Non-Use Values and the Management of Transboundary Renewable Resources

Ferrara, Ida and Missios, Paul

15 February 1997

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February 15^{th}, 1997.

Ida Ferrara and Paul C. Missios,

Department of Economics,

York University,

Abstract: It has long been recognized in economics that individuals can derive benefits from a resource stock without directly or indirectly utilizing that resource. Such non-use values, including existence values and bequest values, however, are often ignored in models of resource management. In this paper, a simple, two-country model of the management of a renewable resource is developed in which at least one country has a non-economic interest in the conservation of the fish stock to examine the impact of such a non-use value on the end-of-period harvest and self-enforcing sharing rule. The model shows that this non-lucrative pursuit serves to decrease the total allowable catch for each period at the expense of the catch share of the more conservation-oriented country, a result is consistent with the September 1995 decision by NAFO ending the dispute between Canada and the European Union over turbot.

* The comments of Charles Plourde, Mike Fraidenburg, Charles Paulsen, and an anonymous referee are greatly appreciated.

1 Introduction and Background

In early 1995, a "fish war," which gained considerable public attention, erupted between Canada and the European Union (EU) over turbot, also known as the Greenland halibut. The conflict arose from Spanish and Portuguese alleged overfishing in the area off the coast of Canada but outside the two hundred nautical mile limit on the Grand Banks of Newfoundland. To justify its overfishing above the quota set by the fifteen-country North Atlantic Fishery Organization (NAFO), the European Union cited the persistent low Canadian share of the turbot caught as an indication of excessively high quotas set for Canada. In contrast, Canada claimed that its low catch share was the immediate consequence of the continued overfishing by the European Union and other NAFO members.

The dispute has only recently come to an end, with Canada and the European Union agreeing on a total allowable catch for 1996 of 20,000 tonnes, approximately 26% lower than that set by NAFO for 1995, and on their respective catch shares of 15% and 55%. While the total allowable catch limits have followed a downward trend in previous years, from over 100,000 tonnes in 1989 to just 20,000 tonnes in 1996, the catch shares have undergone a drastic change, as in the past Canada would typically be granted more than fifty percent of the total allowable catch, and the European Union would consequently receive less than fifty percent. The steady decline of the total allowable catch is likely a consequence of the significant decrease of turbot stocks in recent years to dangerous levels. In fact, even though estimates of the stock size of turbot vary substantially, most conform to the view that turbot could face extinction if the overfishing of the 1980s and early 1990s were to continue.

That greater emphasis on the conservation of turbot has induced NAFO to set a lower total allowable catch for 1996 is consistent with the prediction of the infinite-horizon model developed by Missios and Plourde (1995), in which the steady state total allowable harvest is chosen as to maximize the sum of the two countries objective functionals subject to the relevant constraints. The driving force of their model is the assumption that one of the two countries, denoted the Home country and identified with Canada in the turbot war, has a non-pecuniary incentive to conserve the fish stock in addition to being profit-maximizing, and thus receives benefits from both the harvest and the level of the fish stock. From the continuous time specification of the model, though, a detailed analysis of the sharing rule becomes impossible. Prior to this study, the extent of countries conservation attitudes has been measured by the magnitude of discount factors; specifically, higher discount factors, implying greater emphasis on the future, have been taken to be equivalent to more conservationist positions. However, discount factors merely represent countries' willingness to trade present profit for future profit, so their relatively high levels are necessary but not sufficient to prevent optimal extinction in a finite-horizon setup. On the other hand, if countries derive a non-use value (that is, a value derived neither from direct nor indirect use of the resource stock) from the resource, then reasons of a social, political, ideological, or moral nature exist to conserve the fish stock and extinction is no longer possible as an optimal outcome, given that countries are now utility-maximizing and their utility is not independent of the level of the fish stock. The prime examples of these non-use values are known in the literature as existence value, which refers to preservation for its own sake, and bequest value, which refers to conservation for future generations' use (see Krutilla, 1967). Bishop and Welsh (1992) find evidence that existence values likely exist for species which are obscure or even unknown. Non-use values provide an additional incentive to leave part of the resource stock unharvested (beyond the intertemporal profit-maximization and cost-savings incentives), applying even in the final period in a finite horizon when other profit-based incentives disappear. The existence of a non-use value for at least one country is important not only in the determination of optimal harvests, as Missios and Plourde show, but also in that of catch shares.[1]

In the present paper, we address the harvest division issue in a two-period model of the type proposed by Vislie (1987) and extended by Ferrara and Missios (1995), and derive a

[1] By assuming that the catch shares are determined prior to the negotiation of the total allowable catch, Missios and Plourde do not need to consider the question of how the harvest is divided between the two countries.

self-enforcing contract between two countries, at least one of which is assumed to receive a non-use benefit from the stock. Like Missios and Plourde, we find that the harvest or total allowable catch is smaller compared to that of the benchmark case in which neither of the countries receives a non-use value; furthermore, we show that the harvest share of the country with such a motive is less than fifty percent in both periods, a result which is consistent with NAFO's decision to assign Canada only 15% of the total allowable catch for 1996.

