Resource management and trade policies: a two-country general equilibrium model of trade in renewable natural resource

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Abstract

Most trade literature is concerned with "gains from free trade" under the assumption that traded goody are produced under complete property rights. Seldom have researchers examined the consequences of free trade in the presence of incomplete properly rights over renewable natural resource

In this paper, we explore these consequences. In particular, we look at the welfare effects of trade between two countries, one of which manages its natural resource sector, while the other does not. Using a modified Heckscher-Ohlin-Schaefer model developed by Brander and Taylor and extended in this study, we show that a resource-exporting country with national open access to its resource may not necessarily gain from engaging in free trade, whether or not the importer manages its resource sector. We also demonstrate that there are circumstances in which resource management by one of the two partners may reduce welfare for both, when compared to the case in which neither manages ifs resource sector. We sure further, however, that this may be addressed by the use by the importer of a tariff on the resource good.

Five numerical simulation models compare the national welfare of the trading countries under: (1) autarkic national open access revere production; (2) autarkic national resource management; (3) free trade with national open access resource production; (4) free trade with national open access in the exporting country and managed resource production in the importing country; and (5) trade with national open access in the exporting country, resource management in the importing country together with a tarif imposed by the importing country. In general, our findings suggest that organizations such as the NAFTA and WIO must pay careful attention to the relationships between trade and natural resource policy

Resource management and trade policies: a two-country general equilibrium model of trade in a renewable natural resource1[1]

1. Introduction

Most of the principles of neoclassical international trade theory stem from a model in which each trading country's output mix is the result of combining units of the resources with which the country is endowed, such as labor and capital, in a technically optimal *way* and where the property rights in those resources are complete: that is, where ownership is strongly held and clearly

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1[1] An earlier version of this paper was presented at an Economics Department seminar at Portland State University. We are grateful to seminar participants for their comments and suggestions. After most of the research for this paper was completed, we learned of a third paper on the topic by James Brander and Scott Taylor. Its title is "International Trade Between Consumer and Conservationist Countries," and it will appear in a forthcoming issue *of Resource and Energy Economics.* The manuscript treats aspects of the questions we address in the present paper. We are grateful to Professor Brander for sharing with us a copy of his paper and for his encouragement of our own research.

defined. Under these circumstances, exchange in products (and productive inputs) occurs if the well being of each of the trading partners is improved from its no-trade, or autarky level.

In recent years, the alleged benefits of free trade have been questioned on several grounds, including the argument that the costs associated with externalities may be increased through trade. Much of the discussion surrounding the North American Free Trade Agreement and the establishment of the World Trade Organization, for example, has focused on the environmental consequences of relaxing trade restrictions.

The uses of many "natural" resources are characterized by externalities that are the consequence of weakly defined property rights. Examples include forests and fisheries ("renewable" resources) and minerals ("exhaustible" or "nonrenewable" resources). At least, as early as Hotelling (1931), economists have pointed out that the "socially optimal" and "privately optimal" use of such resources may diverge, in pail because of differing views of the future and because of poorly-defined property rights. Many fisheries, for example, are believed to have "open access" characteristics, under which more capital and labor is allocated to the fishery than would be the case if property rights in the fishery (e.g., the ocean, the lake, the river) could be assigned as they are to landowners in the case of agriculture (Gordon, 1954).

There is a rich literature here. Curiously, it is only recently that this issue has caught the attention of trade economists.2[2] Two papers, both by James Brander and Scott Taylor (1995a and 1995b), deserve particular attention, not only because of their methodological contributions but also because of the important insights that emerge, including their finding that free trade in the presence of an "open access" resource may disadvantage one of the trading partners.

The purpose of the present paper is to build on that work in exploring the consequences of trade policy when one, bull not boll, trading partner is able to manage its resource. Our results offer some surprises, at least to us. In particular, we demonstrate that fishery management may, inadvertently, have "beggar-my-neighbor" consequences but that, under some circumstances. Trade restrictions may offset these consequences. On the other hand, our results suggest that there are circumstances in which fishery management by only one country may reduce the real incomes of both countries. These findings suggest that trade policies adopted by the WTO and by partners in "free trade"

2[2] In 1987, the U.S. Department of Agriculture invited several trade economists and resource economists to a conference on "agricultural trade and natural resources," in the hope of stimulating dialogue between the **two** groups (Sutton, 1988). Some helpful literature has ensued but a full-blown economic Framework in which trade and renewable resource issues are explored simultaneously under generally-specified functional relationships has yet to appear, to our knowledge.

On the other hand, there are many examples of research on trade in exhaustible resources. Kemp and Long (1980, 1984) have derived analogues to the steady-state theorems of the Heckscher-Ohlin model of international trade for the case of exhaustible resources. Segerson (1988) provides an excellent summary of the literature to the late 1980s and offers suggestions for testing the resulting hypotheses.

A few studies have examined particular aspects of trade in renewable resources. Tawada (1984), for example, demonstrates that a modified version of the Rybczynski theorem holds for renewable resources: production of a resource-intensive good that is produced before an increase in the stock of the resource will rise following that increase. McRae (1978) illustrates how, in an open economy where competitive exploitation decisions prevent consideration of user cost, socially inefficient resources use will result. Markusen (1976) examines the trade issues that arise when two countries share a renewable natural resource. A model similar to that of Brander and Taylor is sketched in the appendix to a paper by Scott and Southey (1970).

agreements rim the risk of unanticipated consequences if such policies are developed in the absence of considering the role of resource management.

In the next section, we provide a brief overview of the Brander-Taylor work. The section that follows extends their analysis to consider, first, what happens when one of the trading partners manages its natural resource and, second, the consequences of trade restrictions in such an environment. We conclude with a summary of our findings and suggest both policy implications and possible next steps in the analysis.

2. The Brander-Taylor Model

In the Brander-Taylor or (hereafter, BT) economy there are two goods. H and M produced with the services of two non-tradable factors of production, labor (L), which is mobile between sectors, and a renewable resource stuck (S), a fishery. In the earlier of their two papers, they consider the case of a country that is a price-taker in international markets. In the most recent formulation, there are two countries. The essential difference between the two specifications is that, in the latter model, prices are endogenous. Because this is the formulation that we extend in the present work, ibis overview section describes its major features, most of which are identical to those of the earlier Formulation.

First, consider the "home" country. Here good H is the rate at which harvest of the resource occurs, a process that involves both the resource stock and labor as inputs. The second good, a manufactured good (hence, M), is produced under constant returns to scale, using only labor. By choosing units appropriately, BT specify the M production function as $M^P = L_M$, where L_M is labor used in the manufacturing sector and where superscript P stands for production.

