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Management of fisheries resources in Morocco and access modes : The anticommons model for the Octopus fishery

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Abstract

International fish stocks are mostly overexploited due to overfishing and governance inefficiency. The fishery management failure has negative consequences upon the resource valuation and sustainability. Imperfection in coordination is among the reasons of this management failure. This paper looks at the coordination problems in the context of Moroccan Octopus fishery. Among the causes of the coordination imperfection is anti-commons, which refer to shared knowledge and expertise among disconnected and separated decision makers. We used a theoretical economic model developed by Driouchi and Malki (2011). The most estimated parameter coefficients are significant at 1% and 5% levels. The Lerner index and the conjectural variation elasticity values indicate that the Octopus market is imperfect which confirms the prevalence of anti-commons effects. The Octopus supply is concentrated in a handful number of operators, which own large numbers of fishing vessels. These owners have succeed to impose their decisions in relation to fishery management.

Keywords: anticommons, coordination, fisheries, Octopus, management, market collusion.

Introduction

Fishing is an economic activity that generates significant added value and contributes to job creation. It also plays a vital role in improving health and reducing poverty (FAO, 2014). In Morocco, the value of fish production in 2014 was around 10.74 billion dirhams, which represents 2 to 3% of GDP (MPM, 2015). However, most stocks are threatened by overexploitation due to overfishing and poor governance (FAO, 2014 and OECD, 2014).

The sustainability of fisheries resources will only be ensured through management systems that can adapt the level of fishing pressure to the optimal stock level. The main control variable for this is fishing effort. The fisheries management failure has negative repercussions on the valuation of resources and their sustainability. The reasons for this failure are multiple and not sufficiently understood. The failure or imperfection of coordination are to be mentioned among these reasons.

This study aims to elucidate the problems related to coordination in the Octopus fishery. This was introduced as a response to the fragmentation of decisions. The anticommons are among the reasons for coordination failure (Driouchi, 2016). While in the commons all members of the community have the free right to use common and rare resources and no one can exclude other members, anticommons refers to the situation where several co-users hold rights to exclusion from each other regarding the use of resources, but no one can effectively use this resource.

The Octopus fishery is a composite fishery consisting of three distinct segments. It is managed by the Department of Marine Fisheries and is based on the quota system. The exploitation of this fishery has been marked by the divergence of interests of economic operators, which has led to the overexploitation of Octopus stocks. The interests of the major operators of Octopus fishery have predominated decisions to preserve the resource. This situation had caused the failure of important decisions taken by the Department of Fisheries, namely those relating to biological rest, quota allocation, price policy and plans for the management and restructuring of the Octopus fishery. These failures highlight the imperfection of coordination between the various economic operators in the fisheries sector. The latter have thus endured high private and social costs through several financial, economic and social crises.

The results obtained led to the conclusion that the failure of decision-making in the Octopus growing fishery was the result of insufficient coordination mainly due to an anticommons situation where fishing operators holding exclusion rights, end up blocking the management of the octopus fishery. As a result, stocks are depleted and resource use is inefficient. We tested the imperfection of the Octopus market, thus confirming the prevalence of anticommons.

This study is structured in five main parts. The first part examines the situation of the anticommons and its implications in relation to the modes of access to common resources in the context of fisheries management policy in Morocco. The analysis of the characteristics of the Octopus fishery and its comparison to the anticommons will constitute the second part. Then, we will discuss the working methodology adopted and the main results obtained. We conclude with a discussion.

I- ANTICOMMONS AND RESOURCE ACCESS MODES IN THE CONTEXT OF FISHERIES MANAGEMENT POLICY

Fisheries management aims to maintain stock productivity by adjusting fishing effort to the rate of stock growth. The scarcity of fishery resources is linked to the flow of the stock, limited by the maximum capacity of the environment. Any extraction greater than this stream could threaten the resource with extinction. Is good fisheries management, therefore, necessary to ensure the sustainability of fisheries resources?

Management systems can take many forms depending on how resources are accessed. A distinction is made between open access, private access, commons and anticommons. Open access is where no one has the right to exclude others or the responsibility to preserve the resource. Operators exploit the resource without taking into account the negative externalities related to stocks up to the point where the rent is completely dissipated. This management system often leads to the tragedy of the commons. The mode of private access is the opposite situation of open access, in which a single operator owns part or all of the resource (in the case of sedentary resources) and holds the exclusive right to exploit it. In some situations, private access assumes the existence of several agents, each owning a distinct portion of the 'divisible' resource, such as resources that live in the sand or are fixed on a substrate: shells, algae, coral.

