

Fisheries Negotiations—A Game-theoretical Consideration on the Difference in the Negotiation Procedures*

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Abstract

The coastal countries in the Western and Central Pacific area negotiate over the fishing rights and the access fees with the Distant Water Fishing Nations (DWFNs) such as Japan and the United States. Almost all fisheries negotiations in this area take a *bilateral* approach in which each pair of a coastal country and a DWFN negotiates; if they reach an agreement, a bilateral treaty is established. The only exception is a *multilateral* approach taken in the negotiation between the US and the regional coalition of the coastal countries.

In this paper, we construct a game-theoretical model of the fisheries negotiations comprised of three countries (one DWFN and two coastal countries) and examine how the differences in the negotiation approaches affect the catches of fish, the access fees, and the welfare of the countries concerned. We find that (i) the DWFN obtains the same payoffs under both the bilateral and multilateral approaches; (ii) a coastal country with relatively abundant fishery resources can obtain a higher payoff under the bilateral approach than under the multilateral one, and the opposite is true for a coastal country with relatively scarce fishery resources (i.e., the “fish-rich” country prefers the bilateral approach to the multilateral one); however, (iii) the total payoffs to the coastal countries as a whole under both approaches are the same.

Further, we introduce an alternative, theoretically simple, multilateral approach, which treats all the countries symmetrically. By comparing it with the above two approaches, we demonstrate that in the alternative multilateral approach (iv) the DWFN obtains a lower payoff but the coastal countries as a whole obtain a higher total payoff; (v) if the fishery resource endowments of the coastal countries are sufficiently close to each other, both coastal countries can obtain higher payoffs; however, (vi) if a coastal country has the fishery resource endowment sufficiently greater than the other coastal country, the former country obtains a lower payoff than under the bilateral approach (i.e., the “fish-rich” country may prefer the bilateral approach to the alternative multilateral approach).

1 Introduction

The Western and Central Pacific (WCP) area is well known for its large and valuable tuna resources;¹ and there are more than twenty WCP coastal countries whose exclusive economic zones (EEZs),² within which the coastal countries have property rights to the fishery resources there, divide and cover a large part of this region of the Pacific. In spite of their abundant fishery resources, the WCP countries (mostly, the Pacific Island Countries: PICs) have not succeeded in exploiting the fruits of the fishery resources in the EEZs because of their poorly developed domestic fishing fleets. Instead, many Distant Water Fishing Nations (DWFNs), such as Japan, Taiwan, South Korea, and the United States, who possess more efficient fishing technology and well-developed fishing industries, have long been engaged in tuna fishery in this region. The rights to fish in the EEZs of the coastal countries are allocated to the DWFNs through negotiations between the coastal countries and the DWFNs and, in exchange for the fishing rights, the DWFNs pay to the coastal countries the access fees determined in the negotiations.

Interestingly, almost all of the fisheries negotiations between the coastal countries and the DWFNs have taken bilateral approaches. That is, each pair of a coastal country and a DWFN negotiates over the allocation of the fishing rights and the corresponding access fee in the EEZ of the coastal

¹The Western and Central Pacific Ocean produces 53 percent of the world total skipjack catch, and 41 percent of the world total tuna catch in 2006. (Source: FAO Fishstat plus, capture production 1950–2006)

²EEZ is an ocean area of national jurisdiction within 200 nautical miles of a state's coastline as delineated in the United Nations Convention on the Law of the Sea (United Nations 1994).

country; if they reach an agreement, a bilateral treaty is established.

A notable example of the bilateral approach is the case of the negotiations between the WCP countries and Japan, which is one of the largest DWFNs in this region. Japan has signed bilateral treaties with ten coastal countries, which are listed in Table 1. In the cases of Japan's treaties, we find two characteristics: (i) the access fees per catch are the same across the bilateral treaties with the coastal countries—in each of the treaties, it is arranged that 5 percent of the total value of the catch in the EEZ of a coastal country should be paid to the coastal country as the access fee; (ii) as can be seen from Table 1, the coastal countries with larger EEZs tend to conclude the bilateral treaties with Japan, while those with smaller EEZs do not—the average EEZ area of the countries that have concluded bilateral treaties with Japan is about 2.18 million square kilometers and that of the countries that have not concluded bilateral treaties is about 1.20 million square kilometers (if we exclude Australia and New Zealand and concentrate our attention only on the PICs, the average EEZ area of the former countries is 1.71 million square kilometers and that of the latter countries is 0.75 million square kilometers).

