

Sharing natural resources: a critical time for a conflict¹

Abstract: The objective of this work is to develop a model, which allows analyzing a situation in which local and foreign producers use as input a nonrenewable local resource to produce a particular good. We analyze the possibility that an increasing exploitation of this natural resource generates conflicts between producers. We characterize the time when a potential conflict can blow up. Finally, different elements of fiscal policy for the local authority destined to delay or avoid the conflict are examined.

Keywords: Natural resources; economic concessions; conflicting interests.

JEL: C23; J23; J24; J31; J41.

Elvio Accinelli¹

Alberto Pinto²

Jesús E. Ordaz³

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⁴ Facultad de Economía de la UASLP. E-mail: e10_leibure@live.com.mx

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1. Introduction

An appropriate balance between exploitation and conservation of natural resources, is an important factor to achieve a sustainable social development. In fact, one of the most demanding challenges that every economy faces, is being able to use these resources efficiently, without exhausting them, looking at the same time improve the welfare of contemporary and future generations. Given that most of these resources are non-renewable, to achieve this objective, appropriate rules and regulation are required.

Increasing urbanization and industrialization leads to a significant increase in demand for natural resources which threatens their own existence, see for instance Yeh C. and Huang S. (2012). Currently, almost every country in the world, assigns an increasing strategic significance to natural resources, particularly in relation to oil, gas, water, land, and mineral supplies. The result is a new global landscape in which competition, over these vital resources, is becoming one of the main concerns of many national governments and local administrative authorities. It is necessary to take into account that the overexploitation of these resources, may lead to the collapse of the national economy in a finite time.

As several authors have shown, the sustainable exploitation of natural resources requires of agreements and incentives that look for cooperation between the various interested parties in their exploitation. To achieve this objective, the involvement of a central authority, as a benevolent social planner, is usually required. In this sense, the paper from Maskin, E. and Baliga, S. (2003) is enlightening. It is necessary to take into account that the authority involved should be able to design appropriate mechanisms to ensure the exploitation of these resources in a peaceful manner, i.e; trying to avoid that violent conflicts explode between different groups of peoples with antagonistic interests and taking into account the rights of future generations. As it is considered for several authors, the productive use of natural resources gives place to potential backward and forward linkages, strong and diverse, among the various parties involved. This aspect of the exploitation of the natural resources, is widely considered in Groso et al. (2007). For instance, the importance of local community attitudes, to the success of a tourism destination, towards tourists and tourism development, has become a very important research area in tourism economy. See among others Andriotis and Vaughan (2003).

Since the stock of a natural resource is bounded, if the demand for such resource increases, then a conflict between populations, with different interests in their exploitation, can blow up at some time, even when, until this moment these populations shared a peaceful exploitation of this resource. The intensive and uncontrolled resource exploitation can bring with it the disappearance of a local community or a significant deterioration in their standard of living. In addition, communities often have strong emotional and symbolic attachments to land and the resources on it. See, for instance, Sargent, Lusk, Rivera, and Varela (1991). Of course, the lack of property rights on resources such as land, can be a serious source of conflict. Certainly, the ownership of land means access to many other resources, such fishing, hunting, food in general, or firewood, of high economic value. Around the world, violent conflicts originate in such absence of property rights, have broken out. This happened in countries as diverse as China (Shandong and Guangdong Provinces 2000), Ethiopia (2006), India (2004), Kenya (2005), and Yemen (1999). See "A Study Guide Series on Peace and Conflict" (2007).

In this paper, we will analyze how the increasing exploitation of local natural resource by foreign and local producers, can be a source of conflicts. We aim to characterize the time when a potential conflict become a real one, and then we will consider elements of economic policy to avoid or delay the emergence of this critical time. Some recent literature suggests that the exploitation of natural resources has been a curse more than a blessing for many countries because they increase the social tensions, governance

problems, and economic distortions, that have hampered rather than facilitated growth. See, for instance Coutinho, L.(2011). More specifically, in this paper, we will consider a natural resource originally exploited by a local population (residents in the place where the resource is located), as a primary input to obtain a tradable good or service. In view of an increasing demand for such good or service, foreign investors are attracted. The resource is managed by a local administration that can give concessions for its exclusive use. But, this authority can not sell the resource. We consider that besides the increasing demand for this good, some potential consumers would like more sophisticated or differentiated goods or services than those that can be obtained from the local producers. Local production can not satisfy such increasing and differentiated demand. Attracted by the prospect of profits, foreign investors arrive looking to settle in the place to satisfy this demand. The local authority can give to foreign investors concessions to use this natural resource in exchange for some participation in profits. However, we consider that there is not a possibility of buying or selling such concessions. Once obtained the concession, foreign investors seek to satisfy the increasing demand for new and sophisticated goods, and to do this, they need the natural resource as the main input. Examples of such situations potentially conflictive include the exploitation of petroleum, fishing, grounds, pastures, forests, water, or beaches with tourist interest. For instance, consider an oil country where governments may delegate the exploration and the extraction of oil. Suppose that such productive activity is carried out by a local firm whose technology is lagging or is non-innovative. So, a foreign investment is needed to innovate or make competitive this activity⁵.

