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Rent-extracting tariffs and the management of exhaustible resources

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Abstract. This paper examines the interaction between a resource-exporting and a resource-importing country. The exporting country must choose the optimal rate of depletion of an exhaustible resource and also must decide on the allocation of the extracted resource between exports and domestic use. Optimal management from a national point of view entails inefficiency from a global perspective in that too little resource is exported as the supplying country exploits its monopoly power. The importing country, however, has an incentive to extract some of the resource rent by using a tariff, although rent extraction is limited by the exporter's ability to use the resource domestically. The optimal tariff is positive and induces greater overall inefficiency.

Les droits de douane destinés à extraire la rente et la gestion des ressources non-renouvelables. Le mémoire examine l'interaction entre un pays exportateur de ressources et un pays importateur de ressources. Le pays exportateur de ressources doit choisir le taux d'épuisement optimal de la ressource épuisable et l'allocation de la ressource extraite entre l'usage domestique et l'exportation. La gestion optimale d'un point de vue national entraîne de l'inefficacité d'un point de vue global parce que trop peu de la ressource est exporté à proportion que le pays exportateur exploite son pouvoir de monopole. Le pays importateur a une incitation à extraire une portion de la rente attachée à la ressource en utilisant un droit de douane. Cette capacité à extraire une portion de la rente est limitée par la capacité du pays exportateur à utiliser la ressource dans l'économie domestique. Le droit de douane optimal est positif et il entraîne une inefficacité encore plus grande d'un point de vue global.

INTRODUCTION

Events in the international oil market over the last decade have generated substantial interest in the problem of non-renewable resource management. In a world of certainty such resources are in fixed supply, hence any amount currently used will not be available in the future. If owners of the resource understand this aspect of the problem, they will be willing to sell the resource only at a price that exceeds the cost of extraction by an amount that reflects the opportunity cost associated with having less of the resource available for future use. This difference between the price and the

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cost of extraction is a pure rent, which will, if the resource is traded internationally, accrue to nations that supply the resource. The fixed nature of total supply suggests, however, that consuming nations may have an incentive to impose tariffs in order to extract some (or perhaps all) of the available rent.

When the problem of extracting rent is considered, two related questions emerge. First, how much rent can be appropriated by the consuming nations, and second, is the tariff distortionary. If the supplying nations cannot use the resource internally, it is clear that in the static (one-period) case all rent can be extracted without distortion. In a dynamic context this problem has been studied by Bergstrom (1982) in an interesting paper that examines the non-co-operative tariff-setting game faced by consuming nations. An implication of his analysis is that a consumer's cartel could extract all available rent from the suppliers, leaving the production/consumption path undistorted.[1] However, one important aspect of the rent-extraction problem not considered by Bergstrom, but emphasized in a different context by Dasgupta, Eastwood, and Heal (1978), among others, is that supplier nations may be able to use the resource in the production of final consumption goods within their own economies. It is intuitively clear that in this case the consuming nations are not in a position to extract all of the rent. If they increase the tariff rate, the suppliers will respond by reducing exports, hence the supply of the resource to the consuming nations is no longer fixed.

The purpose of this paper is to analyse the interaction between the rent-extraction problem for the consuming nations and the resource-management problem faced by the suppliers. The analysis is conducted in the context of a simple two-country general equilibrium model of trade in exhaustible resources.[2] We assume that one country is endowed with a fixed stock of the resource, which is an essential input in the production of final consumption goods, while the other country is totally dependent on imports of the resource. Each country tries to maximize its national welfare by making use of its market power. The resource exporting country (REC) exercises its monopoly power; the resource importing country (RIC) uses an optimal tariff.