[Table 1 should be inserted here]

On occasion, the WCP coastal countries have jointly proposed to Japan that they should take a multilateral approach, in which the coastal countries form a regional coalition, and the regional coalition on behalf of the coastal countries negotiates a multilateral treaty with Japan. Nevertheless, Japan had a fundamental concern about the proposed multilateral

approach, as described by Tarte (1998, p. 105) as follows:

... Japan would be further weakened in its position as a distant-water fishing nation if the Pacific island countries were able to present a common negotiating stand (a cartel-like scenario). This would lead inevitably to upward pressure on access fees and thus to a worsening economic performance by the fishing vessels. In such a situation there would not be the option of moving to other fishing grounds under more favourable access arrangements.

Consequently, Japan has refused to accept the multilateral approach and insisted on the bilateral approach.³

The US, on the other hand, has accepted a multilateral approach; this is the only exception to the widespread bilateral approaches in this region. The sixteen WCP countries formed a regional coalition called Pacific Islands Forum (PIF). PIF and the US started the negotiation in 1984; the negotiation was coordinated by the Forum Fisheries Agency (FFA), which is one of the PIF-related organizations.⁴ In 1988, the US and PIF concluded a

³In 2004, a multilateral treaty concerning the conservation and management of the fishery resources in the Western and Central Pacific region (i.e., WCPFC: "Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean") became effective and, one year later, Japan has joined this treaty; the member countries, regions, and organizations include Australia, Canada, China, Samoa, Niue, Tonga, Vanuatu, Cook Islands, New Zealand, Nauru, Palau, Tuvalu, Fiji, Solomon Islands, Marshall Islands, Papua New Guinea, Federated States of Micronesia, Kiribati, France, the European Union, Japan, South Korea, the Philippines, and Taiwan. However, the WCPFC does not concern with the allocation of the fishing rights and the corresponding access fees in the EEZs in this region.

⁴Tsamenyi (1986) discussed the reason that the US prefers the multilateral approach from historical and legal perspectives. The US had denied the sovereignty of coastal countries over highly migratory species (such as tuna) in the EEZs of them and taken a

multilateral treaty (the US-PIF treaty, for short).⁵ The annual fee specified in the latest amendment of this treaty amounts to \$US 18 million, which, as Hunt (1997) pointed out, corresponds to “a rate of payment of about 14% of the value of tuna caught.”

Although the total amount of the payment from the US to PIF is specified in the US-PIF treaty, its distribution among the PIF member countries is not. The PIF member countries by themselves have established another supplementary agreement to effectively implement the US-PIF treaty.⁶ In this supplementary agreement, the distribution of the payment from the US among the PIF member countries is prescribed as follows: (i) administrative costs incurred by FFA and a fixed payment for a fund, which is referred to as the “Project Development Fund,” are deducted from the total payment; (ii) 15 percent of the balance remaining after deduction in (i) is distributed equally among the PIF members; and (iii) 85 percent of the balance remaining after deduction in (i) is distributed according to the share of the volume of catches in each respective EEZ of the member countries. In brief, each PIF member’s revenue in the multilateral approach consists of two parts: one is a fixed part, which is the same across the PIF members, and the other is a variable part, which is proportional to the share of the catch in its own EEZ.

As shown above, there are at least two negotiation approaches avail-

position that these species would belong to the high seas and therefore the US fishermen have rights to catch tuna freely even within the EEZs of coastal countries.

⁵The title of the treaty is “Treaty on Fisheries Between the Governments of Certain Pacific Island States and the Government of the United States of America.”

⁶The title of the agreement is “Agreement among Pacific Island States concerning the Implementation and Administration of the Treaty on Fisheries Between the Governments of Certain Pacific Island States and the Government of the United States of America.”

able to the DWFNs and the PIF member countries: one is the bilateral approach taken by Japan and other DWFNs; the other is the multilateral approach taken by the US. In the bilateral approach, a DWFN enters into bilateral negotiations with coastal countries; in other words, the DWFN participates in all the bilateral negotiations simultaneously, while each coastal country can participate only in its own bilateral negotiation with the DWFN. Consequently, the DWFN can take advantage of its position as the hub of the negotiations and have influence on the results of the negotiations. In the multilateral approach, the negotiation between a DWFN and coastal countries consists of two stages: in the first stage, a coalition of the coastal countries is formed and a rule of the distribution of the total payment from the DWFN among the member countries is determined; in the second stage, given the distribution rule, the total payment from the DWFN to the coalition and the catches in the EEZs of the coalition members are negotiated between the DWFN and the coalition.