In the absence of harvest, the fish stock would grow at the rate G, which is specified as a logistic function of S at time t. That is,

$$G(S)=RS(1-S/K) \quad (1)$$

where K is the maximum possible size of the resource stock, known by biologists as the "carrying capacity" of the environment (ocean, lake, etc.) and where R is the "intrinsic" growth rate. Subtracting the harvest rate from the natural growth rate yields the change in the stock size at any date, i.e.,

$$dS/dt = G(S) - H \quad (2)$$

This specification of the physical relationship between the harvest activity and the growth of the fish stock is only one of several used by biologists in their empirical analyses of renewable resources. However, it has proven to be highly durable and captures the essential ingredients of many single-stock biological systems. Bio-economic analysis has also made extensive use of this specification (see, for example, Schaefer, 1957; dark and Munro, 1976).

For a given stock size, harvest is assumed to occur according to the harvesting production function.

$$H^P = A\ S\ L_H \qquad (3)$$

where H^p is the quantity of fish harvested (per period of time) by producers, LH is the quantity of labor used in harvesting H, and A is a positive constant. Because of the open access nature of the fishery, labor enters that sector whenever it earns through fishing (harvesting) than it would in the M sector. However, since no-one owns the resource stock and, thus, is unable to "hire" that amount of labor that would maximize resource rent, the entry of labor dissipates the stock's potential earnings. In open access equilibrium, then, the average, rather than the marginal, return to labor is equal to the wage rate, W, assumed to be competitively determined.

BT treats M as the numeraire good whose price is normalized to 1. This, in turn, means the competitive wage rate is unity because the marginal productivity of labor in manufacturing is 1.

In this economy, each consumer is endowed with one unit of labor, whose return it allocates to H and M to maximize utility, given by the Cobb-Douglas function

$$u = h^{B}\ m^{1-B} \qquad (4)$$

where *h* and *m* are the individual consumer's consumption of the resource good and the manufactured good, respectively. The taste coefficient, B, is assumed to lie between 0 and 1, With L consumers in the home country, total consumption of the two goods is given by
$H^C = Lh$ and $M^c = Lm$.

The Foreign trading partner can be similarly described to distinguish its variables from those of the home country, we replace upper case letters with their tower case counterparts. Thus, for example, $h^{1'}$ and m^c are the 1foreign country's harvest of fish and consumption of the manufactured good, respectively.

The BT comparison is between two steady-state solutions, one in which each country operates in isolation, the no-trade, autarky case and the second in which trade occurs between the two countries. The authors show that, in autarky, the necessary and sufficient condition for positive steady-state solutions in each country is that $R/L > AB$ and $r/1 > ab$ for the home and foreign countries, respectively.

They use the R/L and r/1 ratios as measures of factor abundance, and treat the foreign country as being natural resource abundant if

$$r/1 > R/L$$

This is an appropriate condition under their additional assumptions that A=a (that is, harvesting efficiency is the same in the two countries), K=k (equal carrying capacities) and B=b (equal taste parameters).3[3]

BT considers temporary equilibrium positions on the way to the steady-state equilibrium. These temporary equilibrium are defined for given levels of the resource stock. If the temporary harvest level exceeds the natural growth rate, the slack size falls; if the growth rate exceeds the harvest rate, the stock size increases. Eventually a steady state level is reached, assuming no changes in parameters over lime. The relevant comparisons an: these between autarky and trade in their respective steady states.

BT focus on the cases where production and consumption of both goods occurs in each country. That is, there is no specialization. They show that, under this condition, the resource abundant (Foreign) country exports the resource good while the labor-abundant (home) country exports the lab or intensive manufactured good.

Perhaps their most significant finding is that free trade makes the resource-importing country better off than in autarky but makes the resource-exporting country worse off. This result contrasts sharply with the standard trade model but is not surprising to resource economists, being analogue to what happens when an open-access resource experiences an increase in demand. As labor moves into the natural resource sector, it dissipates the potential gains from the higher demand by "excessive" entry, driving average returns to labor to their pre-entry level (equal to the wage rate) but reducing the output of the sectors from which labor moved.

The result is a decline in real income. The resource-importing country, on the other hand, benefits from labor moving out of the natural resource sector into sectors where real income increases are realized.

With this result, BT then asks whether trade policy can address the issue. They demonstrate that, if the resource-importing country imposes a tariff on imports, this will increase welfare in the resource-exporting country (above its free trade level) and will either increase or decrease welfare, at home, depending upon whether tariff revenue increases offset income losses through additional entry of labor into the natural resource sector. It is possible, then, that an import tariff will be welfare improving for both countries.

Finally, BT considers the consequences of an export tax levied by the resource-exporting country. Here, the results are unambiguous: the exporting country gains because the tax reduces the incentive for labor to move out of its more productive employment into the rent-dissipating fishery while the importing country's welfare falls for the opposite reason. Both welfare changes are the result of the fact that the export tax reduces the relative price of fish in the exporting country and raises it in the importing country.4[4] This is also true in

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3[3] We preserve the notational differences here because we later relax one or more of these restrictions.

4[4] BT attributes the welfare gains and losses to increases in stock depletion in the home country and stock rebuilding in the foreign country. While the export tax does, indeed, have these effects on fish stocks, it seems to us to be a by-product of the process, having little to do with welfare consequences. An optimally-managed resource that experiences a price increase can generate welfare gains by "stock depletion." The difference between that situation and the "open access" case is that, in the former the additional labor attracted to the fishery generates higher returns - rents - top the fishery itself, much like increase in food prices move labor into agriculture, generating higher land rents. In the

the case of the import tax discussed above but, with the export tax, the tax revenues do not accrue to the country experiencing real income losses through labor reallocation.

3. Resource management and trade

As BT point out, were both countries to manage their resources in the "socially optimal" way5[5] the standard results from neoclassical trade theory would reappear. Their analysis pertains to the situation in which such a result is unavailable to the participating countries, perhaps for political reasons.

In face, countries around the world are striving to find the "optimal" fishery management scheme, especially since the establishment of extended fishery jurisdiction in the late 1970s. Several important fishing nations, such as Iceland and New Zealand, are pioneers in the use of individual transferable quotas. The United States and Canada have experimented with transferable quotas and restricted entry programs. While these efforts have not resolved the "open access" problem to everyone's satisfaction, they have led to significant changes in harvesting rates, often with desirable consequences from the perspective of economic efficiency.