We first consider the supplier's problem. The supplier makes two related decisions: how best to extract the resource over time, and how to allocate the resource between domestic use and exports at a moment in time. Even without a tariff, market failure arises in that the supplier nation tends to export too little of the resource. The imposition of a tariff will exaccerbate this distortion in that the wedge between prices in the two markets will become larger, and in addition, the tariff will usually alter the time pattern of total extraction. We focus on what we regard as an illuminating 'neutral' case in which a constant ad valorem tariff does not affect the extraction path,

1 This result is also implicit in the work of Stiglitz (1976), and has been obtained in the context of a two country model by Kemp and Long (1979).

2 Our approach draws on the standard theory of resource exploitation and taxation arising from the classic work of Gray (1914) and Hotelling (1931). A good modern reference is Dasgupta and Heal (1979). Exhaustible-resource management in an open economy has been considered by Aarrestad (1978), Dasgupta, Eastwood, and Heal (1978), Harris (1981), Kemp and Long (1980), Kemp and Suzuki (1975), and Vousden (1974), among others.

but only the allocation of the resource between exports and domestic use. Turning to the optimal tariff problem faced by RIC, we observe that REC's ability to use the resource domestically limits the extent to which RIC can use a tariff to extract rent. Nevertheless, RIC will have an incentive to impose a distortionary tariff so as to extract at least some of the available rent. The magnitude of the optimal tariff is found to be an increasing function of the relative size of the importing country and approaches the confiscatory level as RIC becomes very large.

THE MODEL

The world consists of two nations: one that is endowed with the resource (REC) and one which is not (RIC).[3] The resource is extracted costlessly and used as an essential input in the production of a homogenous consumption good that both countries have the ability to produce. Letting Q and Q^* denote production of the consumption good by REC and RIC, respectively, we can write the following production functions.[4]

$$Q = f(L, X), \tag{1}$$

$$Q^* = f^*(L^*, X^*) \tag{2}$$

The variable L represents a local, internationally immobile non-produced factor which we refer to as 'labour.' X denotes the resource input. These production functions are assumed to exhibit positive but diminishing marginal products.

$$f_L, f_L^*, f_X, f_X^* > 0, \tag{3}$$

$$f_{LL}, f_{LL}^*, f_{XX}, f_{XX}^* < 0. \tag{4}$$

Production of Q and Q^* is carried out in the two countries by competitive profit-maximizing firms. The price paid by these firms for the resource in REC and RIC, p and p^*, respectively, is set equal to the value of the marginal product of the resource. The final good is regarded as the numeraire, hence

$$p = f_X, \tag{5}$$

$$p^* = f_X^*. \tag{6}$$

If there is a tariff on imports of the resource, p^* will differ from r, the export price received by REC.

Consumption in RIC, c^*, is equal to the difference between output and the cost of the resource

$$c^* = f^*(L^*, X^*) - rX^*, \tag{7}$$

while consumption in REC, c, is the sum of domestic production and imports of final

3 In order to highlight the fundamental aspects of the rent-extraction problem, we abstract from consideration of capital accumulation and trade in financial assets. The bahaviour of oil exporters in a model that has trade in financial assets as one of its central features has been examined by Calvo and Findlay (1978).

4 Throughout the paper, variables with an asterisk pertain to RIC and those without pertain to REC.

goods. Since there are no financial assets in the model, REC's imports of final goods are equal to its export revenus, rX^*.

$$c = f(L, X) + rX^*. \tag{8}$$

The problem for REC is to maximize the discounted value of utility:

$$\max \int_0^\infty u(c)e^{-\delta t}dt, \tag{9}$$

subject to:

$$\dot{S} = -(X^* + X). \tag{10}$$

The variable δ denotes the (constant) rate of time preference and S refers to the resource stock which is known with certainty to be S_0 at the initial point of time. As indicated by equation (10), the rate of depletion of S, $-\dot{S}$, is equal to the sum of exports and domestic use. The time subscripts associated with the flow variables have been surpressed for the present.