The attitudes toward these negotiation approaches are different from country to country. As already mentioned, the US accepts the multilateral approach, while Japan and other DWFNs stick to the bilateral approach. Also, we can find a diversity of the attitudes of the WCP countries. Although the WCP countries as a whole sometimes advocate adopting the multilateral approach in order to exercise a certain coalitional power in the negotiations with the DWFNs, some WCP countries, at the same time, express their hesitation in doing so; for example, Hunt (1997, pp. 158–9) noted as follows:

A major constraint on the development of a united approach to

negotiations with the distant water fleets is, however, the unwillingness of some island states that depend heavily on fishing fees, for example, Kiribati and the FSM [Federated States of Micronesia], to adopt the cooperative model. The FSM fears that it could be worse off under multilateral agreements and sees present bilateral arrangements as providing more opportunities for domestic fisheries development through joint ventures.

In addition, Chand et al. (2003, p. 334) pointed out four reasons that WCP countries (mostly PICs) are reluctant to enter into multilateral agreements as follows:

First, there exists a perception by PICs that such agreements may compromise their sovereign rights. Second, the lack of supporting institutions that could compel or impose an agreement among PICs hinders their development. Third, the benefits and costs of implementing new institutions are likely to be unevenly distributed between PICs. Fourth, some PICs fear that multilateral agreements may jeopardize bilateral aid.

In this paper, we investigate, from an economics perspective, how and why these differences in the attitudes toward negotiation approaches arise. To this end, we construct a simple game-theoretical model of the fisheries negotiations comprised of three countries (one DWFN and two coastal countries). In addition to two negotiation approaches (i.e., the bilateral approach and the multilateral approach), we introduce an alternative, the-

oretically simple, multilateral approach; then, we examine how the differences in the negotiation approaches affect the catches of fish, the access fees, and the welfare of the countries concerned.

The rest of the paper is organized as follows. In Section 2, we construct the basic three country model, which specifies the production and payoff structures. In Section 3, we introduce the three negotiation procedures and examine the variables determined in each of them. We summarize and compare the results of these negotiation procedures in Section 4. Section 5 includes some remarks.

2 Model—Production and payoff

We consider a world economy consisting of three countries. One is a Distant Water Fishing Nation (DWFN), who possesses fishing technology and has its own market for fish, but does not have its own fishery resources. The other two are coastal countries, each of which has fishery resources within its own EEZ, but has neither fishing technology nor its own fish market. Coastal countries are numbered 1 and 2, respectively.

Let x_i be the amount of fish that the DWFN can catch in the EEZ of coastal country i ($i = 1, 2$). Suppose that the production of x_i depends on both the fishery stock K_i in the EEZ of country i and labor input L_i . More specifically, we assume that the production of x_i is represented by a Cobb-Douglas function of the following form:

$$x_i = K_i^{1/2} L_i^{1/2}. \quad (1)$$

By solving this for L_i , we can represent the cost (in terms of labor) of catch

as a function of x_i and K_i :

$$L_i = C_i(x_i) \equiv \frac{(x_i)^2}{K_i}, \quad i = 1, 2. \quad (2)$$

It should be noted that for the DWFN, the cost of catching a certain amount of fish in the EEZ of country 1 is different from that in the EEZ of country 2. This reflects the difference in the coastal countries' endowments of fishery stock. The more abundant the fishery stock of one coastal country is, the easier for the DWFN to catch a certain amount of fish in the EEZ of this coastal country than in the EEZ of the other coastal country. When $K_i > K_j$ ($i \neq j$), we say that coastal country i is "fishery-stock abundant" (or, more simply, "fish-rich") than coastal country j .

If the DWFN catches x_i from the EEZ of country i , the DWFN sells it in its own fish market, which is assumed to be competitive. The price of fish in the market is denoted by p . Further, if the DWFN wants to enter the EEZ of country i and be engaged in fishery there, it has to pay to coastal country i the "access fee," which will be determined in fisheries negotiation. By u_i , we denote the access fee paid by the DWFN to country i . Then, the (net) profit of the DWFN becomes as follows:

$$\pi_0 \equiv px_1 - C_1(x_1) - u_1 + px_2 - C_2(x_2) - u_2, \quad (3)$$

where subscript "0" indicates the DWFN.