Commons refer to different institutional arrangements or governance systems in which resources are used jointly by all or some of the members of a community and according to specific rules (Driouchi, 2013; Lametti, 2013; Caffentzis, 2012; Coelho et al., 2009; Ostrom, 2008; Muzner, 2005). Members of the community exercise exclusion rights vis-à-vis non-members. Users of common resources participate in the decision-making process on the definition of management arrangements but cannot exclude other members from the use of resources. The commons under the open access regime can lead to the tragedy of the commons. The state regulates the level of fishing effort through taxes or tradable quotas in order to avoid this tragedy.

The anticommons are a symmetrical image of the commons and refer to the situation where exclusive rights are added to user rights. Several co-users have exclusion rights vis-à-vis each other regarding the use of a scarce common resource, but no one can effectively use this resource. These exclusion rights or veto powers held by resource users are likely to block the decision-making process, thus limiting the chances of successful fisheries management. The individual maximizing behaviour of users is revealed by separate and disconnected decisions. However, the interferences and interdependencies between these decisions would entail high private and social costs that could hamper opportunities for innovation in fisheries governance.

In Morocco, maritime fisheries policy is articulated around fisheries management plans and the establishment of consultation structures between the administration, the profession and research. These plans are essentially based on the regulation of inputs and outputs and the granting of rights to use fishery resources: licenses and TACs (Total Allowable Catches) divided into individual quotas.

The Octopus management plan is the first plan introduced in 2001. The Octopus fishery is at the top of economically important fisheries, since the value of Octopus catches in 2014 reached 3551 million Dirhams, or 33% of the total value of catches (MPM, 2015). Despite its economic importance, the Octopus fishery has experienced management difficulties resulting in a sharp drop in the Octopus stock of around 80% in 2003 (INRH, 2004). The failure and the blocking of decisions, in particular the approval of the new fisheries Code, are among the consequences of the failure of the managerial process. Offshore shipping companies consider the Octopus resource as a national resource, the overexploitation of which would threaten their interests as the first incumbent operators of the fishery and the heavy investments deployed. However, the freezing units representing the interests of the artisanal segment, consider Octopus as a territorial resource and defend the legitimacy of its exploitation by the artisanal segment (Vegouilla, 2010).

These conflicts of interest between public and private actors, in a situation where the Octopus stock is in an advanced state of overexploitation, would contribute to the emergence of the effects of anticommons in the form of collusive behaviour. Indeed, economic operators have grouped together in powerful professional associations in order to exercise their powers and impose government decisions on the management of the Octopus fishery. They aimed to protect and maintain their market share in order to make their investments profitable.

Moreover, the scarcity of the Octopus resource and the multitude of public and private stakeholders would induce high private and social costs related to the fragmentation of decisions and the efforts made for their monitoring and evaluation, especially in the absence of coordination. This would lead to inefficient use of resources. In the case of the Octopus fishery, this situation manifested itself in financial and social crises that affected almost all economic operators. Indeed, the year 2004 saw the exit of a third of the Octopus freezing units, which were converted to the exploitation of small pelagic and in 2014 leading companies in the offshore segment liquidated part or all of their fleets. This is mainly due to the state of continuous collapse of already weakened stocks combined with the non-viability of economic operators. Which refers to the consequences of the tragedy of the anticommons.

This study will try to elucidate the reasons for the failure of the management of fisheries resources, in particular the problems related to imperfection or the absence of coordination in a context where the sustainability of stocks is threatened. We believe that the divergence of the interests of the various economic operators, in relation to the search for protection and maintenance of market shares, would have contributed to the state of continuous collapse of the resource, to the financial and economic losses of the operators and at high social costs. Could the collusive behaviour of economic operators and the interdependence of their decisions have acted as obstacles to the good management of Octopus resources? Could there be an anticommons situation in the fisheries sector? If so, what would be its implications for the governance of fisheries resources, innovation and economic development?

In order to test these hypotheses, we will conduct an empirical test on the market structure by estimating the Lerner index. This would make it possible to test the hypothesis of equality of the marginal cost with the price of the output. The goal is to check the imperfection of the Octopus market in the case of oligopolistic competition thus confirming the existence of anticommons.