Closer to our model, are those models referred to in places where a precious natural resource can be used by residents or foreign investors to supply tourist services. For instance, a beach can be exploited by specialized tourism firms, building hotels and restaurants, or, alternatively, by local people, offering divers natural and typical tourist services. In some cases this kind of resource, can not be granted on private property, but the local authority can give concessions for its productive use.

Finally it is worth noting that we do not intend to develop a new model for the preservation of the environment or for the sustainable exploitation of natural resources. Simply we use well known tools of the microeconomics and differential equations to model the development of a potential conflict originated in the exploitation of a scarce natural resource and the necessity of the action of a local authority to prevent or stop a violent resolution of such conflict. This kind of intervention should be developed before a certain critical time. We characterize that time. The remainder of this paper is organized as follows. Section 2 introduces the model. We assume that government can offer concessions for exploitation and exclusive use of resources. Section 3 analyzes the equilibrium results. However, there may be conflict of interest between them. Subsections 3.1 and 3.2 study how to overcome such conflicts by the imposition of taxation which is directly related to the benefits obtained from the exploitation of the resource in concession to private. The amount of such tax is related with the profit obtained in the market of these complex goods. Section 4, as away of concluding offers some comments on welfare and social surplus obtained by the productive consumption of this natural resource.

2 The model

Let us consider a simple microeconomic model, but powerful enough to explain complex and real situations related to natural resource exploitation. A local authority allows that a natural resource be exploited privately by foreign investors or by local residents as a primary input. With this input two different types of complex goods can

⁵ One of the most significant discussions in natural resource economics, is about the way to collect the resource rent, as summarized by Daniel et al. (2010). Concession contracts used to be the rule to delegate the exploration and the extraction of hydrocarbons. According to Johnson (1981), the government should receive a low share of the profit oil to promote the exploration and compensate with a resource rent tax..

be obtained. We will call sophisticated products those developed by foreign investors, and basic products will be called those produced by locals. Our interest is to focus on the productive use of a scarce resource such as a feature that causes a conflict between two types of producers, local and foreign.

To simplify the model, we assume that labor is abundant and that it can always be found in the required quantities. We consider that both types of production, local and foreign, are efficient, and that it can always be found prices and quantities follow the laws of the market, at least until the moment when the natural resource is depleted. So, until this moment, prices and quantities are adjusted according to supply and demand.

Consider that the total existence of such resource is given by $\bar{z} > 0$. Suppose that for a given time, the local authority starts to give concession for the exploitation of this natural resource. An amount equal to $\bar{z}_l < \bar{z}$, is left in exclusive ownership of the local population, who uses the resource to obtain their livelihood. In addition, we consider

that in a fixed initial time $t = t_0$, there are $N_{h_0} \geq 1$ foreign firms using these concessions. Suppose these firms use the same technology and that all of them have identical capacity.

1. The production function of each foreign firm is given by the real function

$f_h: \mathbf{R}_+ \rightarrow \mathbf{R}$ given by $y_h = f_h(z) = z^{\alpha_h}$, where y_h represents the number of units of sophisticated good that can be obtained from z units of natural resource and $\alpha_h \in (0,1)$ is the production elasticity of the factor.

2. The production function of locals is given by $y_l = f_l(z) = z^{\alpha_l}$ where y_l denote the number of units of basic good than can be obtained from z units of natural resource and $\alpha_l \in (0,1)$ is the production elasticity of the factor.

3. We consider that the foreign technology is more developed than the local one, i.e; $\alpha_h > \alpha_l$.

4. Also we assume that there are no fixed costs. However, the local authority may impose a foreign exchange rate on its profits.

5. The basic restriction of the model is that the total amount of resource is fixed.

Assume that in time t_0 the inequality $N_{h_0} z_h + z_l \leq \bar{z}$ is verified. Where z_h is the amount of the primary input given in concession to each foreign firm, and z_l is the total amount of the primary input (the natural resource) used, exclusively by the local population.

Suppose that each unit of the sophisticated good has a market price equal to p_h . The optimal supply corresponds to the result of maximizing the profits of the investor, i.e.

$$\pi_h(y_h) = p_h y_h - c_h(y_h), \quad y_h \leq f_h(z_h), \quad \text{and} \quad z_h \leq \bar{z} - \bar{z}_l,$$

where $c_h(y_h)$ is the cost of producing y_h units of the sophisticated good from z_h units of the primary input.

Locals offer basic goods due to a less developed technology. Let p_l be the market unit price of this basic good. Then, locals profits are

$$\pi_l(y_l) = p_l y_l - c_l(y_l), \quad y_l \leq f_l(z_l), \quad \text{and} \quad z_h \leq \bar{z} - \bar{z}_l,$$

where $c_l(y_l)$ is the cost of producing y_l units of the local good from z_h units of the primary input.