However, it is primarily the "developed" countries that can boast such successes. Fishery management is not costless and many less-developed countries have opted for alternatives that more closely approximate the "open access" result.6[6]

Suppose, then, that the two BT countries were such that one of them is able to manage its fishery while the other cannot. Would this improve the situation for both countries? Can trade policy substitute for resource management under such circumstances? These are among the issues that this paper seeks to address.

First, however, it is important to discuss what we mean by resource "management" here. This, in turn, requires a discussion of the nature of the externalities that are associated with "open access." It is, after all these externalities that management seeks to internalize.

A full discussion of the issue is beyond the scope of this paper. Cunningham et al (1985) is helpful in this regard. However, because of the importance attached to the "user cost" question in much of the current discussion of renewable resource use, a cost whose magnitude depends, in part, on the magnitude of the relevant discount rate, and because we implicitly assume a zero discount rate, we feel some discussion is in order.

"open access" case, no such rents result and, thus, movement of labor into the Fishery reduces the country's real income by reducing output in the sectors from which labor moves.

5[5] There is an extensive literature on this topic (see Cunningham, et al, 1985, for example). Analysts have struggled for years to develop schemes that simulate the perfect market under strong properly rights. Entry restriction programs, transferable quota policies and a variety of tax-subsidy schemes are among the alternatives considered. In our analysis we by-pass this issue and assume that one of the management alternatives is capable of mimicking the competitive market

6[6]This is not to say that "open access" does not characterize the fisheries of the "developed" countries. Indeed, some of the recent stock declines in Canada and Europe have been attributed to "overfishing."

Suppose the resource stock were owned by a single decision-maker. Use of that resource would be determined by treating it as a capital asset, capable of generating revenues both today and in the future. The optimal time path of resource use would consider the future net revenues foregone from current consumption, appropriately discounted to reflect the rate of time preference. These foregone revenues are the "user costs" associated with the current use of the resource, costs that are not considered in the absence of the sole owner (Scott, 1955; dark and Munro, 1976). They are not considered because, with no-one able to anticipate that he or she would be the beneficiary of the future earnings, they are, in face, not foregone at all, at least from the perspective of those engaged in the fishing activity. Fishing in this open access environment takes place with no thought to conserving the resource for the future, under this argument. Resource management then, would correct flits externality and the resource would be operated at the dynamically optimal stock (and harvest) level, where the user cost equals the marginal rent associated with current harvesting (dark and Munro, 1976, p. 96).

It can be shown (ibid.) that, at a zero discount rate, where future and present values of the user cost are the same, the dynamically optimal stock level is equal to the static optimal, at which the rent to the resource is maximized. In terms of the BT model, ibis is the level of harvest for the home country that maximizes

$$\mathbf{P_H}\, H^p - W\, L_H \qquad (6)$$

where $\mathbf{P_H}$ is the price of fish (determined endogenously) and the other variables are as defined earlier.

Our justification for not considering the dynamics in the present paper is purely one of ease of analysis. By not considering explicitly the extent TO which future earnings are to be discounted we bypass one important externality, that surrounding the user cost question. However, under the open access assumption, we retain the important externality associated with incomplete property rights, where a fixed factor. In this case, the resource stock, earns no rent. It is this externality that is assumed to be "corrected" through resource management in our extension of the BT model.

We turn next to that extension.

4. The Consequences of Fishery Management by One of the Trading Countries

The BT model uses particular forms of the utility, production and harvest growth functions. The authors report that they are attempting to obtain general results.

While we agree that generalization is an important next step, we believe the specific BT model provides some valuable insights. Beyond this, it permits examination of the consequences of a variety of policy decisions. Here too, of course, it would be appropriate to use more general functional forms but we believe that working within the BT framework is a useful first step. Furthermore, even the relatively straightforward BT relationships do not easily lend themselves to analytical solutions.

Consider one of the BT results: when the two countries engage in international trade, the resource-exporting country suffers a welfare loss relative to its autarky position, while the resource-importing country experiences a welfare gain. If both countries were to manage their fisheries, both would gain from trade. This finding motivated us to ask the following: if one, but not both of two countries were able to manage its fishery, because the costs of enforcement are prohibitive for the second country (see Sutinen and Andersen, 1985) or, perhaps, because political considerations preclude management. Are there circumstances under which this would lead to an increase in tile welfare of both countries? Under these assumed "second best" conditions, is it possible that the result is a reduction in welfare for both countries? Can trade policy (e.g., import or export restrictions) "correct" the externality of an open access fishery and move the trading partners in the welfare levels associated with resource management in both countries?

For reasons the discussed above we have elected to consider the fishery resource to be managed" when under the assumption of a zero discount rate, the long-run rent to that resource is maximized. This requires that the resource be in steady-state equilibrium (i.e., $dS/dt = 0$) and that P_H equal the marginal cost of harvesting. The resulting addition to the home country's, real income is then assumed to be equally distributed among its occupants and together with wage income, is available for expenditure on the harvest good and the manufactured good.

To investigate the questions posed above, we retain the BT functional forms and assumptions, in which only the intrinsic growth rates and the labor stocks differ between trading partners. We eventually relax the assumption of identical testes but, for the present, equation (4) applies to both countries. Our model differs from BT only in the assumption that the home country, which has a comparative advantage in M, manages its fishery. For convenience, we use capital letters when specifying home country relationships and lower case letters for the foreign partner. Our equation system, then, is as follows:

Home Country:

Maximize $U = (H^c)^B (M^c)^{(1-B)}$

subject to :

$Hp = (AK/R)(R-AL_H)(L-L_M) = (AK/R)[R-A(L-L_M)](L-L_M)$ (7)

$= (AK/R)[R-A(L-M^P)](L-M^P)$ (8)

$W = 1 = (P_H AK/R)[R-2A(L-Mp)]$ (9)

$P^H H^p + M^p = PH\ H^C + M^C$

Foreign Country:

Maximize $u = (h^c)b\ (mc)^{(1-b)}$ subject to:

$h^p = [ak/r]\ (r-al_H)(1-1_M) = (ak/r)[r-a(1-lM)](1-1M) = (ak/r)[r-a(l-m^P)](1-m'')$ (10)

$W = 1 = (PH\ ak/r)[r - a(l-m^p)]$ (11)

$P_H h^p + m^p = P_H h^c + m^c$ (12)

Trade Balance Conditions:

$H^P - H^C = h^c - h^p$ (13)

$M^P - M^C = m^c - m^P$ (14)

Note that the income in the foreign country that can be spent on the two goods is (W 1), while in the home country it is (W LM+ $P_H H^p$), a figure that includes both the earnings of labor and the rent to the resource.