II- THE OCTOPUS FISHERIES IN MOROCCO AND THE LINKAGE WITH THE ANTICOMMONS

II-1- Overexploitation of cephalopod resources, a governance problem?

The Octopus stock in southern Morocco is characterized by its fragility and instability (INRH, 2016). It could not be reconstituted after a long period of overexploitation, in particular the very advanced state of collapse that occurred in 2003. Because of this crisis, 29 freezing units threatened with bankruptcy in 2004 left the Octopus fishery and several offshore shipping companies suffering from financial difficulties, have immobilized or liquidated part or all of their fleets. The OMP Group (Ominium Marocain de Pêche) for example, owner of 54 cephalopod boats ceased operations for two years (2012-2013), UMEP (Union Maroc Emirates Arabes Unis de Pêche) owner of 9 cephalopod boats changed ownership following a harsh social dispute, and the MARONA Company sold its fleet of 40 cephalopod boats to several buyers.

This financial and economic crisis had emerged since 1994. After several management measures, the government finally introduced the first management plan for the Octopus fishery in 2001. This plan, revised in 2004, is mainly based on the allocation of individual quotas and the reduction of fishing capacity. However, the latter could not solve all the problems related to the management of the Octopus fishery. An attempt by the Ministry of Maritime

Fisheries, MPM, to strengthen the Octopus Fishery Management Plan in 2010 was doomed to failure.

The Octopus fishery is made up of three main segments: the offshore segment, the coastal segment and the artisanal segment. Its exploitation was at the beginning carried out exclusively by a foreign fleet. After its independence, Morocco encouraged the installation of a national fleet in order to compete with the foreign fleet. Access to the resource was subject to obtaining a fishing license. This is granted to national private operators, on the sole condition of holding at least half of the company's capital. Substantial subsidies and financial and tax benefits have been granted to Moroccan offshore shipping companies with the aim of acquiring fishing means. As a result, the national offshore fleet rapidly proliferated during the 1970s and 1980s, growing from 4 companies in 1973 to 228 companies in 1984.

The establishment of the Exclusive Economic Zones, EEZ, under the jurisdiction of the States within the framework of the United Nations Convention on the Law of the Sea in 1982, conferred on Morocco the right to manage the marine resources, which are in its EEZ and the responsibility for their preservation. The Moroccan government thus created in 1984 a Ministry of Maritime Fisheries (MPM) in order to ensure good governance of the fisheries sector and relaunch its development. During this period, the interests of Moroccan shipping companies were represented and defended by APAPHAM (Professional Association of Offshore Fishing Ship-owners in Morocco) created in 1978. Companies that did not benefit from state subsidies were later formed in association with Chinese. These are Moroccan ship-owners Companies with mixed Moroccan-Chinese capital. This type of association has benefited, on the one hand, foreigners excluded from fishing agreements to access Moroccan cephalopod resources and, on the other hand, Moroccans as a means of exploiting their fishing licenses and acquiring fishing boats. These so-called mixed companies were grouped together in the Moroccan Union of Offshore Fishing Ship-owners, UMAP, created in 1989. The creation of UMAP constitutes a first fragmentation in the interests of Moroccan operators of the cephalopod fishery.

II-2- Actors in the Octopus fishery and fragmentation of decisions, a coordination challenge

The largest Moroccan offshore shipping companies are affiliated with APAPHAM, notably OMP (54 boats), MARONA (40 boats) and SPSA (20 boats). These companies possess high political and economic power in comparison with UMAP companies. This latter association is made up of 67 small companies with mixed Moroccan-Chinese capital, i.e. 20% of the national fleet. As for the foreign fleet, it defended its interests through fishing agreements (Table 1).