Coastal country i will receive a positive u_i if the fisheries negotiation succeeds, while it will receive nothing ($u_i = 0$) if the negotiation fails; then, we can identify u_i with the welfare of country i ($i = 1, 2$). The way how u_i is determined depends on the approach that is actually taken in the fisheries negotiation.

3 Negotiation procedures

We consider three different negotiation procedures, which we shall name the “pairwise negotiation,” the “two-stage negotiation,” and the “round-table negotiation,” respectively. The first one is abstracted from the actual procedure that the Japanese government has insisted to adopt when it entered the negotiations with the WCP countries. The second one is abstracted from the procedure that the governments of the US and the WCP countries have adopted when they entered the negotiations. The last one is a theoretically simple, symmetric negotiation procedure.

3.1 The pairwise negotiation

In the pairwise negotiation, a pair of the DWFN and a coastal country (say, country i) negotiates over catch x_i in the EEZ of country i and the payment u_i to it, taking the results of the negotiation between the DWFN and the other coastal country as given. Actually, in the pairwise negotiation, two parallel negotiations are held. Because the DWFN participates in both of the pairwise negotiations, the results obtained in them cannot be independent; rather, they are determined simultaneously. We call the negotiation between the DWFN and coastal country i as “ $(0, i)$ -negotiation” ($i = 1, 2$).

In the $(0, i)$ -negotiation, the pair of the DWFN and coastal country i negotiates over x_i and u_i , taking x_j and u_j ($j \neq i$) as given. We assume that the $(0, i)$ -negotiation itself is a simple two-player Nash bargaining. Even if the DWFN fails to reach an agreement with coastal country i , it can ensure itself a certain positive payoff from the negotiation with the other coastal

country (i.e., from the $(0, j)$ -negotiation). Therefore, the guaranteed level of payoff for the DWFN in the $(0, i)$ -negotiation is the payoff that it can obtain from the $(0, j)$ -negotiation, that is, $\pi_{0j} \equiv px_j - (x_j)^2/K_j - u_j$.⁷ If the $(0, i)$ -negotiation fails, then coastal country i receives nothing. Thus, the Nash product for the $(0, i)$ -negotiation can be written as follows:

$$(\pi_0 - \pi_{0j})u_i \equiv \left\{ px_i - (x_i)^2/K_i - u_i \right\} u_i, \quad j \neq i. \quad (4)$$

Taking x_j and u_j ($j \neq i$) as given, we can derive the first-order conditions for the maximization of Eq. (4) follows:

$$\{p - 2x_i/K_i\} u_i = 0, \quad (5)$$

$$\left\{ px_i - (x_i)^2/K_i - u_i \right\} - u_i = 0. \quad (6)$$

Similar conditions for the $(0, j)$ -negotiation can be derived. By solving the first-order conditions for (x_1, x_2, u_1, u_2) simultaneously, we obtain the solution $(x_1^P, x_2^P, u_1^P, u_2^P)$ for the pairwise negotiation:⁸

$$x_i^P = \frac{pK_i}{2}, \quad u_i^P = \frac{p^2K_i}{8}, \quad i = 1, 2. \quad (7)$$

Clearly, the DWFN catches fish more in the fish-rich country than in the fish-poor country (i.e., $x_i^P > x_j^P$ if and only if $K_i > K_j$) and it pays more to the fish-rich country than to the fish-poor country (i.e., $u_i^P > u_j^P$ if and only if $K_i > K_j$). Further, by simply calculating, we obtain the following result:

$$\pi_0^P = \frac{p^2[K_1 + K_2]}{8}. \quad (8)$$

⁷Subscripts “0j” indicate “ $(0, j)$ -negotiation.”

⁸Superscript P indicates “Pairwise (negotiation).”

The DWFN's payment to coastal country i per catch (i.e., the price of catch or the access fee per catch) is denoted by $w_i \equiv u_i/x_i$. The price of catch w_i^P in coastal country i evaluated at the solution for the pairwise negotiation becomes as follows:

$$w_i^P = \frac{p}{4}, \quad i = 1, 2. \quad (9)$$

It should be noted that the prices of catch in both coastal countries are the same and independent of their relative abundance of fish stock. In the pairwise negotiation, the DWFN pays *the same price* to the coastal countries; the total payment to one coastal country is proportional to the catch in that country.

3.2 The two-stage negotiation

As the name indicates, the two-stage negotiation consists of two stages. In the first stage, the coastal countries form a coalition and they decide how to divide the fruits of the negotiation between the DWFN and the coalition. In the second stage, the DWFN and the coalition of the coastal countries negotiate over the catches (x_1 and x_2) and the total payment to the coalition, which will be divided among the coastal countries according to the rule determined in the first stage.

