human resources in favour of rent-seeking and ironically results a sharp decline in the standard of living.

5.3 Empirical evidence

Our model suggests some insights about oil economies in development context. The existence of several equilibria with different level of rent-seeking covers a wide range of performances, including failures as well as successes, across oil economies. It further explains why oil-based economies react differently to the common experience of oil boom. The existence of no-activity regime also explains why some natural resource abundant economies are more tolerate with respect to rent-seeking.

This study does not carry out a test of any sort to assess empirically what has been found theoretically. We consult however empirical findings of other studies to evaluate how relevant is our arguments in the context of actual economies.

Regularities of oil economies reveals two facts related to the effect of oil endowment and oil boom on occupational choice between productive and unproductive activities. The first fact addresses the level of unproductive activities in the regions where oil economies are mainly located. Berthélemy et. al.(2000) estimate that amongst the main macro regions, waste of human resources due to rent-seeking in the Middle East and North Africa is very high. This partially supports our theoretical findings that oil economies, *ceteris paribus*, afford higher proportion of rent-seeking relative to other economies.

The second fact refers to the divergent patterns of evolution of oil exporters having faced the common experience of oil booms. Baland and Francois(2000) show how handful oil economies have successfully taken advantage of oil booms to constitute a sound industrial base, whereas others mostly channeled windfalls toward (public and private) consumption and rent-seeking. They also link different reaction of oil economies to the booms with their pre-boom situations ("industrial base" in Baland-Francois setting). This supports our argument that the pre-boom level of rent-seeking has an explanatory power on how the economy reacts to the boom.

The explanation presented in this paper obviously is not the only possible theoretical explanation for the effect of oil boom on the allocation of human resources, but according to the empirical evidence is a plausible one.

5.4 Role of policy

To make the social climate favourable for production, two elements are proposed in the literature. Firstly, people should be *taught* about the social cost of rent-seeking(Hall and Jones, 1999); society should be armed with an *anti-rent-seeking ideology* (Murphy et. al., 1993) to facilitate the required *cultural change* (Baumol, 1990).

The second element is *changing the rules to offset undesired institutional influences* (Baumol, 1990); *raising productivity* of production (Murphy et. al., 1993) and *protecting* it by a *credible treat of punishment* (Hall and Jones, 1999).

In line with Acemoglu(1995), our study shows when reward structure and the allocation of talent are endogenous and jointly determined, a policy addressing the diversion of human resources is not easy to implement. For an economy that is trapped in an equilibrium with acute rent-seeking, the policy should aim to influence reward structure to make rent-seeking less attractive, raise the productivity of production and protect innovators from predation.

Although our paper does not shed light on the performance of the underlying economy by itself, some results are straightforward. Diversion of human resources from productive activities to rent seeking and of government expenditure from provision of public goods to transfer are the most observable aspects of the symptom. Some ingredients might explain this phenomena. Fiscal authorities in allocation of public spending are dominated by rent-seekers' lobby; The income from natural resource is channeled into public fund where the rent-seekers have common access; There is no social control of diversion of talents and of public fund; Workers are politically passive; And finally as long as the stock of natural resource permits, the economy affords high degree of rent-seeking. Baumol(1990)'s advice is worth noting where he says: "*... we do not have to wait patiently for slow cultural change in order to find measures to redirect the flow of entrepreneurial activity toward more productive goals ... it may be possible to change the rules in ways that help to offset undesired institutional influences* " (p. 919).

6 Concluding remarks

This paper elaborates the effect of rent-seeking on misallocation of talent when it competes in employment of human resources with productive activities. We tailour our model to specific aspects of rent-seeking in oil economies where the size of oil rent is substantially high and government is in charge of allocation of the rent.

Regarding the effect of rent-seeking on overall performance of a general economy in the presence of oil endowment, our major findings can be summarized as follows:

1. Reward to productive activities is decreasing in the level of rent-seeking. This is caused by a negative externality from rent-seeking on production.

2. Rent-seeking has a negative level effect for two reasons. Some individuals choose rent-seeking rather than production. Moreover a fraction of pubic expenditure is devoted to transfer rather than productive public goods.

3. Allocation of human resources between production and rent-seeking and the reward to both activities are jointly determined at equilibrium where there is no incentive for change of occupation.

4. There is scope for multiplicity of equilibria including interior and corner solutions.

5. Good equilibrium in which there is no rent-seeking is not feasible unless productivity of working is sufficiently high relative to rent-seeking.

6. Excluding good equilibrium, producers are always underpaid. The extent of this underpayment depends on the level of rent-seeking that imposes extra tax on income.