Table 1: Characteristics of private offshore fishing operators (1990s)

	National fleet		Foreign fleet
	APAPHAM	UMAP	
Creation	1978	1989	1960
Operators	Biggest Moroccan companies (owning 20 to 54 vessels)	Small Moroccan companies (owning a maximum of 3 vessels)	Community vessels
Investments	Government subsidies	Moroccan-Chinese mixt capital	Foreign capitals
Resource access	Fishing licences	Fishing licences	Agreements and fishing licences
Number of vessels	324	67	150

Due to the scarcity of Octopus resources noted during the late 1980s, the first biological rest period was introduced in 1989 and the number of authorized Moroccan boats was limited in 1991 (freeze on investments to obtain new deep-sea and coastal fishing vessels). Despite these measures, the Octopus fishery is experiencing a drop in international prices for cephalopods and a reduction in boat yields. The effects of the withdrawal of Moroccan ships to national ports have worsen the situation of the majority of shipping Companies which were enduring financial difficulties threatening them with bankruptcy. APAPHAM considered this financial situation a crisis in the fisheries sector, threatening the sustainability of resources and requiring government intervention. On the other hand, UMAP considers that the difficulties of large companies were linked to the managerial failure of the companies in question and not to the economic situation of the Octopus fishery. The companies affiliated to UMAP were not in financial difficulties. These two visions relating to the situation of the Octopus fishery had consequences on the decisions taken by the MPM with regard to the management of this fishery (L'Économiste edition n° 71 of 03/18/1993).

APAPHAM was able to convince the MPM of the urgent need to find solutions to their financial difficulties in order to get their companies out of this crisis. For this, a restructuring plan was implemented under pressure from APAPHAM. This plan was criticized by the UMAP, which did not participate in its designing because of its marginalization during the negotiations with the MPM. UMAP was considered not affected by the crisis in the sector since the mixed capital companies were not confronted with the problems linked to financial difficulties. In addition, at the request of APAPHAM, the MPM reduced the duration of biological rest to allow boats to increase their catches (L'Économiste edition N° 77 of 04/29/1993).

The continued fall in yields in terms of CPUE (Catch Per Unit Effort), despite a slight improvement in prices, has prompted Moroccan offshore ship-owners to

unite and put pressure on the foreign fleet in order to reduce the fishing effort. This action would, according to the national ship-owners, reduce the pressure on the resource in order to ensure better yields. APAPHAM and UMAP then united by forming a single association ACM (Association of Moroccan Cephalopods), fighting against the renewal of the cephalopod fishing agreement with the European Community (EC). Consequently, the MPM gradually reduced the number of foreign boats until 1999 when it decided not to renew the fishing agreement with the EC.

Alongside this situation, new private operators have emerged, namely small-scale boats installed thanks to funding from industrial freezing units and coastal fishing boats. The freezing units were able to establish themselves as representing the interests of the artisanal fishing segment. These units have organized themselves into the Association of Seafood Manufacturers of Oued Eddahab, AIPMOD. Their number increased from 4 units in 1994 to more than 70 units in 2004. The majority of these units belong to Sahrawi notables or politicians with the power to influence the decision of the MPM. Coastal fishing is also represented by professional organizations but which did not have the same bargaining power as offshore and artisanal fishing.

Influenced by the continuous fall in prices and the collapse of the resource, the ACM imposed itself again but this time to extend the duration of the biological rest and eliminate the artisanal boats, the majority of which have proliferated without authorization. The ACM and the AIPMOD criticize each other on the responsibility and the causes of the crisis and the legitimacy of the exploitation of the resource (L'Économiste, 04/12/1997). In addition, members of the ACM did not all agree on the measures of the MPM. Conflicts between big and small professionals were already beginning to arise. The ACM therefore split in 2001 into two associations, the former APAPHAM and the UPEC, which was against some measures of the MPM. Due to this fragmentation between the interests of professionals, two five-year plans failed and the fisheries code, which mainly provided for social benefits, could not be approved. However, the imposition of the AIPMOD resulted in the integration of artisanal fishing as the main actor in the decision-making process and the regulation of the situation of artisanal boats (Re-registration).

The Octopus Fishery Management Plan of 2001 puts an end to the showdown between offshore fishing and artisanal fishing operators. It is a plan based on setting the ceiling for catches and the distribution of the TAC based on the history of catches between the three segments of the fishery (51% for the offshore segment, 32% for the artisanal segment and 7% for the coastal segment).

Furthermore, price negotiations on the international market were in favour of freezing units because of the delay in the marketing of production. Offshore

fishing companies were in a weak position when it came to negotiating prices. The latter were able to impose a Marketing and Price-Monitoring Plan on the MPM. It is a plan that set a minimum export price and the date of Octopus marketing coinciding with the period of landing of offshore boats (end of the fishing season). It also establishes the extension of the duration of biological rest, thus making it possible to reduce the operating costs of offshore vessels induced by the increase in fuel prices. However, this marketing plan was strongly criticized by freezing units because of costs and insufficient storage capacities. This is the reason why this marketing plan failed.