The payoff that a coastal country receives in the first stage is divided into two parts: one is a fixed part f , which is the same across coastal countries, and the other is a variable part, which is proportional to the share of the catch in the coastal country relative to the total catch in the EEZs of the coastal countries. Let V be the total payment to the coalition of the coastal countries determined in the second stage. Then, the payoff that coastal

country i receives in the first stage can be written as follows:

$$u_i = f + \frac{x_i}{x_1 + x_2} \{V - 2f\}, \quad i = 1, 2. \quad (10)$$

Although the fixed portion f should be determined in the first stage, we do not explicitly model the first stage; instead, we treat f as an exogenous variable.

The Nash product for the negotiation between the DWFN and the coalition in the second stage becomes as follows:

$$\left\{ px_1 - (x_1)^2/K_1 + px_2 - (x_2)^2/K_2 - V \right\} V. \quad (11)$$

The first-order conditions for the maximization of Eq. (11) with respect to x_1 , x_2 , and V become as follows:

$$(p - 2x_i/K_i) V = 0, \quad i = 1, 2, \quad (12)$$

$$px_1 - (x_1)^2/K_1 + px_2 - (x_2)^2/K_2 - 2V = 0. \quad (13)$$

By solving the first-order conditions for (x_1, x_2, V) , we obtain the solution for the two-stage negotiation (x_1^T, x_2^T, V^T) :⁹

$$x_i^T = \frac{pK_i}{2}, \quad V^T = \frac{p^2[K_1 + K_2]}{8}, \quad i = 1, 2. \quad (14)$$

Substituting the above results, we obtain the payoff to the DWFN in the two-stage negotiation:

$$\pi_0^T = \frac{p^2[K_1 + K_2]}{8}. \quad (15)$$

Further, we can calculate the payoff to each of the coastal countries:

$$u_i^T = \frac{p^2K_i}{8} + f \left\{ \frac{K_j - K_i}{K_1 + K_2} \right\}, \quad i = 1, 2; j \neq i. \quad (16)$$

⁹Superscript T indicates the "Two (stage negotiation)."

Note that the second term in the right-hand-side of the above equation depends on the difference in the endowments of the fishery resources of the coastal countries. As far as the fixed part f is positive, the second term for the fish-rich country is negative and that for the fish-poor country is positive. In a sense, the two-stage negotiation favors the fish-poor coastal country more than proportional to its fishery stock.

3.3 The round-table negotiation

In the round-table negotiation, all the three countries assemble in one place and negotiate simultaneously over catches (i.e., x_1 and x_2) in the EEZs of the coastal countries and the payments (i.e., u_1 and u_2) to them. Theoretically, this is nothing but a simple three-person Nash bargaining.

If the negotiation fails, all the countries receive nothing; that is, the guaranteed payoff levels of the countries are all zero. Then, the Nash product for the round-table negotiation can be written as follows:

$$\pi_0 u_1 u_2 \equiv \left\{ p x_1 - (x_1)^2 / K_1 + p x_2 - (x_2)^2 / K_2 - u_1 - u_2 \right\} u_1 u_2. \quad (17)$$

The countries negotiate over (x_1, x_2, u_1, u_2) to maximize Eq. (17). The quadruple $(x_1^R, x_2^R, u_1^R, u_2^R)$ that maximizes Eq. (17) corresponds to the Nash bargaining solution.¹⁰ The first-order conditions for the maximization of Eq. (17) are

$$(p - 2x_i / K_i) u_1 u_2 = 0, \quad i = 1, 2, \quad (18)$$

$$\pi_0 u_i - u_1 u_2 = 0, \quad i = 1, 2. \quad (19)$$

¹⁰Superscript R indicates the “Round-table (negotiation).”

By solving the above equations, we obtain the following results:

$$x_i^R = \frac{pK_i}{2}, \quad u_i^R = \frac{p^2[K_1 + K_2]}{12}, \quad i = 1, 2. \quad (20)$$

By substituting the above results, we obtain the profit π_0^R of the DWFN evaluated at $(x_1^R, x_2^R, u_1^R, u_2^R)$:

$$\pi_0^R = \frac{p^2[K_1 + K_2]}{12}. \quad (21)$$

Clearly, we have $\pi_0^R = u_1^R = u_2^R$. This means that in the round-table negotiation, the fruits of fishery in the region are equally divided among all the concerning countries irrespective of their positions (of being the catcher or the holder of fishery stock) or relative abundance in fishery stock. The DWFN pays the same amount of the access fee to each of the coastal countries.