In order to simplify the model, without loss of generality, assume that there are only two types of consumers for these goods, they are characterized by their respective preferences. The aggregated demands for these two goods are derived from two different

utility functions, representing these two different preferences:

$$u_1(y_l, y_h) = y_l^{\gamma_1} y_h^{\beta_1}, \quad 0 \leq \gamma_1 < \beta_1 \leq 1.$$

$$u_2(y_l, y_h) = y_l^{\gamma_2} y_h^{\beta_2}, \quad 0 \leq \beta_2 < \gamma_2 \leq 1.$$

For a consumer of type 1, the marginal utility of the more sophisticated good is bigger than the marginal utility of the local good and reciprocally for a consumer type two. Extreme cases would be those in which one of the two exponents is zero and the other is equal to one, indicating preferences for only one of the two goods. Note also that, if $a < b$ a consumer of type 1 prefer the bundle set (a, b) more than the bundle set (b, a) and reciprocally a consumer of type 2. In resume good 1 is an imperfect substitute of good 2, meaning that one can be substituted by the other, but only up to a limit.

In addition assume that consumers of type 1, are willing to spend I_1 monetary units in tourism and type 2 I_2 monetary units. So the total expenditure in tourism will be $I = I_1 + I_2$.

In order to focus on the main issue of this paper, we consider that preferences are represented by well known utility functions for consumers and technologies by simple production functions. We assume that this two types of goods or services can be considered as imperfect substitutes. For example, olive oil and sunflower oil can be considered as partial or imperfect substitutes, but to produce olive oil involves different costs and technologies. Similarly with the same petroleum can be obtained fuel red or green, but production of either requires different technologies, however they can be considered as imperfect substitutes. Thinking on tourism, ecotourism and tourism in luxury hotels may be imperfect substitutes. Some people prefer the first way more than luxury hotels, and others prefer luxury hotels more than ecotourism, but under certain conditions they can accept the substitute.

3 The equilibrium of the model

Now we look for equilibrium prices. To this we must solve the following maximization problem:

$$\max_{y_l, y_h} u_i(y_l, y_h) \text{ s.t. } p_l y_l + p_h y_h \leq I$$

$$\max_{z_h} \pi_h(y_h) = p_h y_h - c_h(y_h), \text{ s.t. } y_h \leq f_h(z_h), \text{ and } 0 \leq z_h \leq \bar{z} - \bar{z}_l.$$

$$\max_{z_l} \pi_l(y_l) = p_l y_l - c_l(y_l), \text{ s.t. } y_l \leq f_l(z_l), \text{ and } 0 \leq z_l \leq \bar{z}.$$

As it is well known, to solve an equilibrium problem we proceed as follows. First, we assume the existence of an equilibrium interior to the restriction of the model. So, as under this assumption, the total resource demanded in concession by foreigners and residents is less than the supply, we can consider this resource as a free good, i.e; a good whose market price is zero. Certainly to transform this good in a tourist services has associated a cost.

1. Considering prices of tourism services, as parameters.

- We obtain the supply function, $y_h^o(p_l, p_h)$, of the investors. To do this we maximize

$$\pi_h(y_h) = p_h y_h - c_h(y_h), \text{ s.t. } y_h \leq f_h(z_h) \text{ and } z_h \leq \bar{z} - \bar{z}_l.$$

For simplicity we assume a technology with decreasing return to scale $y_h = f_h(z_h) = z_h^{\alpha_h}$ and as usual, when input are scarce, the marginal costs are increasing⁶. Again for simplicity, we consider $c_h(y_h) = c_h(f_h(z_h)) = a_h z_h^2$, where $a_h > 0$ is a positive constant. So, foreign firms must solve the following maximization problem:

$$\pi_h(z_h) = p_h z_h^{\alpha_h} - a_h z_h^2, \text{ s.t. } z_h \leq \bar{z} - z_l. \quad (1)$$

- To obtain the supply function for the local good, $y_l^o(p_l, p_h)$ of locals, i.e: maximizing

$$\pi_l(y_l) = p_l y_l - c_l(y_l), \text{ s.t. } y_l \leq f_l(z_l), z_l \leq \bar{z}_l.$$

Again for simplicity we are assuming, $y_l = f_l(z_l) = z_l^{\alpha_l}$; and $c_l(z_l) = a_l(z_l)^2$ where a_l is a positive constant. Equivalently, local solve the maximization problem

$$\pi_l(z_l) = p_l z_l^{\alpha_l} - a_l z_l^2, \text{ s.t. } z_l \leq \bar{z}_l. \quad (2)$$

- In addition we assume $0 < \alpha_l < \alpha_h < 1$ and $0 < a_h < a_l$.