The current value Hamiltonian associated with this problem can be written

$$H = u[f(X, L) + rX^*] - \lambda(X^* + X). \tag{11}$$

At each moment in time REC chooses the values of X and X^* to satisfy the first order conditions that characterize the optimal plan.

$$H_X = 0 \rightarrow u'f_X - \lambda = 0 \tag{12}$$

$$H_{X^*} = 0 \rightarrow u'\text{MR} - \lambda = 0 \tag{13}$$

$$-H_S = 0 \rightarrow \dot{\lambda} - \delta\lambda = 0, \tag{14}$$

where MR is marginal revenue from foreign sales, λ is the shadow value of the resource in terms of utility, and $\dot{\lambda}$ is its time derivative, $d\lambda/dt$. Equation (14) indicates that λ must grow at the rate of time preference. Equations (12) and (13) require that the marginal product of the resource at home be equal to the marginal revenue from foreign sales. If there is no tariff, $\text{MR} = X^*f_{XX}^* + f_X^*$, so

$$f_X = X^*f_{XX}^* + f_X^*. \tag{15}$$

Efficiency from a global perspective requires that $f_X = f_X^*$: the marginal product of the resource should be equal in the two countries. Since f_{XX}^* is negative, (15) implies that, at each moment in time, too little of the resource is exported and too much is used at home. World consumption would rise if a unit of the resource were shifted from REC to RIC.

A tariff imposed by RIC on imports of the resource will exaccerbate this distortion in the sense that, other things being equal, the wedge between the marginal products in the two countries will increase. With an ad valorem tariff θ, we have $p^* = r(1 + \theta)$, and condition (15) becomes

$$f_X = (X^*f_{XX}^* + f_X^*)/(1 + \theta). \tag{16}$$

Expressions (12), (13), and (14) can be used to compare the price paths in the two countries. Since $p = f_X$ and $p^* = f_X{}^*$, the resource price is higher in the importing country, even without a tariff. (We are assuming that price discrimination is possible over the range of interest; that is, arbitrage is sufficiently costly that it does not induce binding constraints over pricing policy.[5]) This price difference is larger if a tariff is imposed. The price paths can be examined by totally differentiating (12) and (13) to yield

$$-\eta\hat{c} + \hat{p} = \hat{\lambda} = \delta \tag{17}$$

$$-\eta\hat{c} + \widehat{\text{MR}} = \hat{\lambda} = \delta, \tag{18}$$

where 'hats' denote proportional rates of change and $\eta \equiv -u''c/u' > 0$ is the elasticity of marginal utility with respect to consumption.[6]

Expressions (17) and (18) indicate that p, the domestic resource price in REC, rises over time at the same proportional rate as the marginal revenue from resource exports. However, p^*, the resource price in the importing country, may rise at a proportional rate that is either greater or less than $\hat{p}$, depending on whether $\widehat{\text{MR}}$ falls short of or exceeds $\hat{p}^*$ as RIC moves upward along its derived demand curve for the resource.

The relationship between $\hat{p}^*$ and $\widehat{\text{MR}}$ can be expressed using the elasticity of demand. Specifically, since $\text{MR} = p^*(1 - 1/\epsilon^*)/(1 + \theta)$ where ϵ^* is the (positive) elasticity of derived demand, $-(dX^*/dp^*)(p^*/X^*)$, it follows that $\widehat{\text{MR}} > \hat{p}^*$ if $\hat{\epsilon}^* > 0$, and $\widehat{\text{MR}} < \hat{p}^*$ if $\hat{\epsilon}^* < 0$, provided that θ is constant. Since use of the resource falls over time, $\hat{\epsilon}^* > 0$ if the demand curve has decreasing elasticity as use rises, as for example, with linear demand.

Proposition 1

With a constant ad valorem tariff, the resource price in RIC rises proportionately more quickly or more slowly than the price in REC, depending on whether derived demand in RIC has increasing or diminishing elasticity, respectively.[7]

What is the effect of the tariff on price and utilization paths? We have seen that a tariff alters the allocation of the resource at any moment in time. In addition, it will usually change the overall extraction path. The tariff may tilt the extraction path either towards or away from present extraction, depending on the structure of demand for the final good, on production functions, and on asymmetries between the two

5 The assumption that price discrimination is possible seems empirically appropriate from our knowledge of resource markets, such as oil.