2 The Model

We consider two countries, denoted the Home country and the Foreign country, which are engaged in a two-period exploitation of a transboundary renewable natural resource, such as fish, and which (in the absence of reliable enforcement mechanisms) need to design a contract specifying both the total allowable catches and the sharing rules that neither party has any incentive to breach. For the sake of exposition, we assume that the two countries face a world demand for harvested fish that is infinitely elastic, implying a parametric price, p,[2] and an identical constant unit cost of extraction, c.[3] In a bargaining situation where the agreement is negotiated at the beginning of the first period, the two countries maximize the product of their individual gains from cooperation, subject to the relevant constraints, and obtain dynamic consistency (or self-enforcement) by incorporating into the two-period Nash-product the optimal second-period catch shares. A Nash-product is the product of the net benefits from cooperation to each country, and the "two-period Nash-product" is simply the product of present values of the net benefits from cooperation. This yields a solution which is Pareto-optimal so that making one country better off must be done so at

[2]This assumption, made by both Munro (1979) and Vislie, removes the "market" externality associated with the impact of management decisions on the price, leaving only the dynamic or stock externality associated with the effects of the same decisions on the fish biomass.

[3]The assumption of a constant extraction cost, as opposed to a cost decreasing in the level of the fish stock, will have no impact on the sharing rule in either period. Although a stock-dependent cost would lower the harvest in the first period because of the "marginal stock effect" developed by Clark (1976), by which additional fish are left unharvested in order to decrease the future harvesting cost, our conclusions regarding the impact of non-use values under both equal and differing no-agreement payoffs will remain unchanged.

the expense of the other country.[4]

Here we will initially consider the general case in which the payoffs without cooperation are not necessarily equal, as in the Canada-European Union turbot dispute, as a result of one countries' proximity to the resource,[5] and later consider the simpler equal payoff specification. We define B_t^H, and B_t^F as the no-agreement payoffs in period t, and B^H and B^F as the two-period discounted no-agreement payoffs, of the Home country and Foreign country.

The Home country is assumed to hold a non-use value and thus benefits from both the harvest and the fish left unharvested, so that its objective functional is

$$W^H = V(x_1) + \alpha_1(p-c)h_1 + \delta_H[V(x_2) + \alpha_2(p-c)h_2], \tag{1}$$

where x_t , α_t , and h_t are the fish biomass, the Home country's share, and the total harvest in period t, respectively, and $\delta_H = \frac{1}{1+r^H}$ is the Home country's discount factor,[6] and where $V'(x_t) > 0$ and $V''(x_t) \leq 0$. On the other hand, the Foreign country does not receive utility from the level of the fish stock and therefore remains purely profit-oriented, so that its objective functional is

$$W^F = (1-\alpha_1)(p-c)h_1 + \delta_F(1-\alpha_2)(p-c)h_2, \tag{2}$$

where δ_F is the Foreign country's discount factor. The two countries therefore choose the total harvest and sharing rule for both periods by maximizing the two-period Nash-product,

$$\{V(x_1) + \alpha_1(p-c)h_1 + \delta_H[V(x_2) + \alpha_2(p-c)h_2] \tag{3}$$

$$-B^H\}\{(1-\alpha_1)(p-c)h_1 + +\delta_F(1-\alpha_2)(p-c)h_2 - B^F\}, \tag{4}$$

[4] Nash (1953) demonstrated that the maximization of the Nash-product yields the only solution that satisfies the axioms of feasibility, independence of irrelevant alternatives, rationality, and symmetry, in addition to Pareto-optimality.

[5] For example, the European Union can only employ "offshore" technologies that must incorporate both the harvesting and the processing (e.g., canning and freezing) of the fish caught.