The price of catch w_i^R in coastal country i evaluated at the Nash bargaining solution for the round-table negotiation becomes as follows:

$$w_i^R = \frac{p[K_1 + K_2]}{6K_i}, \quad i = 1, 2. \quad (22)$$

As can be easily seen from the above equation, the price of catch evaluated at the Nash bargaining solution is lower in a fish-rich country than in a fish-poor country, that is, $w_i^R < w_j^R$ if and only if $K_i > K_j$.

4 Comparison of the results

Table 2 summarizes the results obtained in the previous section. The third row of Table 2 shows that $x_i^R = x_i^P = x_i^T = pK_i/2$ ($i = 1, 2$). The difference in the negotiation procedures does not affect the catches of fish in the EEZs

of the coastal countries; the catch of fish in the EEZ of a coastal country is proportional both to the price of fish and to the fishery stock there.

[Table 2 should be inserted here]

Unlike the catches, the payoffs to the concerning countries are definitely affected by the choice of the negotiation procedure. First, let us consider the payoff to the DWFN. From the first row in Table 2, we have $\pi_0^R < \pi_0^P = \pi_0^T$. The payoffs to the DWFN under the pairwise negotiation and the two-stage negotiation are the same and they are higher than the payoff under the round-table negotiation. Clearly, the DWFN always prefers either the pairwise negotiation or the two-stage negotiation to the round-table negotiation.

This observation partly explains the reason that in the actual fisheries negotiation, the Japanese government has insisted on the pairwise negotiation. If the Japanese government surmised that some coastal countries were proposing the round-table negotiation rather than the two-stage negotiation, it was surely reasonable for the Japanese government to reject the proposal of the multilateral negotiation. However, if the proposed approach were the two-stage negotiation, the Japanese government would not be harmed by accepting the proposal.

Let us turn to the payoffs to a coastal country. From the second row of Table 2, we obtain the following relations: for $i, j = 1, 2$ with $i \neq j$,

$$u_i^T \geq u_i^P \quad \Leftrightarrow \quad K_j \geq K_i, \quad (23)$$

$$u_i^R \geq u_i^P \quad \Leftrightarrow \quad 2K_j \geq K_i, \quad (24)$$

$$u_i^R \geq u_i^T \Leftrightarrow \frac{p^2(2K_j - K_i)}{24f} \geq \frac{K_j - K_i}{K_i + K_j}. \quad (25)$$

The above relations determine the preference of a coastal country over the negotiation procedures; and the preference depends on the combinations of the fishery stock endowments in the EEZs of the coastal countries.

For expositional simplicity, we assume hereafter that coastal country 1 is fish-rich and country 2 is fish-poor (i.e., $K_1 \geq K_2$). Figure 1 illustrates possible combinations of K_1 and K_2 , where K_1 is measured horizontally and K_2 vertically. The straight line 0ℓ is the graph of $K_1 = K_2$; therefore, the wedge-shaped area $K_10\ell$ represents the set of all combinations of K_1 and K_2 satisfying $K_1 \geq K_2$. The straight line $0m$ is the graph of $2K_2 = K_1$; the curve $0rs$ represents the graph of $p^2(2K_1 - K_2)/(24f) = (K_1 - K_2)/(K_1 + K_2)$; and the curve tn represents the graph of $p^2(2K_2 - K_1)/(24f) = (K_2 - K_1)/(K_1 + K_2)$. These lines and curves divide the area $K_10\ell$ into five subregions A through E as shown in Figure 1.¹¹

[Figure 1 should be inserted here]

Let us first consider the payoffs to country 1. Since $K_1 \geq K_2$, we have $u_1^P > u_1^T$ from Eq. (23). If (K_1, K_2) is included in either A or C, we have $u_1^R > u_1^P$ from Eq. (24); otherwise $u_1^R < u_1^P$. Further, if (K_1, K_2) is included in either one of subregions A through D, we have $u_1^R > u_1^T$ from Eq. (25); otherwise, $u_1^R < u_1^T$.