7. No-activity is always an equilibrium. In this situation the extraction and liquidation of oil reserves is the only economic activity and everybody is a rent-seeker. In no-activity equilibrium rent-seeking is self-sustained.

8. Apart from direct predation on producers, rent-seeking can take the form of claiming on oil rent and influencing fiscal authorities to divert productive spending to public transfer.

9. Other type of equilibria than good equilibrium, emerges because people can not coordinate to abandon rent-seeking. Each agent takes reward structure as given and chooses the occupation that pays more.

10. Given reward structure, inherited allocation of talent determines in which equilibrium the economy lands unless it shocked by a substantial change in exogenous parts of reward structure including productivity, size of the economy, tax rate, and the extent of resource rent.

11. Multiplicity of equilibria accommodates performance of successful economies as well as failures in a unified framework.

On the specific aspects of rent-seeking in oil economies we conclude the followings:

1. In the case of coexistence of production and rent-seeking, resource boom may reward both activities unequally. In this case boom motivates people to change their current occupation. Whether boom favours productive or unproductive activities depends on the characteristics of pre-boom situation. In the latter case where boom pays more to the rent-seekers, it is possible that the overall effect of boom is welfare worsening.

2. Under plausible assumptions, oil boom can cause changing of regime from coexistence of both activities to full rent-seeking. In this case temporary shock has permanent effects and the after effects of boom persists even when the oil rent returns to its pre-boom level.

3. Voracity effect is operative in our setting when the marginal productivity of lobbying exceeds one. In this case boom favours misallocation of talent and may lead the economy toward full rent-seeking.

Our analysis here leaves some questions unanswered. The model does not explain why fiscal authority is influenced by rent-seekers but not by producers. It does explain that the power for extraction of fiscal transfers emerges from being organized. It does not elaborate however why rent-seekers get politically organized and producers not.

We treat in this approach, lobbying as a "block box". In other words, our treat of lobbying and influence lacks a precise model of the process whereby rent-seekers get politically organized and producers not. The "fiscal authority" and the process of policy choice is also a black box.

Lacking a structural model to drive the policy outcome on the ground of agents preferences, we can not answer these questions. We believe however that our simple approach by taking an influence function and abstracting from an active fiscal policy, succeeds to shed light on some of the aspects of the economies we are concerned about.

A Multi-winners contest

The k-winners rent-seeking contest can be considered as a game among N/k groups, each consists of k players for appropriation of a prize with value of R to be won by one winner. The expected pay-off in the latter contest to the i-th player is $\widetilde{V}_i = \widetilde{x}_i(R/\widetilde{X} - 1)$ where tilde refers that the variables are in the artificially one winner case.

The i-th player chooses his outlay, $\widetilde{x}_i$ in such a way to maximize his expected payoff, $\widetilde{V}_i$. Maximization leads to the FOC of $R(1 - \widetilde{x}_i/\widetilde{X}) = \widetilde{X}$. Summation on the number of players gives the total outlays as $X = \widetilde{X} = R(1 - k/N)$. Symmetry of outlays now gives $\widetilde{x} = k\widetilde{X}/N$ and $\widetilde{V} = k^2R/N^2$ as the outlay and the expected payoff of each group respectively. Now for simplicity we assume that each group distribute the outlay and the payoff equally among themselves. This gives $x = \widetilde{x}/k$ and $V = \widetilde{V}/k$ as presented in the text.

B Proof of Proposition 1

Simple differentiation gives

$$G'(n) = -\frac{R'(n)\left[1 - t(n)\right] + t(0)(Q - R)}{\left[1 - t(n)\right]^2}$$

and

$$T'(n) = \frac{-t(0)}{[1-t(n)]^2}\{(Q-R) + (1-n)R'(n)[1-t(n)]\}$$

where both expressions according to the properties of R and assumption 1 are negative.

C Proof of Proposition 6

Take R_Q and ϕ as two continuous functions of n on $[0,1]$. Based on the properties of these two, we have $R_Q(0,Q) = \phi(0) = 0$, and $R_{Qn}(0,Q) < \phi'(0) = +\infty$. For low values of n, R_Q is flatter than ϕ and therefore remains below it for some $n \in (0,1)$. On the other hand $R_Q(1,Q) > \phi(1)$ by assumption. Apply the zero theorem now on $R_Q - \phi$ to establish the existence of $n^* \in (0,1)$. The uniqueness comes from the monotonicity of both R_Q and ϕ. We have therefore $R_Q \lesseqgtr \phi$ for $n \lesseqgtr n^*$. Now by applying lemma 15, the proof is complete.

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