[6] It is possible for the Home country to discount profits and utility at different rates. In particular, utility is sometimes discounted at the rate of "impatience" and profits at the appropriate rate of interest. While the former refers to preferences, the latter refers to opportunities. See Silberberg (1990), 419-426. Here, we assume that these two rates coincide.

such that

$$0 \leq \alpha_t \leq 1, \tag{5}$$

$$0 \leq h_t \leq h_{MAX}, \tag{6}$$

and

$$x_t = x_{t-1} + F(x_{t-1}) - h_t \geq 0. \tag{7}$$

where h_{MAX} is determined by economic catch constraints, and $F(x_{t-1})$ is the biomass growth function. Since the countries seek a self-enforcing contract, they need to take into account the second-period harvest and sharing rule which maximize the second-period Nash-product,

$$[V(x_2) + \alpha_2(p-c)h_2 - B_2^H][(1-\alpha_2)(p-c)h_2 - B_2^F], \tag{8}$$

subject to the above constraints for $t = 2$, when choosing the first-period harvest and catch shares.

The constrained maximization of (7) with respect to α_2 yields

$$\alpha_2 = \frac{1}{2} + \frac{(B_2^H - B_2^F) - V(x_2)}{2(p-c)h_2}, \tag{9}$$

and with respect to h_2 upon substitution for α_2 from (8) yields

$$p - c = V'(x_2), \tag{10}$$

which states that the marginal benefit from harvesting, i.e., the constant average profit from the harvest, must be equated to the second-period marginal benefit the Home country receives from leaving the fish unharvested. Only if the agreed-upon first-period harvest and catch shares are such that this condition is satisfied in the second period will the two-period contract be self-enforcing so that neither party has any incentive to deviate from it.

For the first period, the sharing rule and total harvest must satisfy

$$W^H - B^H = W^F - B^F, \tag{11}$$

or

$$V(x_1) + (2\alpha_1 - 1)(p-c)h_1 + \frac{\delta_H - \delta_F}{2}[V(x_2) + (p-c)h_2] - (B^H - B^F) = 0, \tag{12}$$

and

$$\{-V'(x_1) + \alpha_1(p-c) + \frac{\delta_H}{2}[V'(x_2)\frac{\partial x_2}{\partial h_1} + (p-c)\frac{\partial h_2}{\partial h_1}]\}[W^F - B^F]$$

$$+\{(1-\alpha_1)(p-c) + \frac{\delta_F}{2}[V'(x_2)\frac{\partial x_2}{\partial h_1} + (p-c)\frac{\partial h_2}{\partial h_1}]\}[W^H - W^H] = 0. \quad (13)$$

Rearranging (11), we obtain that

$$\alpha_1 = \frac{1}{2} - \frac{V(x_1)}{2(p-c)h_1} - \frac{(\delta_H - \delta_F)[h_2(p-c) + V(x_2)]}{4(p-c)h_1} \quad (14)$$

$$+\frac{[(B^H - B^F) - \frac{(\delta_H+\delta_F)}{2}(B_2^H - B_2^F)]}{2(p-c)h_1}. \quad (15)$$

Manipulating (12) and using (9), (10), and $\partial x_2/\partial h_1 + \partial h_2/\partial h_1 = -[1 + F'(x_1)]$, we have that

$$V'(x_1) - (p-c) + \frac{(\delta_H + \delta_F)}{2}[1 + F'(x_1)](p-c) = 0. \quad (16)$$

By (9) and (14) we confirm the result obtained by Ferrara and Missios that the assumption of differing default payoffs has no impact on the choices of the optimal first- and second-period harvests; in other words, the second-period harvest maximizing the second-period Nash-product and the first-period harvest maximizing the two-period Nash-product are independent of the corresponding no-agreement payoffs. However, the assumption does have an effect on the choices of the optimal first- and second-period sharing rule; as indicated by (8) and (13), α_2 is positively related to the difference between the Home country's second-period breakdown payoff and that of the Foreign country, and α_1 is positively related to the average "perceived value" of the first-period no-agreement payoff differential.[7] On the other hand, a non-use value on the part of the Home country affects not only the sharing rule but also the harvest choice. In particular, it reduces α_2, may increase or decrease α_1, depending on the difference between the two countries' discount factors,[8] and serves to increase the fish stock levels, and thus decrease the harvests, in both periods by the concavity of the growth function.

[7]The numerator of the fourth term on the right-hand-side of (13) is one-half of the sum of the first-period non-cooperative payoff differential discounted by δ_H and the same differential but discounted by δ_F.

[8]The derivative of α_1 with respect to the difference between δ_H and δ_F is negative; in fact, if the Home country is more future-oriented and thus willing to accept a lower harvest today for a larger one tomorrow, then it has to compensate the Foreign country with a higher current catch share.