Most of the variables in the above system have been defined earlier. Equations 7 and 10 are the production possibility frontiers for the home and foreign countries, respectively. They are found by deriving the "steady state" relationship between harvest and harvest labor (from equations 1-3 for the home country and their counterparts for the foreign country) and solving that simultaneously with *the* production function for the manufactured good, subject to available labor. Equation 8 represents fishery management at home, where the value of the marginal productivity of labor is equaled to the wage rate, while equation 11 retains the assumption of an open access fishery, so that fishing tacks to where the wage rate is equal to the value of the average product of labor in that industry. Equations 9 and 12 assure that the value of consumption and the value of production are the same in that countries. Finally, equations 13 and 14 require that trade is in balance.

Our interest is in comparing the trade patterns that emerge under the above system with those that result from replacing equation 8 with its "open access" counterpart. While we have been successful in generating an analytical solution to the question (that is, we can express the utility differences in terms of the system's parameters), this solution is cumbersome and, so far, has not lent itself to readily generalizable results. For this reason, we have simulated the system through assigning parameter values and incrementally varying them to examine the consequences.

Table 1 reports the results of the simulation analysis with the parameter values indicated in that table's footnote. The first three columns of that table confirm two of the principal Biander and Taylor results: (I) the welfare of both countries (the "U" values') rise under autarky when they manage their naUirii.1 resource sectors, a result that is depicted in Figure 1, and (2) alternatively, when neither manages its resource sector, free trade benefits the importer of the resource good but harms the exporting country, relative to their respective autarky positions.7[7]

7[7] The utility levels for home and foreign countries are represented by upper case and lower case letters respectively. For example, "um" (uo) in figure 1 indicates the foreign country's welfare (utility) level in autarky when its resource good is produced under management (open access). The UOO (uoo) shows the utility level for home (foreign) country when resource good is produced under open access in both countries. The UMO (umo) indicates utility level of home (foreign) country when resource good is produced under management at home but under open access in the foreign country. The UMM (umm) stands for utility level achieved by the home (foreign) country when both countries manage their resource sector. The UMT (umt) in figure 7 shows the utility of the home (foreign) country when resource good is produced under management at home and under open access at the foreign country and an import tariff is imposed by the home country.

[8] From Brander and Taylor's third paper (see footnoted # 1) it appears that there are circumstances when management by the exporting, as opposed to the importing, country may lead to welfare gains beyond and the open-access, autarky levels.

Table 1: Comparison of Models Variables for Home and Foreign Countries

Countries and Variables	**Autarky**		**Free Trade**		
	Open Access	Managed	Home-open access Foreign-open access	Home-managed Foreign-open ACCESS	Hume-managed Foreign-managed
Home :					
H^p	3.15	3,63	3.5H	3.42	3.57
Hc	3.15	3,63	4,15	4,38	3.88
L_H	70,1)0	41.17	60.45	35.35	39.17
M^p	30,00	58,82.	39.54	64,64	60.82
M^c	30,00	58,82	30,00	42.79	51.27
L_M	30.00	58.82	39,54	64.64	60.82
U	6.19	8,37	7.51	8.69	8.42
P^H	22,22	37.77	16.85	22.75	30.80
P^M	1	1	1	1	1
W	1	1	1	1	1
Foreign:					
H^P	4.48	4.19	4,30	3.72	4,28
h^C	4.48	4.19	3.73	2.76	3.97
l_H	63.00	44,28	72.54	84,84	47,01
m^P	27.00	45.71	17.45	5,15	42.98
m^C	27.00	45,71	27.00	27.00	52.53
1_m	27,01	45,71	17.45	5.15	42.98
U	7.68	8,58	6,76	5.48	8.62
P^H	14.03	25.45	16.85	22.75	30.80
P^M	1	1	1	1	1
W	1	1	1	1	1
Trade					
P^H_W	-	--	16. .85	22.75	30,80
MH	0	0	0.56	0.95	0,30
XM	0	0	9.54	21.84	9.54

xh	0	0	0.56	0.95	0.30
mm	0	0	9.54	21.84	9.54
Lamda:					
Home	0.061	0.042	0,075	0.060	0.049
Foreign	0.085	0.056	0.075	0.060	0.049

Parameters: Home Country A= 0.0005; B= 0.7, R= 0.05; L= 100; K= 300; Foreign Country: a = 0,0005

b = 0,7, r = 0,06; 1 = 90; k = 300; MH = Imports of H by the home country: XM = Exports of M by the home country: xh = Exports of H by the foreign country; mm = Imports of M by the foreign country.

When, in addition, we allow the home country to manage its resource sector, some surprises result. For most of the cases explored we find that, *when* only the importing country manages its renewable resource, that country's welfare rises while the welfare of the exporting country declines relative to the case of trade without resource management. This is demonstrated in Table 1 by comparing columns 3 and 4 and is illustrated in Figure 2. This occurs because managing the resource leads, in general, to an increase in the price of the resource good, relative to the free trade price under open access conditions in both countries. The higher price induces labor to move from the manufacturing sector IN the (inefficient) natural resource sector in the foreign country, reducing welfare there. At home, management leads to efficiencies in the fishing sector, increased production of M and, as a consequence increased welfare.

We have been unable to find a circumstance under which management by only one country raises the welfare for both above their respective open access (and free trade) levels. We suspect, but have not yet been able to prove, that this is a general rc.si.ilEsd for the following reason. Fishery management in the importing country releases labor to the manufacturing (M) sector, increasing output there. The resulting fall in the relative price of M and the associated rise in the relative price of H leads to increased imports of M abroad and, to maintain trade balance, increased production and exports of H, increasing the inefficient use of labor. It is this latter result that keeps welfare from rising in the open-access country .[8]

When the foreign country manages its fishery as well (column 5), that country's welfare rises. However, in comparison whit the case in which the home country is the only resource manager, the home country loses when its trading partner elects to manage its export sector. An example of this situation is depicted in Figure 3 and is a consequence of the increased price of the home country's import good, with no additional offsetting gains from management. This finding leads to the counter-intuitive observation that there may be circumstances under which the interests of a country that imports a natural resource product are not advanced by its trading partner seeking to correct the natural resource sector externality.

We have identified circumstances in which, with resource management in the home country, the welfare of both countries falls. This can occur when the home country's taste for H is high relative to the situation abroad. We demonstrate this result in Table 2, whose conditions differ from those of Table 1 in that the "b" value for the foreign country is reduced from 7 to 1, Figure 4 shows the welfare of both countries under autarky when they produce the resource good under open access and management. With lower "h" value for the foreign country, the home country's preferences are more strongly weighted towards the resource good than is the case for the foreign country. In that case, when management at home leads to a higher price of H, this more than offsets the real income gains from management in the home country: the welfare in that country declines. As before, the higher price of H leads to welfare losses in the foreign country, as well. This phenomenon is demonstrated in Figure 5. Figure 6 compares the welfare of both countries under open access, partial and full management scenarios.