The Octopus stock having recorded its biggest fall in 2003 (decrease of more than 80% according to the INRH). Consequently, the operators were forced to stop their fishing activity for more than 7 months. Freezing units in financial difficulty have been forced to convert to small pelagic fishing. Faced with this state of stock collapse and economic and social crisis, the MPM reviewed the Octopus Fishery Management Plan, implementing new measures. These are mainly : a) individual quotas 'transferable' only between boats of the same company ; b) a new allocation key adjustment of the TAC (63% for the offshore segment, 26% for the artisanal segment and 11% for the coastal segment) ; c) the reduction in the number of coastal boats and artisanal boats, and d) the establishment of four new consultation and monitoring commissions, the most important of which is the biological watch commission.

These measures have been criticized by operators in the coastal and artisanal segment who have been excluded from the negotiations for the development of these new measures. The small operators as well as the representatives of the sailors excluded from the negotiations also expressed their disagreements. Consequently, AIPMOD withdrew from negotiations with MPM, which it considered unfair and marginalizing the artisanal segment. This crisis has been exacerbated by the proliferation of illegal fishing due to insufficient control and the refusal of professionals to align themselves with the measures.

The failure of the Octopus fishery management measures on the biological, economic and social levels, pushed the MPM to generalize the biological rest of the Octopus and the individual quotas on all the Moroccan coast and to reinforce the control (INN: Illegal, unregulated and unreported fishing and VMS). Strengthening the Octopus fishery management plan (PAP) was also studied by the MPM in consultation with the profession. This new enhanced PAP aimed to adjust overall capacity and strengthen fishing rights through the market. However, this MPM initiative was blocked in its embryonic phase.

This failure in the decision-making process is the result of the absence or insufficient coordination and which could be due to an anticommons situation where fishing operators holding exclusion rights end up blocking the management of the Octopus fishery. This may tend towards a tragedy of the

anticommons characterized by inefficient use of resources and limited opportunities for innovation. The anticommons can manifest themselves in a form of collusion where operators could control prices or their market shares. The main purpose of this study is therefore to verify the existence of a situation of anticommons through the analysis of the market structure and the test of existence of market power in the case of the Octopus fishery.

III- METHODOLOGY

III-1- The theoretical framework

The theoretical corpus that will be mobilized is based on neoclassical theories of institutional economics, in particular the economics of law and public choices applied to common resources, as well as theories related to costs and profits. The recent theory of anticommons will also be used through the model of anticommons.

a- Anticommons model

The management policies for these resources involve several public and private economic actors. The interdependencies between these actors and the interference of their activities would lead to high private and social costs in the absence or insufficiency of coordination, thus leading to market failure. The problems related to anticommons would be among the causes of this situation. The anticommons are characterized by the fragmentation of decisions, the increase in cost and the inefficiency of the use of resources.

In order to elucidate the effects of anticommons in relation to the imperfection of markets and their implications for the governance of fisheries resources, we adopt in this study, the model of anticommons developed by Driouchi and Malki (2011). This model highlights the existence of problems related to anticommons in the case of the oligopolistic market.

It is a simplified theoretical model that integrates different market structures and several agents with exclusion rights. This theoretical model assumes the linearity of the aggregate inverse demand function for goods and services.

According to Driouchi and Malki (2011), the inverse demand is expressed by the following formula :

$$P = \alpha - \beta Y$$

Where:

P : prices

Y : quantities

α : intersection with ordinate axis

β : positif coefficient

Agents maximize their profits under the condition of zero production costs : $\pi = PY$. The first-order conditions of the profit maximization problem $\pi' = 0$ would make it possible to determine the optimal solutions of prices, P^* , and quantities, Y^* . The authors considered four market structures under the situation of anticommons (number of agents ranging from 1 to n), namely : Perfect competition, monopoly, duopoly and oligopoly (Table 2).