If the Foreign country receives a higher payoff under non-cooperation than the Home country in each period, that is, $B_i^H < B_i^F$, for $i = 1, 2$, α_2 is unambiguously less than one half, given that both the differential and the benefit to the Home country from the second-period fish stock left unharvested work in the same direction to increase the bargaining power of the Foreign country. In other words, the Home country is willing to accept a lower second-period catch share in return for a lower harvest, and thus a higher fish stock; further, for an agreed upon harvest, the Home country has to accept an even lower share because of the Foreign country's better default position.[9] In the first period, the Home country is to receive a share less than one half, again provided that the Foreign country is not significantly more future-oriented, or that $\delta_F \gg \delta_H$, for the same reasons as discussed above. The result that α_2 and α_1 are both less than one half holds as well for the identical breakdown payoff case, or $B_i^H = B_i^F$, for $i = 1, 2$.

For $B_H > B_F$, whether the former agrees to a catch of less than fifty percent of the total harvest in the second period depends on the magnitude of the second-period default payoff differential relative to the benefit the Home country receives from the fish left unharvested. As intuition suggests and (8) confirms, the larger the differential is relative to the benefit, a benefit which in turn depends on the strength of the conservation commitment, the more likely the Home country must receive more than fifty percent of the second-period harvest to conform to the agreement. Similarly, under the assumption that the two countries have identical discount factors, the Home country agrees to a first-period catch share less than one-half if the first-period average breakdown payoff differential is less than the benefit from the fish stock at the end of the same period. On the other hand, if the discount factors differ, and, in particular, if $\delta_H > \delta_F$, implying that the Home country places more emphasis on the future, a dynamically consistent settlement between the two countries has to assign the more future- and conservation-oriented country more than fifty percent of the first-period

[9] In Munro (1979), compensation is made through explicit "side-payments," although the need for such compensation arises from differences in discount factors, fishing effort costs, and/or consumer preferences.

total catch if

$$\frac{(\delta_H - \delta_F)}{2}[(p-c)h_2 + V(x_2)] + V(x_1) < B^H - B^F - \frac{(\delta_H + \delta_F)}{2}(B_2^H - B_2^F), \tag{17}$$

that is, if the sum of the average social net benefit from the Home country's higher discount factor and the benefit from the first-period fish biomass is smaller than the average perceived value of the first-period no-agreement payoff differential. The result is again intuitive, as the Home country bargaining power is positively related to its relative non-cooperative advantage over the Foreign country, but negatively to the benefit from the fish stock and the discount factor differential. Clearly, the more favourable default position the Home country enjoys serves to increase its catch shares in both periods. However, while in the absence of the non-use value the Home country must receive a harvest share greater than fifty percent in the second period and, under the assumption of identical discount factors, in the first period,[10] here it is still possible for the country to agree upon a share smaller than fifty percent if its utility from the fish biomass is greater than the non-cooperative payoff differential.

The results that the first-period harvest is smaller and that the Home country's share is less than fifty percent are consistent with the terms of the September 1995 agreement with NAFO ending the dispute between Canada and the European Union over turbot, whereby Canada is entitled to catch only 3,000 tonnes of turbot for 1996, or 15% of the total allowable catch. The decision by NAFO seems to have been dictated by the need of a settlement that would accommodate the two parties' conflicting positions and prevent future losses associated with the reoccurrence of fish wars (non-cooperation).[11] Specifically,

[10] In such a case, both the first- and second-period shares are greater than one-half by the average ratio of the default payoff differential to the harvesting profits for the corresponding period, that is,

$$\alpha_2 = \frac{1}{2} + \frac{(B_2^H - B_2^F)}{2(p-c)h_2},$$

and

$$\alpha_1 = \frac{1}{2} + \frac{[(B^H - B^F) - \delta(B_2^H - B_2^F)]}{2(p-c)h_1}.$$

[11] Levhari and Mirman (1980) and Plourde and Yeung (1989) show that cooperation Pareto-dominates non-cooperation with two countries and n countries, respectively.

NAFO seems to have taken into account Canada's apparent greater future orientation[12] and ideological commitment to conservation, and the increased risk of turbot extinction resulting from the continued overfishing by the European Union. That Canada has a more conservation-oriented attitude is also in concert with the observation over recent years of its low share of the turbot caught, around 20%, in spite of its high allowable catch share, over 60%, and the visible signs of non-cooperative behaviour of the European Union. Obviously, if Canada's sole objective had been maximization of harvesting profits, then it would have responded to the overfishing of some NAFO members by fishing itself above the set quota. Instead, in light of the declining stock of turbot, apparently the last commercially viable fish stock in the North Atlantic, it chose to fish below its allowable quota, and this clearly identifies conservation as one of the key determinants of Canada's policies regarding fisheries.