Table 2: Comparison of models variables for home and countries with different taste

Countries and Variables	**Autarky**		**Free Trade**			**Import** Tariff ($7)
	Open Access	Managed.	Home-open .icccss Foreign-open access	Home-man aged Foreign-open access	Home-managed Foreign-managed	
Home;						
H^P	3.15	3.63	3.45	2.61	2.92	3.14
H^c	3.15	3.63	6.72	6,32	5.66	6.00
L_H	70.00	41.17	35.90	22.43	26.51	29.88
M^p	30.00	58.82	64.09	77.57	73,48	70.11
M^c	30.00	58.82	30,00	32.74	34,49	42.67
L_M	30.00	58.82	64.00	77.57	73.48	70.11
U	6.19	8.37	10.53	10.35	9.74	10.81
P^H	22.22	37.77	10.40	12.09	14.19	16.57
P^M	1	1	1	1	1	1
w	1	I	1	1	1	1
Foreign:						
h^P	1.25	1.17	4.14	4.45	3.50	3,80
h^C	1.25	1.17	0.86	0.74	0.76	0.94
l_H	9.00	8.38	43.09	53,83	31.82	36.43
m^P	81.00	81.61	46.90	36.16	58.17	53.56
m^C	81.00	8!.61	81.00	81.00	97.17	81,00
l_m	81.00	81-61	46.90	36.16	58.17	53.56
U	53.36	53.38	51.44	50.67	59.82	51.87
p^H	7.20	7.49	10,40	12,09	14.19	9.57
p^M	1	1	1	1	1	1
W	1	1	1	1	1	1
Trade:						
P^H_W W	-		10,40	12.09	14.19	9.57

MH XM xh mm	0 0 0 0	0 0 0 0	3,27 34,09 3.27 34,09	3.70 44,83 3.70 44.83	2.74 38.99 2.74 38.99	2.86 27.43 2.86 27.43
Lamda:						
Home Foreign	0,061 0.592	0.042 0.588	0.100 0.570	0.090 0.560	0.084 0.554	0,076 0.576

Home Country A = 0.0005, B - 0.7, R = 0.05, L = 100, K = 300
Foreing Country a = 0-0005, b = 0.1, r = 0.06,1 = 90, k = 300

We are surprised by *this* result and are exploring it further. If it is correct, it suggests that there may be circumstances in which resource management, if done in isolation, does not have the beneficial effects usually attributed to it. It is premature to carry this conclusion beyond the "needs additional analysis" stage, however.

An examination of the last column of Table 2 reveals that a tariff imposed by the home country on its imports of H may improve the situation. In particular, this tariff yields welfare gains for both countries. A consequence of shifting the labor in the foreign country to the M sector and of increased consumption of M at home. The latter occurs because the tariff revenue stays at home and thus, even though the home price of H increases, the resulting efficiency losses are more than offset by the consumption gains. Here is a case, then, where a "second best" solution to a case where some property rights are only weakly held, may involve a restrictive trade practice (Figure 7).

5. Conclusions and caveats

It appears that the consequences of resource management in a tradable, renewable resource good depend on parameter values. While Brander and Taylor were able to conclude that international trade under conditions of open access in both countries increases the welfare of the importer and decreases the welfare of the exporter, we are unable to report such a general finding in the case we examine. It appears that resource management by an importer of the resource good may benefit the importing country but, under some circumstances, may have adverse consequences both at home and abroad. When preferences for the resource good at home are relatively high and when the foreign country harvest, in an open-access regime, the benefits of management at home may be offset by penalizing domestic consumers of the resource good through the higher price of that good. These results may be offset by the imposition of a restrictive import tariff, however.

We note that our work is highly preliminary and the results dependent on particular functional forms and parameter values. In addition, we have focused on the long-run "steady-state" solution, ignoring the gains and losses during the transition from one steady state to another. Clearly, much work needs to be done. We intend to pursue this further and welcome comments and suggestions.