- Consumers of type 1, maximize

$$u_1(y_l, y_h) = y_l^{\gamma_1} y_h^{\beta_1}, \text{ s.t. } p_l y_l + p_h y_h = I_1,$$

and consumers of type 2 solve the maximization problem:

$$\max u_2(y_l, y_h) = y_l^{\gamma_2} y_h^{\beta_2}, \text{ s.t. } p_l y_l + p_h y_h = I_2,$$

The result will be the demand for sophisticated goods and basic goods, they are $y_h^d(p_l, p_h)$ and $y_l^d(p_l, p_h)$ respectively.

2. Now equating aggregate supply and demand.

$$y_h^d(p_l, p_h) = N_h y_h^o(p_l, p_h), \quad y_l^d(p_l, p_h) = y_l^o(p_l, p_h).$$

Assuming that the the solutions of programs (1) and (2) are interior we obtain that

• Locals' supply is:

$$y_l^o(p_l, p_h) = \left[\frac{\alpha_l p_l}{2a_l} \right]^{\frac{1}{2-\alpha_l}} \text{ and so, } z_l = \left[\frac{\alpha_l p_l}{2a_l} \right]^{\frac{1}{2-\alpha_l}} \leq \bar{z}_l. \quad (3)$$

• Foreign investors' supply is:

$$y_h^o(p_l, p_h) = \left[\frac{\alpha_h p_h}{2a_h} \right]^{\frac{1}{2-\alpha_h}} \text{ and consequently, } z_h = \left[\frac{\alpha_h p_h}{2a_h} \right]^{\frac{1}{2-\alpha_h}} \leq \bar{z} - \bar{z}_l. \quad (4)$$

• Moreover, given that we consider that in time $t = t_0$ there are N_{h_0} identical foreign firms producing, then we assume in addition that $N_{h_0} z_h \leq \bar{z} - \bar{z}_l$.

• Assuming $\alpha_j \neq 0$ and $\beta_j \neq 0 \forall j \in \{1, 2\}$, consumers' demand is:

$$y_l^d = \left[\frac{\gamma_1 I_1}{(\gamma_1 + \beta_1)} + \frac{\gamma_2 I_2}{(\gamma_2 + \beta_2)} \right] \frac{1}{p_l},$$

$$y_h^d = \left[\frac{\beta_1 I_1}{(\gamma_1 + \beta_1)} + \frac{\beta_2 I_2}{(\gamma_2 + \beta_2)} \right] \frac{1}{p_h}. \quad (5)$$

where $\gamma_1 I$, $\gamma_2 I$, $\beta_1 I$ and $\beta_2 I$ the shares of total consumption expenditure in

⁶ Recall that as more of a scarce resource is used the marginal costs increases. Precisely the scarcity of a natural input is reflected in the fact that marginal cost increases. See, for instance, Mercurio, N. (1997).

local and luxuries goods for each type of consumers, respectively.

• Therefore, when there are N_h foreign firms in the market the equilibrium prices are:

$$p_l^e = \left[\frac{\gamma_1 I_1}{(\gamma_1 + \beta_1)} + \frac{\gamma_2 I_2}{(\gamma_2 + \beta_2)} \right]^{\frac{2-\alpha_l}{2}} \left[\frac{2a_l}{\alpha_l} \right]^{\frac{\alpha_l}{2}} \quad (6)$$

$$p_h^e = \left[\frac{1}{N_h} \right]^{\frac{2-\alpha_h}{2}} \left[\frac{\beta_1 I_1}{(\gamma_1 + \beta_1)} + \frac{\beta_2 I_2}{(\gamma_2 + \beta_2)} \right]^{\frac{2-\alpha_h}{2}} \left[\frac{2a_h}{\alpha_h} \right]^{\frac{\alpha_h}{2}}.$$

• Consequently, the equilibrium demand and supply are:

$$y_l^e = \left[\frac{\gamma_1 I_1}{(\gamma_1 + \beta_1)} + \frac{\gamma_2 I_2}{(\gamma_2 + \beta_2)} \right]^{\frac{\alpha_l}{2}} \left[\frac{\alpha_l}{2a_l} \right]^{\frac{\alpha_l}{2}} \quad (7)$$

$$y_h^e = N_h^{\frac{2-\alpha_h}{2}} \left[\frac{\beta_1 I_1}{(\gamma_1 + \beta_1)} + \frac{\beta_2 I_2}{(\gamma_2 + \beta_2)} \right]^{\frac{\alpha_h}{2}} \left[\frac{\alpha_h}{2a_h} \right]^{\frac{\alpha_h}{2}}$$

• Let z_l^e and z_h^e be the amounts of primary inputs such that $y_l^e = f_l(z_l^e)$ and $z_h^e = N_h z_{ih}^e$ where $y_{ih}^e = f_h(z_{ih}^e)$, respectively.

• Note that in time $t = t_0$ we consider that the feasibility constraint are verified.