For Canada, the decision by NAFO to set the total allowable catch for 1996 at a level lower than that of 1995 may signify an increase in the benefit received from the fish stock at the end of the year, a benefit which is only partially offset by the loss in the harvesting profits resulting from the lower 1996 total harvest. For the European Union, on the other hand, the smaller total allowable catch amounts exclusively to a loss in the profits from its share of the total harvest. Therefore, had NAFO limited itself to a reduction in the 1996 total allowable catch by about 26% relative to the 1995 harvest, and had Canada and the European Union accepted the decision, the latter would have not delayed to deviate from the negotiated sharing rule, as it would have not been willing to pay for the increase in the welfare of the former without adequate compensation. In the context of the dispute over turbot, given the absence of a legally binding agreement which requires not only monitoring[13] but also a system able to severely punish the parties deviating from the agreed-upon terms, Canada, which gains from NAFO decision to allow a smaller total turbot catch for 1996 at expense

[12]European interest rates, which can be regarded as a rough proxy for discount rates, have been traditionally higher than Canadian interest rates, implying a lower discount factor for the European Union, consequently a greater future-orientation for Canada. This claim is supported by the notorious reputation of the main European Union fleets (Spain and Portugal) as exploitive. Notwithstanding, Canada has also been involved in similar incidents, but not to the same extent.

[13]One of the terms of the September 1995 agreement is that vessels be monitored by satellite. Monitoring, however, may be necessary but certainly not sufficient to bind parties to their commitments regarding future actions.

of the European Union, has to somehow compensate the latter in order to prevent it from overfishing.

NAFO, which is likely to also aim at minimizing the costs associated with the continued switching from cooperation to non-cooperation and vice versa, seems to have given due attention to the need of a dynamically consistent agreement, and thus to the requirement that the European Union must be compensated for the loss in the net profits from its share of the harvest. This would explain the other NAFO decision, which won the support of both Canada and the European Union, to assign the former only 15% and the latter 55% of the total harvest, 75% lower and 337% higher, respectively, than the 1995 catch shares, or, in terms of the allowable quantity of turbot, a maximum of 3,000 tonnes for Canada, 81% lower than the 1995 quota, and a maximum of 11,000 tonnes for the European Union, 223% higher than the 1995 quota.

3 A Self-Enforcing Agreement When Both Countries Receive Non-use Values

Until now we have been concerned with situations in which only one country benefits from the fish stock and made no mention that both countries may pursue conservation for non-lucrative reasons, even if to different extents. This possibility arises in the context of the salmon dispute between Canada and the United States, as they are both known to contemplate policies aiming at preserving the natural status quo.[14] Paradoxically, the century-old conflict has been recently exacerbated by the decision of the American President Bill Clinton to ban salmon fishing in the area from California to the Canadian border in order to avoid the complete depletion of the US-spawned salmon, a resolution that carries the name of conservation but does not exclude the strategic attempt of the United States to expropriate some of the profits from the harvesting of the Canadian-spawned salmon. In fact, US fishermen responded by moving to Alaska, thereby adding to the pressure on the

[14]Munro and Stokes (1989) point out that the salmon dispute is not simply between Canada and the United States, as there is considerable antagonism between Washington, Oregon and Alaska. However, if we assume that the United States can solve their internal conflicts by a self-enforcing division of their national quota, then Canada will have to negotiate only with the United States as a whole.

salmon originating in British Columbia. In turn, Canadian fishermen, on instruction of the Canadian Department of Fisheries and Oceans, began to fish the Fraser river aggressively in order to deny the catch to Americans, contributing to devastate the west coast salmon fishery.