6 η is a measure of the relative curvature of the utility function and is positive if marginal utility is declining. In problems involving uncertainty, η is referred to as the 'Arrow-Pratt measure of relative risk aversion.' The natural presumption would be that η is roughly constant and we assume constancy of η for some purposes later in the paper.

7 Proposition 1 is analogous to the results of Lewis (1976) and Stiglitz (1976) that a monopoly may have either a slower or a faster extraction path than a corresponding competitive firm, depending on whether the elasticity of demand is decreasing or increasing along the demand curve. Here, however, there is a single producing nation that finds it desirable to act 'competitively' at home but as a monopolist in the foreign market.

countries. However, there is one illustrative special case (which, incidentally, is widely used in resource economics) in which the introduction of a constant ad valorem tariff would have no effect on the overall extraction path. This case involves identical Cobb-Douglas production functions:

$$Q = X^{\alpha} L^{\beta} \tag{19}$$

$$Q^* = X^{*\alpha} L^{*\beta}, \tag{20}$$

where $\alpha + \beta = 1$. With profit-maximizing firms in the two countries $p = f_X = \alpha Q/X$ and

$$\text{MR} = (X^* f_{XX}^* + f_X^*)/(1 + \theta) = \alpha^2 Q^*/X^*(1 + \theta) = \alpha p^*/(1 + \theta) = \alpha r. \tag{21}$$

In this case $\widehat{\text{MR}} = \hat{r} = \hat{p}^*$, so (17) and (18) become

$$\delta - \hat{p} = -\eta \hat{c} = \delta - \hat{p}^*, \tag{22}$$

which leads to

Proposition 1′

With Cobb-Douglas production the resource price must rise at the same proportional rate in both countries: $\hat{p} = \hat{p}^*$

Proposition 1′ follows from Proposition 1, because Cobb-Douglas production gives rise to constant-elasticity derived demand. (The assumption that production functions are identical in the two countries is not used in Proposition 1′.)

It is now possible to characterize the price, consumption, and extraction paths. Using expression (8) and the fact that $f(L, X) = X^{\alpha} L^{\beta}$ and $rX^* = \alpha X^{*\alpha} L^{*\beta}/(1 + \theta)$, and differentiating the resulting expression with respect to time, we obtain

$$\dot{c} = \alpha X^{\alpha-1} \dot{X} L^{\beta} + \alpha^2 (X^*)^{\alpha-1} \dot{X}^* L^{*\beta}/(1 + \theta), \tag{23}$$

where dots denote time derivatives. Then

$$\hat{c} = \dot{c}/c = \alpha q \hat{X} + \alpha(1 - q)\hat{X}^*, \tag{24}$$

where $q \equiv Q/[Q + \alpha Q^*/(1 + \theta)]$ is the share of domestic output in REC's consumption. Thus the proportional rate of change of consumption in REC is a weighted average of the rates of change of domestic resource use and exports. Using the behaviour of firms, it is also possible to link $\hat{X}$ and $\hat{X}^*$ to price changes. We have

$$p = \alpha Q/X; \qquad p^* = \alpha Q^*/X^*. \tag{25}$$

Therefore

$$\hat{p} = -\beta \hat{X}; \qquad \hat{p}^* = -\beta \hat{X}^*. \tag{26}$$

Then, from (24), (26) and Proposition 1′

$$\hat{c} = -(\alpha/\beta)\hat{p}. \tag{27}$$

Expressions (17) and (27) are two relationships between $\hat{c}$ and $\hat{p}$, which can be solved to yield

$$\hat{p} = \beta\delta/A, \tag{28}$$

and

$$\hat{c} = -\alpha\delta/A. \tag{29}$$

where $A = \beta + \alpha\eta$.