Table n°2 : Market structures and optimal solutions in relation to anti-commons

Market structures	Optimal solutions
Perfectly competitive	$\max_Y \pi = PY \rightarrow P^* = 0 \text{ and } Y^* = \frac{\alpha}{\beta}$
Monopoly (sole agent)	$\max_Y \pi = (\alpha - \beta Y)Y \rightarrow P^* = \frac{\alpha}{2} \text{ and } Y^* = \frac{\alpha}{2\beta}$
Duopoly (two agents)	$\max_{y_1} \pi_1 = (\alpha - \beta(y_1 + y_2))y_1$ $\max_{y_2} \pi_2 = (\alpha - \beta(y_1 + y_2))y_2$ $\rightarrow P^* = \frac{\alpha}{2} \text{ et } Y^* = (y_1 + y_2)^* = \frac{\alpha}{2\beta}$
Commons with n agents (open access)	$\max_{y_i} \pi_i = P y_i = (\alpha - \beta \sum_{i=1}^n y_i) y_i \text{ given } Y = \sum_{i=1}^n y_i$ $\rightarrow Y^* = \sum_{i=1}^n y_i = \frac{n\alpha}{(1+n)\beta} \text{ and } P^* = \frac{\alpha}{1+n}$ <i>When $n \rightarrow \infty$, then $Y \rightarrow \frac{\alpha}{\beta}$ et $P \rightarrow 0$</i>
Anticommons with n agents ($i = 1, 2, \dots, n$)	$\max_{p_i} \pi_i = p_i Y = p_i \left(\frac{\alpha}{\beta} - \frac{1}{\beta} \sum_{i=1}^n p_i \right) \text{ given } P = \sum_{i=1}^n p_i$ $P = \sum_{i=1}^n p_i = \frac{n\alpha}{(1+n)} \text{ and } Y^* = \frac{\alpha}{(1+n)\beta}$ <i>When $n \rightarrow \infty$; then $P \rightarrow \alpha$ et $Y \rightarrow 0$</i>

Source : Driouchi, 2013

This anticommons model with 'n' agents shows the expected results of an anticommons situation. Indeed, the existence of several operators (Very high number) with each having a right of exclusion vis-à-vis the other operators, leads to an underuse of resources (Y tends towards zero) with costs or prices very high (Driouchi and Malki, 2011). In the situation of anticommons, the optimization behaviour of the operators is done through the choice of prices.

Anticommons issues have been studied in several areas, including biotechnology, agriculture, health, business development, media and fisheries.

The oligopoly structure is likely to manifest the effects of the anticommons when the number of exclusionary rights is high. The resulting market imperfection in this case provides information on the existence of anticommons and the need for better coordination. The implicit private and social costs would be high and the quantities produced would tend towards zero.

b- Supply and demand equations and market power

Suppose that the behaviour of fishing operators would be to minimize their production cost function, $C(Y, w_i)$, under the constraint of a production level given, $Y(P, w_i)$, using n inputs x_i , with $i = 1, \dots, n$ (producer dual problem). P represents the price of output Y and w_i the price of input x_i . According to the Lemma of Shephard, the input demands x_i are represented by the following equations :

$$x_i = \frac{\partial C(Y, w_i)}{\partial w_i}$$

Let us also consider that these fishing operators produce a homogeneous output $Y(P, w_i)$ and set as their objective the maximization of their profits :

$$\pi = P(Y) * Y(P, w_i) - C(Y, w_i)$$

Under the oligopoly condition, the optimality conditions of the maximization behaviour allow to derive the relation between the price and the marginal cost:

$$P = \frac{1}{(1 - \theta/\eta)} (\partial C(Y, w_i) / \partial Y)$$

P represents the output supply equation. θ denotes the elasticity of conjectural variation and is the price elasticity of demand for output. We assume θ fixed and equal for all operators of each segment (within the same category of operators). This elasticity is used to test the existence of market power. $\theta=0$ in the case of a market in perfect competition implying the equality of price at marginal cost and $\theta=1$ in the case of a monopoly. Values between 0 and 1 correspond to the oligopoly situations.

The demand for output is assumed to be a Marshallian demand function : $Q = Q(P, Z, R)$ which depends on the price of output, P , the price of substitute goods, Z , and income, R .

The combination of the supply function with the demand makes it possible to know the level of competitiveness of a market. The supply's response to a change in the demand will depend on the structure of the market. The estimate of some parameters of the demand and supply equations would require the introduction of other equations. This is why we have integrated the system of

equations relating to input demands. Therefore, the final system to be estimated will consist of the following equations:

$$\begin{cases} x_i = \frac{\partial C(Y, w_i)}{\partial w_i} & ; i = 1, \dots, n \\ P = \frac{1}{(1 - \theta/\eta)} (\partial C(Y, w_i)/\partial Y) \\ Q = Q(P, Z, R) \end{cases}$$

III-2- The empirical model to be estimated

In order to be able to test the existence of anticommons in the fisheries sector, we took as an example the Octopus fishery in Morocco. For this, we carried out a test on the Octopus market structure. We believe that imperfection at the market level would confirm the existence of anticommons that we can highlight through the estimation of the oligopoly power exercised by fishing operators.