This means that $0 \leq N_{h_0} z_{ih}^e \leq \bar{z} - \bar{z}_l$, $0 \leq z_l^e \leq \bar{z}_l$ and $z_l^e + N_{h_0} z_{ih}^e \leq \bar{z}$. Suppose that this restriction is verified, otherwise we will have a conflict between locals and foreign investors, which will be analyzed later.

The next proposition is straightforward.

Proposition 1 *The profits of foreign and local firms are positive therefore there are incentives for the entry of new local and foreign firms until the resource is exhausted*

Proof: Note that in equilibrium profits are: $\pi_j^e = p_j^e \left[\frac{\alpha_j p_j}{2a_j} \right]^{\frac{\alpha_j}{2-\alpha_j}} - a_j \left[\frac{\alpha_j p_j}{2a_j} \right]^{\frac{2}{2-\alpha_j}}$

after some algebra the following identity holds,

$$(\pi_j^e)^{2-\alpha_j} = \left[\frac{p_j^e}{2} \right]^2 \left[\frac{1}{a_j} \right]^{\alpha_j} \left[\frac{2}{\alpha_j} - 1 \right]^{2-\alpha_j} > 0 \quad \forall j \in \{1, 2\} \text{ and } 0 < \alpha_j < 1. \bullet$$

Despite being positive, the benefits of foreign firms decrease as new firms are installed in the place. Certainly note that:

$$\pi_h(p_h^e) = \left[\frac{1}{N_h} \right] \left[\frac{\beta_1 I_1}{(\gamma_1 + \beta_1)} + \frac{\beta_2 I_2}{(\gamma_2 + \beta_2)} \right] \left[\frac{2-\alpha_h}{\alpha_h} \right]^{\frac{2}{2-\alpha_h}} \frac{\alpha_h}{2}. \quad (8)$$

Moreover $\pi_h(p_h^e) \rightarrow 0$ if $N_h \rightarrow \infty$.

3.1 Conflict I: the increasing supply

If the net profits of the foreign firms are higher than the expected profits in similar places, then there are incentives for potential entrant firms, enter. To simplify we consider

that the expected profit in similar places is equal to zero.

So, a possibility of a conflict between incoming and local firms appears when the number N_h^c of foreign firms in the place verify the equation:

$$N_h^c z_h = z - z_l. \quad (9)$$

Taking account equation (4), substituting from equation (6) and after some algebra we obtain that:

$$N_h^c \left[\frac{\beta_1 I_1}{(\gamma_1 + \beta_1)} + \frac{\beta_2 I_2}{(\gamma_2 + \beta_2)} \right] \left[\frac{\alpha_h}{2a_h} \right] = (z - z_l)^2.$$

Then we obtain the maximum amount of foreign firms before a conflict blows up, is given by:

$$N_h^c = \frac{(z - z_l)^2}{\left[\frac{\beta_1 I_1}{(\gamma_1 + \beta_1)} + \frac{\beta_2 I_2}{(\gamma_2 + \beta_2)} \right] \left[\frac{\alpha_h}{2a_h} \right]} \quad (10)$$

From this time, the entry of a new firm, supposes the expansion of the foreign firms towards the territory given by the corresponding authority, in exclusive usufruct to the local population. This possibility is a result of the existence of incentives (positive benefits) for the entry of new firms and the fact that the natural resource used as inputs escapes.

On the other hand, since foreign firms have more advanced technology than the local firms, foreign firms are willing to pay (if it is possible) for concessions, until now held them by local people. In this moment, a potential conflict can become real. In terms of our model, the assumption over the different productivity of technologies is captured by the inequality: $\alpha_h > \alpha_l > 0$ besides local production is more expensive than foreign production because $0 < a_h < a_l$.

To analyze with a little more detail the nature of this conflict, let us make the following assumptions.

1. We assume that the local population is fixed, and each individual has grant or concession over the natural resource. However, the total amount z_l of this resource, in the locals' hands, does not exhaust its existence because of $z_l \leq z$.
2. Foreign investors can arrive to the place and obtain concessions from the local authority.
3. It is natural in these cases, assuming that the technology of the foreign firms is more productive than the local technology. In our case, these assumptions can be summarized by the inequality $\alpha_h > \alpha_l$.
4. Consider that all the foreign firms have the same capacity of production and the same technology. Hence, the supply of each incumbent foreign firm is, equal to: $N_h y_{ih}^e = y_h^e$,

where N_h is the amount of foreign firms producing in the place. The amount of natural resource used to produce the optimal amount of this good is denoted by z_{ih}^e thus $y_{ih}^e = f_h(z_{ih}^e)$, and the total amount of natural resources used by foreign firms is equal to $z_h^e = N_h z_{ih}^e$.

Now, if the foreign firms, which are established in the place, are obtaining positive benefits, then new companies will want to enter this market. While there exist some available amount of primary input, concession can be given by the local administration. So, there is no conflict between local and foreign firms. But, if this situation persists, and new foreign investors continue arriving, the potential conflict between locals and

foreigns can explode.