Then, since $\hat{p}^* = \hat{p}$,

$$\hat{p}^* = \beta\delta/A. \tag{30}$$

Equations (26), (28), and (30) also imply that

$$\hat{X} = \hat{X}^* = -\delta/A. \tag{31}$$

resulting in Proposition 2.

Proposition 2
The rates of extraction of the resource for export and for domestic use fall at the same proportional rate.

Assuming that η is constant, expression (31) allows us to solve for $X(t)$ and $X^*(t)$.

$$X(t) = X_0 e^{-(\delta/A)t} \qquad X^*(t) = X_0{}^* e^{-(\delta/A)t}. \tag{32}$$

Given the initial stock of the resource S_0, and the constraint that total extraction must just be equal to this stock, we have

$$\begin{aligned} S_0 &= \int_0^\infty (X^*(t) + X(t))dt \\ &= \int_0^\infty (X_0 + X_0{}^*)e^{-(\delta/A)t}dt \\ &= (X_0 + X_0{}^*)A/\delta. \end{aligned} \tag{33}$$

Therefore,

$$X_0 + X_0{}^* = S_0\delta/A \tag{34}$$

Defining $\tilde{X} \equiv X + X^* = -\dot{S}$, equations (32) and (34) can be used to characterize the time path of the total extraction rate, $\tilde{X}$.

$$\tilde{X}(t) = (S_0\delta/A)e^{-(\delta/A)t}. \tag{35}$$

Expression (35) does not contain the tariff θ, which leads to Proposition 3.

Proposition 3
The overall extraction path $\tilde{X}(t)$ is independent of the tariff rate θ. The tariff rate affects only the allocation of the resource between the two countries at a moment in time; it does not affect the allocation of the resource over time.

Proposition 3 is a rather striking result. However, it depends crucially on the assumption that the production technologies are identical in the two countries. To illustrate the effect of changes in the tariff rate when technologies are not identical let $Q = X^{\alpha}L^{\beta}$, $Q^* = X^{*\alpha^*}L^{*\beta^*}$, and suppose, for example, that $\alpha^* > \alpha$. Since the elasticities of derived demand are equal to $1/(1 - \alpha)$ and $1/(1 - \alpha^*)$ in REC and RIC respectively, this implies that the importing country has a more elastic derived demand for the resource. However, it is still the case that $\hat{p} = \hat{p}^*$ by Proposition 1′, since RIC's derived demand has constant elasticity. A little algebra[8] shows that an increase in the tariff causes $\hat{p}$ and $\hat{p}^*$ to rise if $\alpha^* > \alpha$. The tariff then has two effects: it results in a reallocation of the extracted resource between exports and domestic use (as indicated by expression (16)), and in addition, it makes the paths $X(t)$ and $X^*(t)$ steeper (as can be seen in equation (26)). This is consistent with overall extraction of the resource stock only if $\tilde{X}(0)$ rises: overall extraction is tilted toward the present. Similarly, if $\alpha^* < \alpha$ a higher tariff shifts extraction away from the present. More precisely, an increase in the tariff rate rotates the overall extraction path clockwise or counterclockwise as the elasticity of demand in RIC is greater or smaller than the elasticity in REC. If technologies are identical but not Cobb-Douglas, or if the elasticity of marginal utility is not constant, other intertemporal biases are induced by the introduction of a constant ad valorem tariff.

These intertemporal allocation effects of a tariff are rather interesting. In order to focus on the rent-extraction problem however, we continue with our special 'neutral' case, which, as we shall see, allows a consistent and relatively simple solution for the optimal tariff.

We now consider the effect of the tariff on the exporting country's willingness to sell the resource abroad. Given the production functions (19) and (20), the first order conditions for the maximization of REC's objective function (equations (17) and (18)) imply that

$$X^{\alpha-1}L^{\beta} = \alpha X^{*\alpha-1}L^{*\beta}/(1 + \theta). \tag{36}$$

Noting that $X = \tilde{X} - X^*$, we can write (36) as

$$(\tilde{X} - X^*)^{\alpha-1} = \alpha X^{*\alpha-1}l^{\beta}/(1 + \theta), \tag{37}$$

where $l = L^*/L$.