Next, let us consider the payoffs to country 2. Similar to country 1, we have $u_2^T > u_2^P$ since $K_1 \geq K_2$. If (K_1, K_2) is included in either one

¹¹Similarly, the area $K_20\ell$ can be partitioned into five subregions; however, for simplicity, we omit the illustration.

of subregions C through E, we have $u_2^R > u_2^T$ from Eq. (25); otherwise, $u_2^R < u_2^T$. Further, we have $u_2^R > u_2^P$ from Eq. (24).

By summarizing the above results, we obtain the following relations:¹²

$$u_1^R > u_1^P > u_1^T, \quad u_2^T > u_2^R > u_2^P \quad \text{if } (K_1, K_2) \in A; \quad (26)$$

$$u_1^P > u_1^R > u_1^T, \quad u_2^T > u_2^R > u_2^P \quad \text{if } (K_1, K_2) \in B; \quad (27)$$

$$u_1^R > u_1^P > u_1^T, \quad u_2^R > u_2^T > u_2^P \quad \text{if } (K_1, K_2) \in C; \quad (28)$$

$$u_1^P > u_1^R > u_1^T, \quad u_2^R > u_2^T > u_2^P \quad \text{if } (K_1, K_2) \in D; \quad (29)$$

$$u_1^P > u_1^T > u_1^R, \quad u_2^R > u_2^T > u_2^P \quad \text{if } (K_1, K_2) \in E. \quad (30)$$

Several points should be noticed. First, in almost all cases, the two-stage negotiation is the worst procedure for the fish-rich country (country 1); the only exception is the case where (K_1, K_2) is included in subregion E. Second, the pairwise negotiation is always the worst procedure for the fish-poor country (country 2). Third, the fish-rich country always prefers the pairwise negotiation to the two-stage negotiation; however, the opposite is true for the fish-poor country.

If it is appropriate to consider the area of a country's EEZ as proxy for the fishery stock of the country, we can assert that the second and third points are consistent with the observation that in the Japan's bilateral treaties, the coastal countries with larger EEZs tend to conclude the bilateral treaties, while those with smaller EEZs do not, as pointed out in the Introduction. The coastal countries with smaller EEZs—the fish-poor countries—have disincentive to take the bilateral approach (the pairwise

¹²If the combination of the endowments of fishery stock, (K_1, K_2) , falls on one of the boundaries of the subregions, some equalities need to be added appropriately to the relations.

negotiation); they rather prefer the multilateral approach (the two-stage negotiation).¹³

Note also that if (K_1, K_2) is included in C , the best procedure both for the fish-rich and fish-poor countries is the round-table negotiation. This suggests that if the coastal countries closely resemble each other (in the sense that their fishery resource endowments are almost the same), they can agree to adopt the round-table negotiation as the candidate procedure to be proposed to the DWFN. Of course, even if the coastal countries propose the round-table negotiation, the DWFN may not accept it, because the DWFN always prefers the pairwise negotiation or the two-stage negotiation to the round-table negotiation.

Further, note that we always have $u_1^R + u_2^R > u_1^P + u_2^P = u_1^T + u_2^T$. This implies that, among those procedures examined in the previous sections, the round-table negotiation is *potentially* the best procedure for the coastal countries as a whole; that is, if lump-sum transfers between the coastal countries after the conclusion of the round-table negotiation are possible, every coastal country can be better off than it would be under the pairwise negotiation or under the two-stage negotiation.

Furthermore, since we have $\pi_0^R + u_1^R + u_2^R = \pi_0^P + u_1^P + u_2^P = \pi_0^T + u_1^T + u_2^T$, the choice among the three alternative negotiation procedures is a constant-sum game for the DWFN and the coastal countries. Hence, there is no single negotiation procedure (among those examined in this paper) that all the countries can unanimously agree to adopt.

¹³Note that all the coastal countries that have concluded no bilateral treaty with Japan participate in the multilateral treaty with the US.

5 Concluding remarks

In this paper, we have developed a game-theoretical model of fishery negotiations, which consists of one DWFN and two coastal countries. Although our model is very simple, it can provide economic explanations for some of the characteristics of the actual fisheries negotiations between the DWFNs and the coastal countries in the WCP area. Our analysis suggests that the choice of the negotiation procedure really matters to the determination of the welfare of the concerning countries.