So, if in time t , the profit, $\pi^e(t) = \pi_h(N_h(t))$ is possitive, then there exist incentives to new firms come to the place. However; as this happens, the incentives for the entrance of new firms in the place decrease at the same time that the supply increases.

We describe this dependence by the function $\pi(N_h(t))$ where $N_h(t)$ represents the amount of foreign firms set in place at the time t . Then:

$$\pi_h(N_h(t)) = \pi_h(P_h^e) = \left[\frac{1}{N_h} \right] \left[\frac{\beta_1 I_1}{(\gamma_1 + \beta_1)} + \frac{\beta_2 I_2}{(\gamma_2 + \beta_2)} \right] \left[\frac{2 - \alpha_h}{\alpha_h} \right]^{\frac{2}{2 - \alpha_h}} \frac{\alpha_h}{2} \quad (11)$$

Substituting de expression of the equilibrium price in the expression of the profits, and after some algebra, we ca write the profits of the foreign firms as:

$$\pi_h(N_h(t)) = K_1 \frac{1}{N_h(t)} \quad (12)$$

where:

$$K_1 = \left[\frac{\beta_1 I_1}{(\gamma_1 + \beta_1)} + \frac{\beta_2 I_2}{(\gamma_2 + \beta_2)} \right] \left[\frac{2 - \alpha_h}{\alpha_h} \right]^{\frac{2}{2 - \alpha_h}} \frac{\alpha_h}{2}$$

Let $\dot{N}_h(t) = \lim_{\Delta t \rightarrow 0} \frac{N_h(t + \Delta t) - N_h(t)}{\Delta t}$ be the instantaneous flux of the entrants new firms.

Note that

$$\dot{\pi}_h(N_h(t)) = \frac{d\pi_h(N_h)}{dN_h} \dot{N}_h(t) \leq 0. \quad (13)$$

Using the replicator dynamics, the following proposition show that there exists a critical time form which a conflict between incumbent and entrant firms can burn.

Proposition 2 *If profits of foreign firm are positive for a time large enough, then there exists a critical time t^c in which the potential conflict between local and foreigner producers becomes real. Before this critical time, the natural resource is not fully utilized and local and foreign coexist without problem.*

Proof: Consider that the rate of entry of new investors' firms is proportional to $\pi_h(N_h(t))$. Then, given that $\pi_h(N_h(t)) > 0$ there exists incentives to new firms come to the place. This process can be described by the following differential equation:

$$\frac{\dot{N}_h}{N_h}(t) = r\pi_h(N_h(t)), \quad N_h(0) = N_{h_0}. \quad (14)$$

where $r > 0$. Now substituting, it follows from equation (12) that

$$\frac{\dot{N}_h}{N_h} = rK_1 \frac{1}{N_h} \quad (15)$$

We obtain that

$$N_h(t) = rK_1 t + N_{h_0} \quad (16)$$

As a result of new incoming firms supply increases, until a critical time $t = t^c$ such that $N_h(t^c) = N_h^*$. According with the equation (10) the critical time is giving by the equation

$$rK_1 t^c + N_{h_0} = \frac{(\bar{z} - \bar{z}_l)^2}{\left[\frac{\beta_1 I_1}{(\gamma_1 + \beta_1)} + \frac{\beta_2 I_2}{(\gamma_2 + \beta_2)} \right] \left[\frac{\alpha_h}{2\alpha_h} \right]}$$

Finally we obtain that

$$t^c = \frac{1}{rK_1} \left[\frac{(\bar{z} - \bar{z}_l)^2}{K_1 \frac{2 - \alpha_h}{\alpha_h}} - N_{h_0} \right] \quad (17)$$

We call this time t^c , the critical moment for the conflict. It indicates the moment when the conflict between local and foreign is no longer potential but real.

Note that, until the critical moment, the primary resource is not fully utilized, i.e.:

$z_l^e + N_h(t)z_h^e < z$ i.e. the primary resource until this critical time can be considered as a free good. Thus, the only potential conflict is between incumbent and entrant foreign firms. These kind of conflicts are well known in the literature and are modeled as a predation game. The solution of these conflicts is the only subgame perfect Nash equilibrium (free of no credible threats) in a predation game, according to which, incumbent accommodates and entrant enters. See, for instance Fudenberg and Tirole (1991). We will not continue with this approach; however we remark the fact that our result is supported by this classical result of game theory. But we go beyond: the threat of a conflict becomes credible only when the natural resource is fully utilized

But at time t^c a qualitative different conflict arises. From this time a conflict between local and entrant foreign firms arises. The possible solutions for this conflict are not so easy and are not endogenous. In particular because the natural resource is fully used in the production of goods and services. In some cases, as a solution for this conflict, it is possible to establish a market for the exchange of concessions to the utilization of the primary resource by setting one of the following rules or a combination of both:

1. The local population becomes salaried workers in foreign firms, with salaries equal to profits that they could obtain working in they own firms.
2. Foreign firms pay for the concession to the local the value of a life policy update equal to

$$W = \int_0^T \pi_l(t) e^{-rt} dt,$$

where r is a discount factor over the future (for example equal to the bank interest rate at the time $t = 0$) and T is the expected time of life for the resident population.