Differentiating this relationship with respect to X^* and θ, and remembering that $\tilde{X}$ is independent of θ, we obtain

$$X_{\theta}^* \equiv dX^*/d\theta = -X^*/\beta(1 + \theta)\,(1 + l[\alpha/(1 + \theta)]^{1/\beta}) < 0. \tag{38}$$

An increase in the tariff rate causes exports to fall and domestic use to rise. This sharply limits the ability of the importing country to extract resource rents. There is, nevertheless, an optimal tariff for the importing country. Because a tariff does not affect the overall rate of extraction, and therefore has no intertemporal effects, the

8 From (22) $\hat{p} = \hat{p}^*$ and $-\eta\hat{c} = \delta - \hat{p}$. Since $c = Q + rX^*$, $\hat{c} = q\hat{X} + \alpha^*(1 - q)\hat{X}^*$, where $q = Q/[Q + (\alpha^*Q^*/(1 + \theta)]$. Using $\hat{p} = -\beta\hat{X}$ and $\hat{p}^* = -\beta^*\hat{X}^*$, it follows that $\hat{c} = -\hat{p}[(\alpha - \alpha^*)q + \alpha^*\beta]/\beta\beta^{**}$ and therefore that $\hat{p}[1 + \sigma] = \delta$ where $\sigma = \eta((\alpha - \alpha^*)q + \alpha^*\beta)/\beta\beta^*$. It is easily shown that $\sigma > 0$. Also $dq/d\theta > 0$ so $d\sigma/d\theta \gtrless 0$ as $\alpha \gtrless \alpha^*$. Therefore $d\hat{p}/d\theta \gtrless 0$ as $\alpha^* \gtrless \alpha$.

optimum tariff is found by maximizing the utility, or just the consumption, of the importing country at a moment in time.

$$\max c^* = X^{*\alpha}L^{*\beta} - rX^*, \tag{39}$$

where the importing country understands that X^* is a function of θ as described in equation (38).

$$dc^*/d\theta = 0 \rightarrow \alpha X_\theta{}^*L^{*\beta}((\beta + \theta)/(1 + \theta))\, X^{*\alpha-1} + \alpha X^{*\alpha}L^{*\beta}/(1 + \theta)^2 = 0,$$

or

$$\theta = \beta/[\alpha/(1 + \theta)]^{1/\beta}, \tag{40}$$

which is a solution for the optimal tariff in implicit form.

We should draw attention to the use of the equilibrium concept. The strategy variable of REC at a moment in time is its export quantity, X^*. The strategy variable of RIC is the tariff rate θ. Our view is that REC should be thought of as reacting to θ in an optimal way; the tariff is set then REC chooses its export level. The exporting country has the last move. It has the resource and can decide to sell it or not, given the tariff rate. Naturally enough, RIC should take into account the optimal non-co-operative response of REC in choosing its tariff. The equilibrium is therefore a very simple example of a subgame perfect equilibrium. In equilibrium, expectations about the other country's strategy variable are confirmed.[9]

Subgame perfect equilibria in which one agent moves after the other are sometimes referred to as Stackelberg equilibria to emphasize the asymmetry of the structure. The asymmetry is not arbitrary but follows from the strategy variables that the two countries have access to. As mentioned, it seems natural that the owner of the resource has the last move. An alternative is the simultaneous Nash equilibrium in which each country takes the strategy variable of its rival as given. In this case there is no interior Nash equilibrium; if RIC takes X^* as given at any time, its optimal response is to charge a confiscatory tariff, and the optimal response of REC is to supply nothing. Clearly this is not the appropriate equilibrium concept.