Our simple model can be extended to several directions. First, in view of the fact that there are many DWFNs operating in the WCP region, it is important to incorporate the competition among the DWFNs in acquiring the fishing rights within this region; through the competition among the DWFNs, each of the coastal countries becomes able to exercise a higher degree of bargaining power in each bilateral negotiation than that in the case without the DWFNs' competition since each coastal country negotiating with one DWFN can have some outside options to negotiate with other DWFNs. Second, since the actual bilateral negotiations were not held simultaneously (as modeled in our bilateral negotiation) but held *successively*, it is possible that the results of one negotiation affects those of successive negotiations; therefore, it is also important to examine whether and how the successive structure of the bilateral negotiations affect the overall consequences. Third, although we have ignored the growth of the fishery stock in the EEZs, the relation between the fish growth and the negotiation procedures is also an interesting point to be investigated. We

will deal with these issues in separate articles.

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| Country | Size of the EEZ (km ²) | Treaty w/Japan |
|---------------------------------|------------------------------------|----------------|
| Australia | 6,384,731 | yes |
| *Kiribati | 3,441,810 | yes |
| *Federated States of Micronesia | 2,996,419 | yes |
| *Papua New Guinea | 2,402,288 | yes |
| *Marshall Islands | 1,990,530 | yes |
| *Solomon Islands | 1,589,477 | yes |
| Fiji | 1,282,978 | yes |
| *Tuvalu | 749,790 | yes |
| *Palau | 603,978 | yes |
| *Nauru | 308,480 | yes |
| New Zealand | 3,468,998 | no |
| Cook Islands | 1,957,430 | no |
| Vanuatu | 663,251 | no |
| Tonga | 659,558 | no |
| Niue | 321,876 | no |
| Samoa | 127,950 | no |

Table 1: The Western and Central Pacific Countries, their EEZs and treaties with Japan

Source: Yearbook of Fisheries 2003 (*SUISAN-NENKAN* 2003), Suisan-sya Co., Tokyo, Japan. (An asterisk [*] indicates the member of the Nauru Agreement.)

| Variables | Pairwise ($h = P$) | Two-stage ($h = T$) | Round-table ($h = R$) |
|-----------|----------------------------|---|-----------------------------|
| π_0^h | $\frac{p^2[K_1 + K_2]}{8}$ | $\frac{p^2[K_1 + K_2]}{8}$ | $\frac{p^2[K_1 + K_2]}{12}$ |
| u_i^h | $\frac{p^2 K_i}{8}$ | $\frac{p^2 K_i}{8} + f \left[\frac{K_j - K_i}{K_1 + K_2} \right]$ | $\frac{p^2[K_1 + K_2]}{12}$ |
| x_i^h | $\frac{p K_i}{2}$ | $\frac{p K_i}{2}$ | $\frac{p K_i}{2}$ |
| w_i^h | $\frac{p}{4}$ | $\frac{p}{4} + \frac{2f}{p} \left[\frac{K_j/K_i - 1}{K_1 + K_2} \right]$ | $\frac{p[K_1 + K_2]}{6K_i}$ |

Table 2: Summary of the results

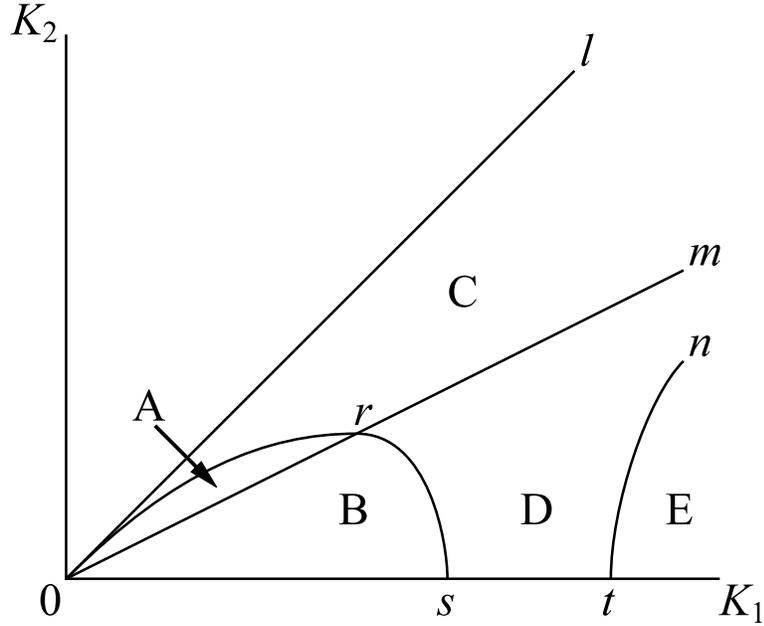


Figure 1: Partition of the K_1 - K_2 plain ($K_1 \geq K_2$)