As a conclusion of the proposition (2) we obtain the following corollary about fiscal policies.

Corollary 1 *The critical time can be delayed if the central authority imposing a tax $0 < \lambda < 1$. Over profits, according to which the authority collects an amount equal to $\lambda N_h(t)\pi_h(t)$.*

proof: In such case we obtain that $(1 - \lambda)\pi_h(t) \leq \pi_h(t)$ now the proposition follows from (14).

Moreover, if $\lambda' > \lambda$ then

$$t'^c = \frac{1}{r(1 - \lambda')K_1} \left[\frac{(\bar{z} - \bar{z}_l)^2}{(1 - \lambda')K_1 \frac{2 - \alpha_h}{\alpha_h}} - N_{h_0} \right] > t^c = \frac{1}{r(1 - \lambda)K_1} \left[\frac{(\bar{z} - \bar{z}_l)^2}{(1 - \lambda)K_1 \frac{2 - \alpha_h}{\alpha_h}} - N_{h_0} \right] \dots$$

Eventually if in some time $t < t^c$ the local administration impose $\lambda = 1$ then $t^c = \infty$. In the opposite sense, t^c decreases as π^e increases. An extensive work on the impact of fiscal policy on tourism can be found in Feliziani, V. and Monni, S. (2013) and in Coutinho, L.(2011).

Note that according to the remark in the previous section, the same effect can be obtained using tax over the production, but this is a distortionary tax, which is transferred to service users.

3.2 Conflict II: the increasing demand

Suppose that the total income destined to consumption of tourism goods and services increases. In particular the demand for tourism goods or services in natural regions. In order to simplify, consider the case where this happens, because the amount of individuals demanding for these goods or services increases. In this case, if profits in the sector are positives, it can be expected that both types of producers, local and foreign, require from the central authority more natural resources given in concession. See, for instance, Kahl(2008). As a consequence, the critical time becomes smaller (see equation (21) below) and the risk of the emergence of social conflict increases.

To prove this assertion, consider, without loss of generality, that every individual in the population is willing to spend I monetary units in the consumption of these goods. So, if the total population consuming these goods in time t is $T(t)$ the total expenditure on consumption of these goods is given by $I(t) = T(t)I$. As in classical model of growth theory, where population increases at a constant rate, assume that the amount of consumers of these good grows steadily with a constant rate $\rho > 0$.

Recall that the supply and demand in equilibrium are given by equations (7), i.e:

$$y_l^e = \left[\frac{\gamma_1 I_1}{(\gamma_1 + \beta_1)} + \frac{\gamma_2 I_2}{(\gamma_2 + \beta_2)} \right]^{\frac{\alpha_l}{2}} \left[\frac{\alpha_l}{2a_l} \right]^{\frac{\alpha_l}{2-\alpha_l}},$$

$$y_h^e = N_h y_h^e = N_h^{\frac{\alpha_h}{2-\alpha_h}} \left[\frac{\beta_1 I_1}{(\gamma_1 + \beta_1)} + \frac{\beta_2 I_2}{(\gamma_2 + \beta_2)} \right]^{\frac{\alpha_h}{2}} \left[\frac{\alpha_h}{2a_h} \right]^{\frac{\alpha_h}{2-\alpha_h}}.$$

The total amount of the natural resource used in production of the sophisticated good is given by:

$$z^e = (y_l^e)^{\frac{1}{\alpha_l}} + N_h (y_h^e)^{\frac{1}{\alpha_h}}.$$

Which clearly shows that in equilibrium the consumption of both types of these goods increases with income. Note that if at time $t = t_0$ the amount of consumers of local goods is $T_1(t_0)$ and $T_2(t_0)$ is the amount of consumers of sophisticated goods, then

$$T_1(t) = T_1(t_0)e^{\rho(t-t_0)} \text{ and } T_2(t) = T_2(t_0)e^{\rho(t-t_0)}.$$

It follows that $I_k(t) = T_k(t)I_k$, $k \in \{1, 2\}$. Then in time t , under equilibrium, the demand and supply for these goods are given by:

$$y_l^e(t) = \left[\frac{\gamma_1 I_1 T_1(t_0)}{(\gamma_1 + \beta_1)} + \frac{\gamma_2 I_2 T_2(t_0)}{(\gamma_2 + \beta_2)} \right]^{\frac{\alpha_l}{2}} \left[\frac{\alpha_l}{2a_l} \right]^{\frac{\alpha_l}{2-\alpha_l}} e^{\frac{\alpha_l}{2} \rho(t-t_0)}, \quad (18)$$

$$y_h^e(t) = N_h^{\frac{\alpha_h}{2-\alpha_h}} \left[\frac{\beta_1 I_1 T_1(t_0)}{(\gamma_1 + \beta_1)} + \frac{\beta_2 I_2 T_2(t_0)}{(\gamma_2 + \beta_2)} \right]^{\frac{\alpha_h}{2}} \left[\frac{\alpha_h}{2a_h} \right]^{\frac{\alpha_h}{2-\alpha_h}} e^{\frac{\alpha_h}{2} \rho(t-t_0)}. \quad (19)$$