One might also raise the issue: if RIC can anticipate the reaction of REC, why can't REC anticipate the reaction of RIC. The point is that it is not consistent for both parties to believe the other has the last move. Either REC moves after RIC, or RIC moves after REC, or both move simultaneously. Our view is that the first is most natural.

Turning back to our solution for the optimal tariff, we note that it does not depend on anything that changes over time. Therefore, the value of θ that maximizes welfare at one moment in time is the same as the value of θ that maximizes welfare at any other moment in time. The constant tariff rate that satisfies equation (40) is therefore credible in that REC can reasonably expect an announced constant tariff to be maintained. Expression (40) leads to the following result.

9 The idea of credibility is important here. The agent with the last move cannot credibly threaten to do anything except act in its own non-co-operative self-interest. This idea dates back at least to Schelling (1960). See also Dixit (1980).

Proposition 4
This optimum tariff is positive and varies directly with the relative size of the importing country (as measured by l).

That the optimal tariff is positive and increasing in l is seen by rewriting (40) as

$$\theta^{\beta}(1 + \theta) = \alpha(\beta l)^{\beta}. \tag{41}$$

It can be readily seen that as l approaches infinity, so does the optimal value of θ and the tariff becomes nondistortionary and confiscatory. (An ad valorem tariff of infinity is the case in which the tariff is 100 per cent of the consumer price.) How can this be explained? Suppose L^* is fixed at some number and we let l approach ∞ by letting L, the labour supply in REC, approach zero. As L declines, the ability of REC to use the resource domestically is reduced, and in the limit REC becomes an owner with no alternative use. This is the setting in Bergstrom (1982) and Kemp and Long (1979), who concluded that that optimal tariff is indeed nondistortionary and confiscatory. Their result can be thought of as a special case of the model presented here.

It is also interesting to note that since the optimal value of θ is independent of variables that change over time, such as the remaining stock of the resource, it follows that the discovery of an additional stock within the exporting country has no effect on the optimal tariff. Such a discovery does, however, increase the rate of extraction, exports, and domestic use of the resource in the same proportion as the increase in the stock of the resource. Correspondingly, the time paths of p and p^* shift downward, but less than in proportion to the increase in the stock of the resource. This is because of the fact that demand is elastic and implies that welfare in both countries improves as a result of the discovery.

CONCLUDING REMARKS

The objective of this paper is to examine the interaction between optimal resource management by a resource owning country and optimal rent-extraction (via a tariff) by a resource-importing country. The importer of the exhaustible resource has an incentive to extract some of the resource rents by using a tariff. The response of the supplying country is to shift resource exports into domestic use. However, under the assumption that the elasticities of demand for the resource are constant and identical in the two countries, the imposition of a tariff has no effect on the overall extraction path. In that special case, if the exporting country expects a constant ad valorem tariff, the importing country has no incentive to change the tariff rate over time, which leads to a simple consistent equilibrium. The optimum tariff is positive and increasing in the relative size of the importing country but is independent of the exporting country's rate of time preference and the remaining stock of the resource.

Even without a tariff, optimal resource management by the exporting country is inefficient from a world point of view. In exploiting the downward sloping demand curve for resource exports, the producing country sets marginal revenue from foreign sales equal to domestic price, which has the implication that the marginal product of the resource is higher in the importing country than in the exporting country at each moment in time. The imposition of a tariff worsens this distortion. Thus the non-co-operative equilibrium that arises from independent pursuit of national objectives is inefficient and would seem to provide an incentive for direct bargaining (or co-operative behaviour) between resource-importing and resource-exporting countries.

In any case, it appears that simple extention of the analysis of resource taxation in a purely domestic context to an international framework can be misleading. Domestic resource owners do not have an alternative untaxed use for the resource (unless they have a taste for direct 'well-head' consumption) and therefore have much less market power than a foreign country that can mitigate the effects of a tax/tariff by transforming the resource into final goods within its own economy.

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