Fig.1:Open access and management autarky equilibria

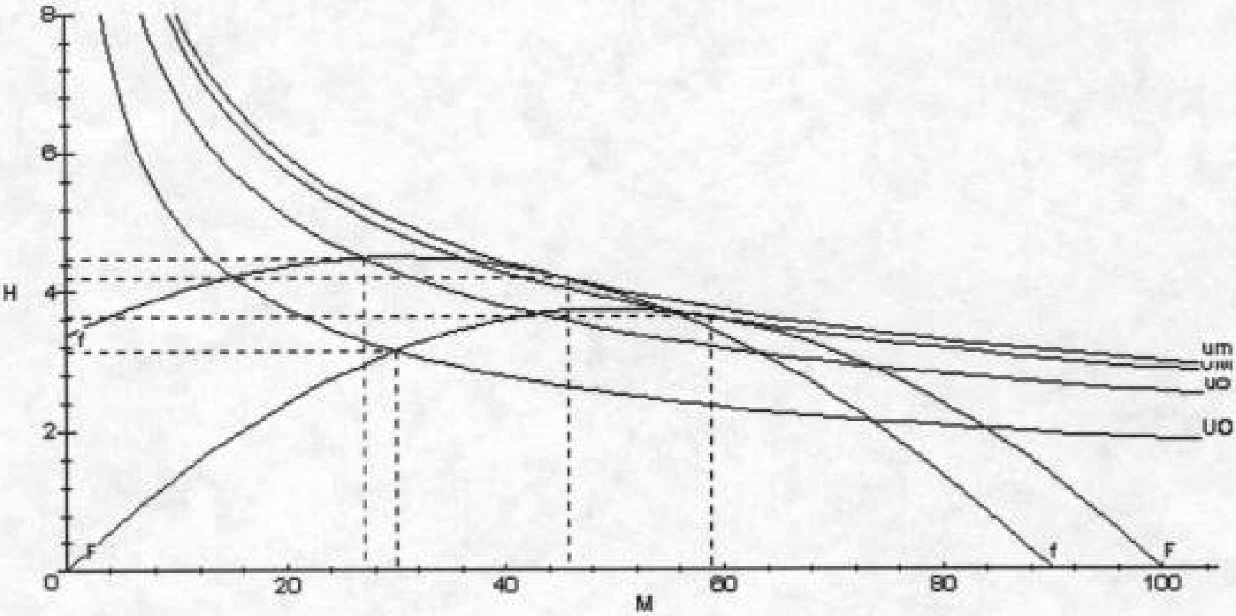
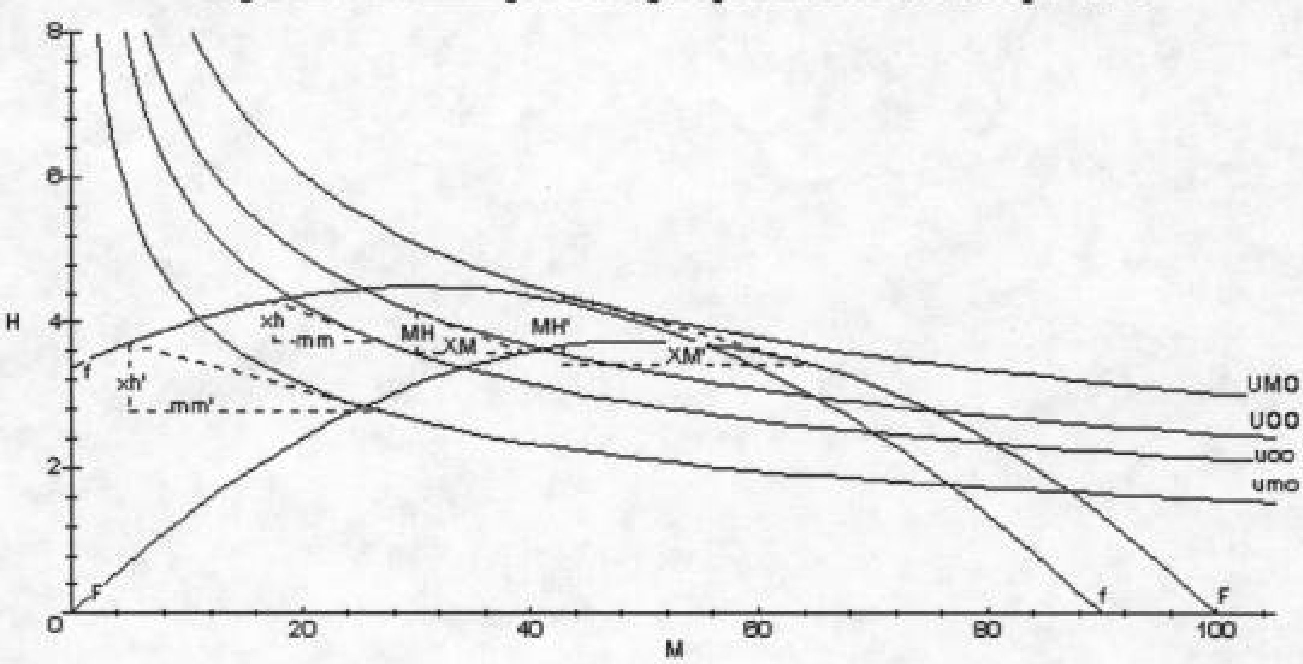


Fig.2: Home managed-foreign open access trade Equilibria



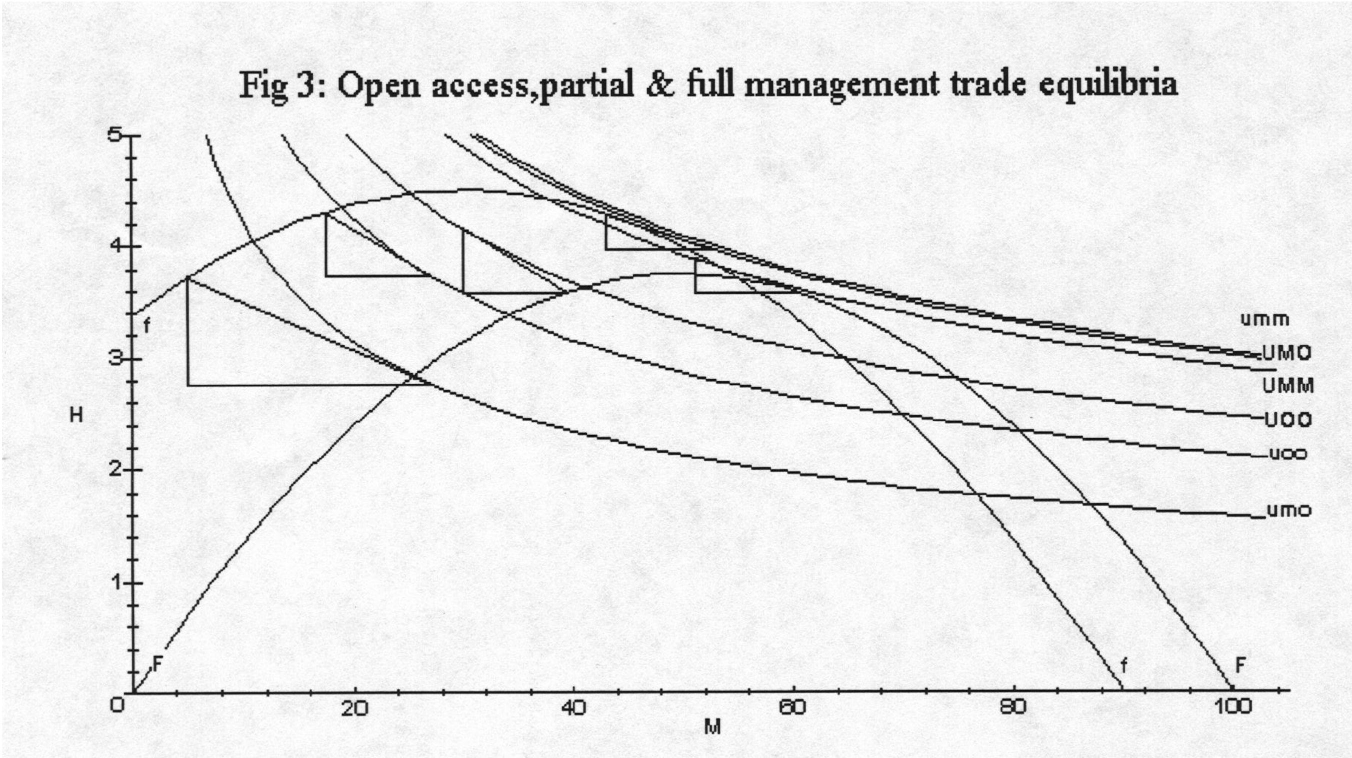


Fig 3: Open access,partial & full management trade equilibria
H
M
f
F
umm
UMO
UMM
UOO
uoo
umo
0
20
40
60
80
100
1
2
3
4
5