In view of the dangers of competition in common-access fisheries in the absence of an international system that provides safeguards against the actions of self-interested entities, dynamic consistency or self-enforcement becomes a vital requirement in any cooperative attempt to address the total allowable catch and harvest division issues. For completeness, we find it necessary to adapt the above model to encompass the case in which both countries have some incentive to conserve the fish stock. Given that the analysis is of most relevance in the evaluation of the positions of Canada and the United States in potential resolutions of the salmon dispute, and that neither of the two countries seems to have a relative better position in the harvesting of salmon under non-cooperation, we assume identical and equal to zero breakdown payoffs and introduce $U(x_t)$, to represent the benefit the Foreign country receives from the fish biomass, with $U'(x_t) > 0$ and $U''(x_t) \leq 0$, so that its objective functional is now

$$W^F = U(x_1) + (1-\alpha_1)(p-c)h_1 + \delta_F[U(x_2) + (1-\alpha_2)(p-c)h_2]. \tag{18}$$

Under the same constraints and assumptions about the price and cost structures as before, the two countries stipulate a contract in which the sharing rule and total allowable catch maximizing the second-period Nash-product are given by

$$\alpha_2 = \frac{1}{2} + \frac{[U(x_2) - V(x_2)]}{2(p-c)h_2}, \tag{19}$$

and

$$p - c = [V'(x_2) + U'(x_2)], \tag{20}$$

respectively, and the first-period terms maximizing the product of the objective functionals of the two countries, or two-period Nash-product, subject to (among the other relevant restrictions) the condition that (21) and (22) are satisfied, so that self-enforcement is ensured, are given by

$$\alpha_1 = \frac{1}{2} + \frac{[(U(x_1) - V(x_1)]}{2(p-c)h_1} + \frac{(\delta_F - \delta_H)[U(x_2) + V(x_2) + (p-c)h_2]}{4(p-c)h_1}, \qquad (21)$$

and

$$V'(x_1) - (p-c) + U'(x_1) + \frac{(\delta_H + \delta_F)}{2}[1 + F'(x_1)](p-c) = 0. \qquad (22)$$

Although we cannot determine whether the Home country is to receive a higher harvest share in either period or both periods unless we have a proxy for the benefit derived from the fish stock or at least some kind of relative measure of the extent of the two countries commitment to conservation, we are able to conclude that the Home country's marginal cost of not harvesting in terms of its catch share is lower here than in the case where the Foreign country does not hold a non-use value, as in the present framework both countries benefit from the level of the fish stock, and therefore there is no longer the need for the Home country to fully compensate the Foreign country with a higher share in exchange for a larger fish biomass. On the other hand, we are able to assert without a shadow of a doubt that the total allowable catch satisfying (22), which says that the constant average harvesting profit has to be equal to the sum of the two countries respective marginal benefits from the fish stock, is smaller than that from (14), and, similarly, the fish stock satisfying (24) is larger than that from (18), by the concavity of the utility functions. In conclusion, the assumption that even the Foreign country has some non-economic interest in the conservation of the fish stock results in a lower total harvest and higher catch share of the Home country in both periods.

4 Concluding Remarks

In this paper we have examined the impact of non-use values on the optimal choice of dynamically consistent total harvest and catch shares in a two-period, two-country setting. Notwithstanding the simplicity of the model, we have been able to show the very intuitive result that the more a country benefits from the fish stock, or the more committed to conservation it is, the larger the portion of the harvest it has to forego in order to induce the other country to accept a reduction in the total allowable catch. This tradeoff holds independently of whether the two countries share the non-use value, and of their respective threat-point positions. In other words, if both countries gain from the fish stock and for reasons completely unrelated to its potential of enhancing future harvesting profits, in any self-enforcing contract it is the party benefitting the most from leaving the fish unharvested that has to receive a lower share of a lower second-period or future harvest, as the second period can be roughly thought of as representing the future, and of a lower first-period, or present, harvest. Differing discount factors, with the more conservation-oriented country also placing more emphasis on the future, have a negative effect on the catch share of the less present-oriented country but only in the first-period, contributing therefore to reduce its already less than one-half harvest portion. On the other hand, differing breakdown positions, with the conservation-committed country enjoying a better payoff under non-cooperation, have a positive impact on the same share, thus making it possible for the country with the higher default payoff to receive more of the harvest in both periods if the negative effect of its non-economic incentive to conserve the fish stock, which also result in a lower total allowable catch, is more than offset by the positive effect of its better default position.

Even though the conclusions of the models above presented are seemingly applicable to the current conflicts in fishery management, our analysis is also intended to stress the importance of clearly identifying all the variables relevant to the decision-making of the various parties involved in any such dispute. In fact, far from aiming at criticizing the often assumed profit-maximizing objective, we have shown how a simple variation in the behaviour of at least one of the parties influences not only the optimal level of the fish stock, but also the self-enforcing sharing rule. Understanding the determinants of the behaviour of the countries exploiting a transboundary fishery then becomes essential in the formulation of lasting cooperative policies.

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