In this case the critical time is given by the equation:

$$N_h (\bar{T}^c)^{\frac{2-\alpha_h}{2}} \left[\frac{\beta_1 I_1 T_1(t_0)}{(\gamma_1 + \beta_1)} + \frac{\beta_2 I_2 T_2(t_0)}{(\gamma_2 + \beta_2)} \right]^{\frac{\alpha_h}{2}} \left[\frac{\alpha_h}{2a_h} \right]^{\frac{\alpha_h}{2-\alpha_h}} e^{\frac{\alpha_h}{2} \rho(\bar{T}^c - t_0)} = \bar{z} - \bar{z}_l. \quad (20)$$

Note that under these assumptions, and considering $t_0 = 0$ the new critical time $\bar{t}^c$ is given by the equation:

$$\left[rK_1\bar{t}^c + N_{h_0} \right]^{\frac{2-\alpha_h}{2}} K_3 e^{\frac{\alpha_h}{2}\rho\bar{t}^c} = \bar{z} - \bar{z}_l. \quad (21)$$

$$\text{where } K_3 = \left[\frac{\beta_1 I_1 T_1(0)}{(\gamma_1 + \beta_1)} + \frac{\beta_2 I_2 T_2(0)}{(\gamma_2 + \beta_2)} \right]^{\frac{\alpha_h}{2}} \left[\frac{\alpha_l}{2a_h} \right]^{\frac{\alpha_h}{2}}.$$

Given that the profits of investors are positive, then supply will continue growing with the demand. Summarizing, given that the people demanding such goods or services increases at rate ρ , from equations (18) and (19), it follows that both demand and supply in equilibrium will grow exponentially with time. Since that, the natural (or primary) resource is bounded, necessarily there will come a time when conflicts between investors and locals arise. This time becomes smaller as the rate of growth of demand for natural products increases.

The local authorities must solve this situation. For instance, imposing a variable tax over the foreign profit, or when is legally possible, establishing a market for concessions, see section (3.1). Note that even when in time $t = t_0$ the local administrative authority imposes on investors the tax λ over profits, the foreign investors can obtain positive profits. To delay the flux of new investors, the authority must increase the tax rate over profits. However; this policy, that is aimed at avoiding or delaying the conflict, may become a source of new social conflicts. This fiscal policy could rise at the same time, a rent seeking behaviour on the part of several economic groups. Pressure on the part of different interest groups, combined with weak institutions, leads to a misallocation of revenues. See, for instance, Auty, R. (2007), Boschini, A.D., and Pettersson, J. (2007).

4 Conclusion

A central question is: if national authorities must leave foreign firms to use a natural resource, when this exploitation can give rise to a conflict. The answer depends on the critical time. Before this time the answer may be yes. But after this moment the central authority must consider additional restrictions to the entrance of new firms. As we shown the conflict in an initial period is only potential, however after some time, it can blow up.

Before this critical time, the participation of foreign firms in the exploitation of a natural resource can be beneficial for the national economy. Because, while it is true that such participation generates conflict, it as well generates social welfare. This welfare corresponds to the producer and consumer surplus, generated by the production and interchange of these goods or services in the market.

It is mandatory that the national authority legislates above the distribution of the social surplus. A suitable legislation can prevent the conflict from exploding. It is necessary to remark that windfalls caused by the recent exploitation of natural resources, combined with weak institutions, can give place to a rent seeking behavior on the part of several economic groups, or misallocations given rise to news social conflicts or tensions between different power groups.

In some cases, the local or central authority can implement a mechanism to get a fraction of the surplus, which is generated by the foreign firms and consumers, for the benefit of the local people. For instance, this is achieved by means of a taxation of

tourism activities. See, for instance, instance Gago et al (2009).

On the other hand, more advanced technology is able to use less natural resources than a less developed one. That is, new technology can be able to obtain similar levels of well fare from a more rational utilization of the scarce good.

Summarizing, we can say that, the activity of investors on the exploitation of a local natural resource can be justified because such activity generates social welfare and because a more developed technology can be more sustainable. It ups to the national authority to establish rules for the distribution of surplus, and at the same time, it should try to prevent that a conflict between the local and foreign companies blows up. An exhaustive analysis of different rules to avoid the natural resources degradation problems is given in Schlager, and Ostrom (1992).

How the central authority can be controlled by the action of the citizen, looking to avoid corruption or favoritism in the allocation of the profits from the exploitation of natural resources, will be the object of a new work.

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