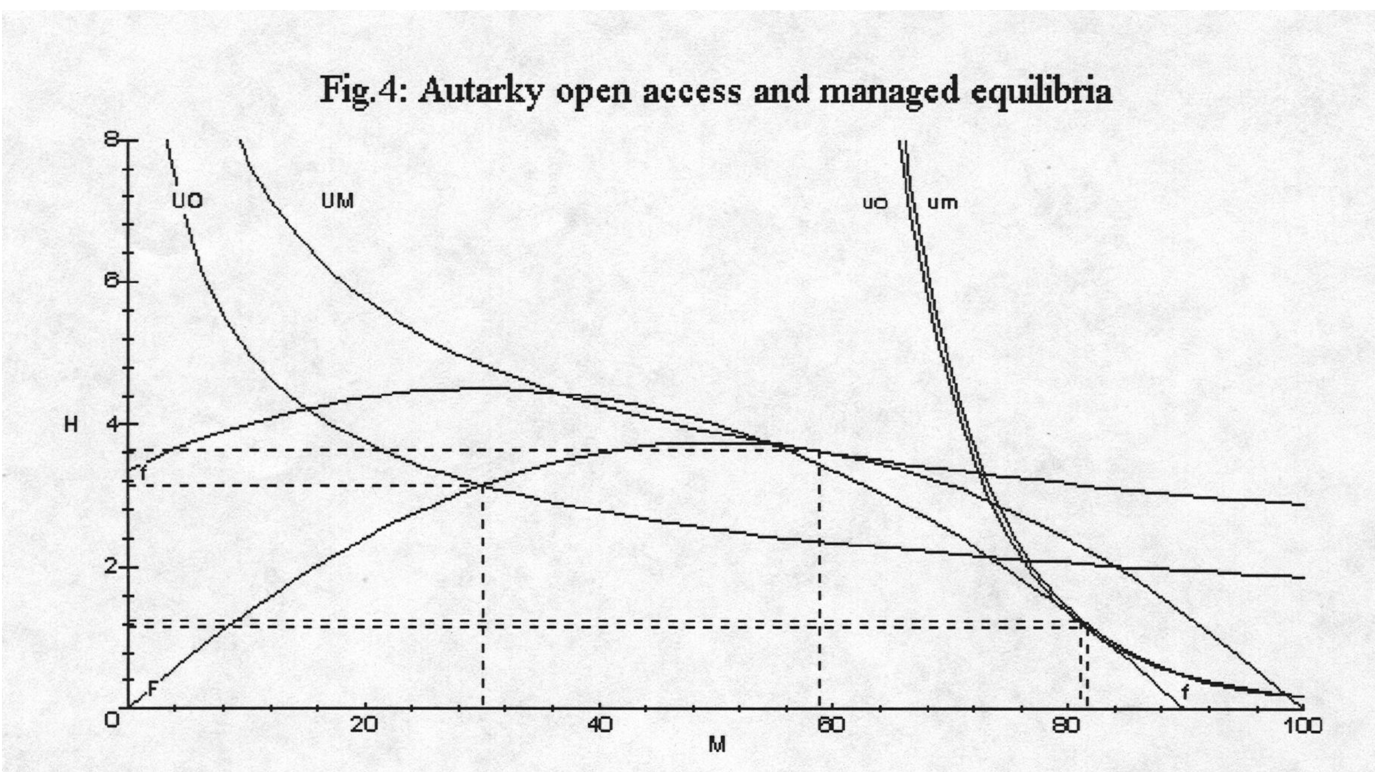


Fig.4: Autarky open access and managed equilibria
H
M
UO
UM
uo
um
f
F
0
20
40
60
80
100
2
4
6
8

