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Fishing access agreements and harvesting decisions of host and distant water fishing nations

Rachel Nichols [a], Satoshi Yamazaki [a,*], Sarah Jennings [a], Reg A. Watson [b]

[a] Tasmanian School of Business and Economics, University of Tasmania, Private Bag 84, Hobart 7001, TAS, Australia
[b] Institute for Marine and Antarctic Studies, University of Tasmania, Private Bag 49, Taroona 7001, TAS, Australia

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ABSTRACT

The declaration of exclusive economic zones (EEZs) granted coastal states sovereign rights over the marine resources in their EEZs and enabled developing coastal states to legally charge access fees to distant water fishing (DWF) nations for access to the resources in these waters. Despite the potential for economic gains, however, the ability of coastal states to benefit from the granting of sovereign rights and to ensure the sustainable use of their fisheries resources depends on how domestic fishing effort responds to the harvesting decisions of the DWF nations. We develop a stylized bioeconomic model to explore the change in fishing behavior of host and DWF nations when the two nations enter into an access agreement with varying levels of access fee. We further conduct an econometric analysis of changes in Pacific island nations' harvesting behavior in response to the harvest decisions of DWF nations using data from the Western and Central Pacific tuna fishery. Our model results show that there is a range of variable access payment levels over which the host nation substitutes benefits from its domestic fishing activity with access payments from the DWF nation and that setting fees in this range can create a trap whereby host nations are forced to trade-off receiving a fair return to their fishery resources through access fees and retaining their own active fleet capacity. Our empirical analysis further shows a gradual shift in the way in which Pacific island host nations responded to the harvest decision of DWF nations as a result of the creation of the 200-nautical-mile EEZ.

1. Introduction

Many developing countries are highly dependent on their natural resource endowments as a source of economic growth and social development [1]. In the case of developing island nations, marine resources in particular make important contributions to GDP and government revenue, and underpin the primary livelihood, food security and opportunities for an increased standard of living of coastal communities [2–4]. However, both the national economies and food security of these developing island nations are highly vulnerable to changes in the coastal environment and the degradation of marine resources [5–8]. Both the immediate and long-term benefits these island nations derive from sustainably exploiting their marine resources, including fisheries, are thus substantial.

Despite the importance of fisheries, many developing island nations lack the harvesting and governance capacity required to capture the full benefits of the fisheries resources found in their waters by themselves [9,10]. Consequently, for many island nations the majority of income gained from fisheries resources often comes from selling access rights to their waters to fleets belonging to Distance Water Fishing (DWF) nations. The fisheries sector in Kiribati, for example, contributes more than 20% of the country's GDP; yet more than 60% of the total catch in their waters is taken by foreign fleets, and additionally around 40% of the government revenues comprise access fees paid by DWF nations [11].

Developing island nations' ability to charge fees for DWF fleets to access their waters depends on whether island nations have property rights over the resources found in their waters. The third United Nations Law of the Sea Convention (UNCLOS) introduced Exclusive Economic Zones (EEZs) extending 200 nautical miles (nm) from the territorial sea baseline of coastal states. The declaration of EEZs granted coastal states sovereign rights over the marine resources in their EEZs and enabled developing island host nations to enter into access agreements with DWF nations. The number and scope of access agreements worldwide has escalated from the time of the first agreement in 1980, for example the European Union now has access arrangements in place to harvest demersal and migratory species, such as tuna, from the territorial waters of coastal states in the African, Caribbean and Pacific regions [12,13]. Pacific island countries have also entered into access agreements with Japan since the end of

* Corresponding author. Tel.: +61 3 6226 2820.
E-mail addresses: rachel_nichols07@hotmail.com (R. Nichols), satoshi.yamazaki@utas.edu.au (S. Yamazaki), sarah.jennings@utas.edu.au (S. Jennings), R.A.Watson@utas.edu.au (R.A. Watson).

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the 1970s, and with other DWF nations, such as the United States, Taiwan, and the Republic of Korea since the 1980s [11,14,15].

A substantial body of literature explores the effectiveness of existing fishing access agreements for enabling developing coastal states to achieve desired economic benefits from their fisheries resources, and describes their impacts on the development of domestic fishing industry and management capacity [14,16–19]. Furthermore, while the exact terms of access agreements are often not publicly available, many studies have investigated the types and structure of different access agreements worldwide [12,13,15,20].

However, knowledge of the way in which access agreements impact the harvesting behavior of developing island nations and their implications for fisheries exploitation remain largely unexplored in the literature. Our overall aim in this paper is to address this gap, in particular by exploring how host nations respond to the opportunity to secure access payments from DWF nations in return for access to the fisheries resource. To the best of our knowledge, there is no study that quantitatively models and evaluates: first, how different levels of access fee affect the harvesting decisions of host and DWF nations; and second, whether the way in which host nations respond to the harvesting behavior of the DWF nations was affected by the creation of the 200-nm EEZs, and thereby their ability to legally demand payment for access to the resources within their waters.