Fig.5: Home manged-foreign open access trade equilibria

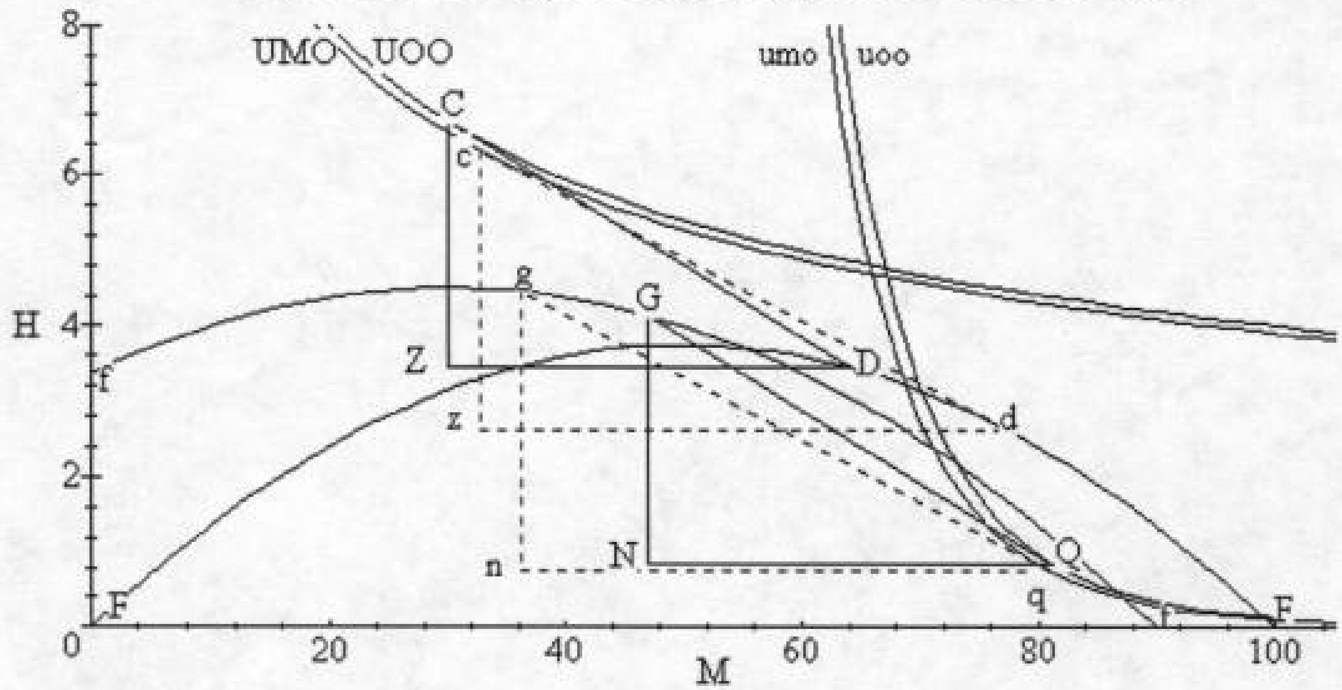


Fig. 6: Open access,partial and full management Equilibria

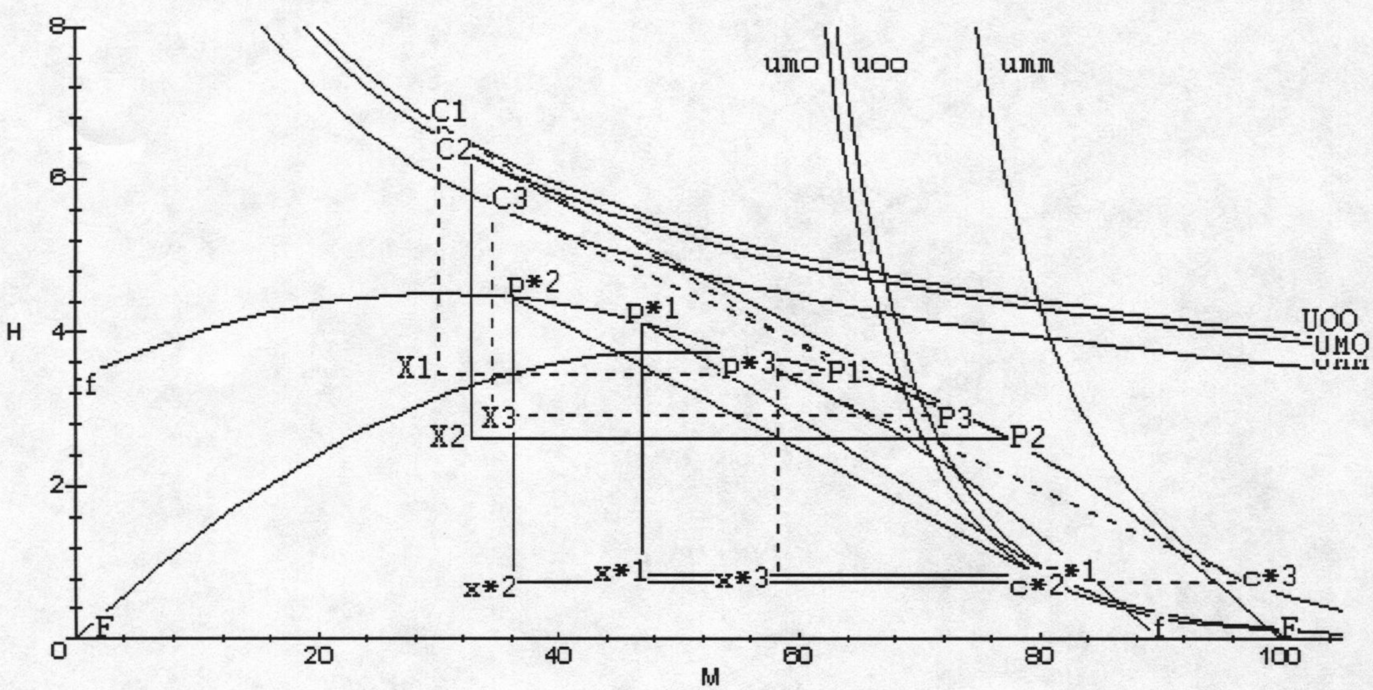
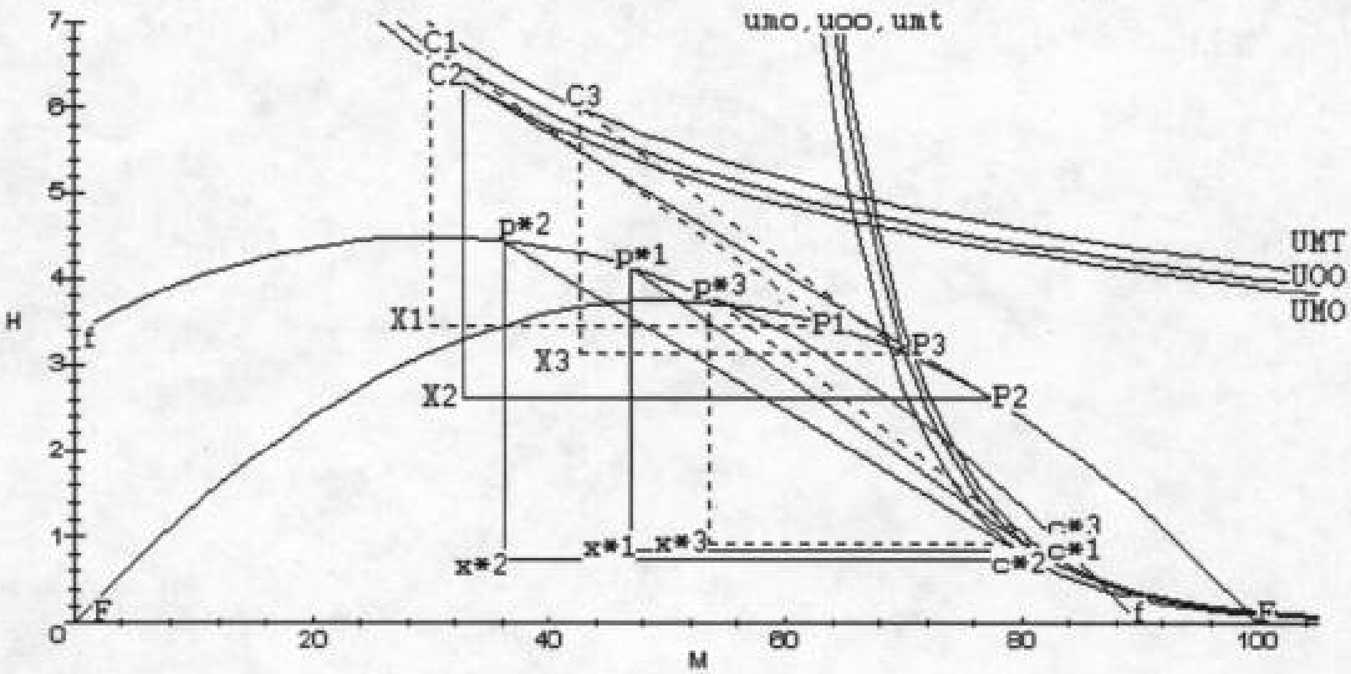


Fig. 7: Trade equilibria with import tax on resource good



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