We address these questions using two approaches. In Section 2 we develop a stylized bioeconomic model in which both host and DWF nation fleets exploit a single fish stock located in the host nation's EEZ, and the DWF nation is required to pay a fee to the host nation for access to the fishery. Using the bioeconomic model we analytically examine the way in which the level of access payments affects the harvest decisions of the host and DWF nations[1]. We further use a parameterized version of our model to simulate steady state levels of effort, and hence total biomass, for the two nations and compare these to the case in which the fishery is exploited by the host nation as a sole operator. In Section 3 we conduct an empirical analysis for the Western and Central Pacific tuna fishery, in which various access agreements for harvesting tuna are in place between Pacific island host nations and DWF nations. Using data spanning the period 1969 to 2010, we explore how the tuna harvesting decisions of the Pacific island host nations were affected by the harvesting behavior of different DWF nations in the host nations' EEZs. We explore the way in which this relationship has changed over time by re-estimating our empirical model for various sub-periods.

2. A stylized bioeconomic model of a fishery with access agreement

2.1. Fishery exploitation with access agreement

Fishing access agreements can be bilateral or multilateral [11] and we consider the case of a bilateral agreement, in which two fishing fleets, belonging to a host (H) and distant water fishing (DWF) nation, both of which exploit a fish stock located in the host nation's EEZ. The biomass dynamics is given as

$$\frac{dx}{dt} = F(x) - h_H - h_{DWF} \tag{1}$$

where x is the size of the fish population, $F(x)$ is the natural growth rate of the population, and h_i is the harvest by nation i's fleet where $i=\{H, DWF\}$. We assume that the natural growth of the population is given as $F(x)=rx(1-x/K)$ where r is the intrinsic growth rate and K is the environmental carrying capacity of the population within the EEZ.

Our interest here is to examine the way in which the host nation maximizes the net benefits from the fisheries resource when they can derive benefit from the fishery either by harvesting the resource themselves or by selling access rights to DWF nations. For the DWF nation to exploit the fish stock in the host nation's EEZ, the DWF nation and the host nation must enter into an access agreement. Such agreements generally require the payment of an access fee comprising two components: a variable fee, which depends on either the DWF nation's catch or gross revenue received from fishing in the EEZ; and a fixed fee, which may include various payments such as development aid, research support and technical assistance [16,20]. We specify the total access fee (AF) as

$$AF = \alpha(Ph_{DWF}) + F \tag{2}$$

where P is the unit price of the fish caught and $\alpha \in [0,1]$ is an access fee parameter which specifies the proportion of the landed value of fish payable by the DWF to the host nation. The term $\alpha(Ph_{DWF}) \geq 0$ therefore represents the variable fee component and $F \geq 0$ is the fixed fee component of the total access fee.

In the presence of an access agreement, the host nation's profit from the fishery (π_H^{AA}) includes the net benefits from fishing and the access payments received from the DWF nation, such that

$$\pi_H^{AA} = Ph_H - C_H E_H + (\alpha Ph_{DWF} + F) \tag{3}$$

where E_H is the fishing effort and C_H is the cost per unit of fishing effort of the host nation. Similarly, the profit of the DWF nation from the fishery (π_{DWF}^{AA}) includes both the net benefits associated with their own fishing in the host nation's EEZ less the amount they are required to pay to the host nation for access to the fishery, that is

$$\pi_{DWF}^{AA} = Ph_{DWF} - C_{DWF}E_{DWF} - (\alpha Ph_{DWF} + F) \tag{4}$$

where E_{DWF} is the fishing effort, and C_{DWF} is the cost per unit of fishing effort, of the DWF nation.

We assume that the harvest–effort relationship is given by the Schaefer production function, i.e., $h_i = qE_i x$, $i=\{H, DWF\}$ where q is the catchability coefficient [21]. For analytical tractability, we confine our analysis to the equilibrium outcome where the level of biomass remains constant over time, such that

$$\frac{dx}{dt} = 0 \Leftrightarrow x = K\left(1 - \frac{qE_{DWF}}{r} - \frac{qE_H}{r}\right) \tag{5}$$

The DWF nation and the host nation both make harvesting decisions to maximize their economic return to fishing in the EEZ[2].

[1] Our stylized bioeconomic model is developed to characterize the interaction between host and DWF nations' harvesting behaviors. The model is specified with the minimum level of complexity needed to achieve this and is not intended to undertake an empirical evaluation of a specific fishery, such as the Western and Central Pacific (WCP) tuna fishery, on which our econometric analysis is based. For example, our model does not incorporate the migratory nature and natural fluctuations of tuna stocks. See Bertignac et al. [37], Chand et al. [38], and Kompas et al. [39] for bioeconomic models specifically developed for the WCP tuna fishery.

[2] We assume profit-maximizing behavior for both the host and DWF nation in the knowledge that other objectives may guide harvesting decisions. While fishing profit is a major driver of global fishery development [40] and fleet behaviors [41], broader social, economic and political considerations, including food security and supporting artisanal fishing livelihoods, may affect the harvesting decisions of both nations. We also assume that the host nation's ability to exploit the resource, either in conjunction with the DWF nation under an access agreement or as a sole operator (Section 2.2), is not constrained by a lack of fishing capacity or access to technology. We note these considerations as limitations to our study and suggest possible extensions in our concluding remarks.