Market power can be assessed by estimating the Lerner index and the elasticity of conjectural variation. The latter reflects the market reaction anticipated by an operator when he increases the quantity of the good produced, while the Lerner index provides information on the existence of oligopoly power and therefore makes it possible to characterize the structure of the market.

The functional form retained for the cost function is the flexible form Translog represented by the following logarithmic function:

$$\begin{aligned} \ln C(w_i, Y_k) = & \alpha_0 + \sum_{i=1}^4 \alpha_i \ln w_i + \sum_{k=1}^2 \gamma_k \ln Y_k + \frac{1}{2} \sum_{i=1}^4 \sum_{j=2}^4 \alpha_{ij} \ln w_i \ln w_j \\ & + \frac{1}{2} \sum_{k=1}^2 \sum_{l=1}^2 \gamma_{kl} \ln Y_k \ln Y_l + \frac{1}{2} \sum_{i=1}^4 \sum_{k=1}^2 \beta_{ik} \ln w_i \ln Y_k \end{aligned}$$

$C(w_i, Y_k)$ is the cost function depending on input prices w_i , where i takes K for Capital, L for Labor, E for fuel and M for intermediate consumptions and output quantities Y_k ($k = O$ for octopus and $k = F$ for associated fish).

$\alpha_0, \alpha_i, \gamma_k, \alpha_{ij}, \gamma_{kl}$ and β_{ik} are the parameters of the cost Translog function.

We have chosen this function since it allows us to directly derive the requested input shares, it imposes relatively little constraints on the levels of elasticity and returns to scale and incorporates enough parameters to take into account the interactions between the variables and the nonlinearity in these parameters (Bjorndal and Gordon, 2000 and Weninger, 1998).

The following restrictions are imposed on the cost function so that it respects the conditions of concavity, monotony and degree of homogeneity equal to one:

$$\sum_i \alpha_i = 1, \quad \alpha_{ij} = \alpha_{ji}, \quad \sum_j \alpha_{ij} = 0, \quad \sum_k \beta_{ik} = 0, \quad \beta_{ik} = \beta_{ki}, \quad \gamma_{kl} = \gamma_{lk}$$

In the case of the Translog function, the conditional demands of the inputs are not linear with respect to prices, but the shares of the requested inputs are. They are represented by the following equations $S_i(w_i, Y_k)$:

$$S_i(w_i, Y_k) = \frac{\partial \ln C(w_i, Y_k)}{\partial \ln w_i} = \alpha_i + \sum_{j=1}^4 \alpha_{ij} \ln w_j + \sum_{k=1}^2 \beta_{ik} \ln Y_k$$

Fishing vessel owners minimize the costs of their vessels under the constraint of their production levels. They are also price-takers and face Octopus market prices. In equilibrium, these prices are related to quantities by the following supply and demand equations:

Supply equation linking price and marginal cost with the Lerner index

$$P = \frac{C}{Y_1} [\gamma_1 + \gamma_{11} \ln Y_1 + \gamma_{12} \ln Y_2 + \beta_{11} \ln w_1 + \beta_{21} \ln w_2 + \beta_{31} \ln w_3 + \beta_{41} \ln w_4] / (1 + \theta/\eta)$$

P is the price of Octopus, θ is the elasticity of conjectural variation and is the price elasticity of demand for output. C stands for the cost of production.

The output demand equation is of the form Cobb-Douglas represented by:

$$\ln(Q) = \tau + \rho \ln(P/CPI) + \delta \ln(CPIF) + \varphi \ln(GDP)$$

Q represents the quantity of Octopus demanded by Japan, Morocco's largest importer, CPI is the consumer price index for Japan, $CPIF$ is the consumer price index for fish as an estimate of substitute products and GDP is Japan's gross domestic product representing the level of Japanese consumer spending.

a- Octopus fishery operators and selected variables

In the Octopus fishery, there are three distinct types of operators : offshore, coastal and artisanal. Offshore shipping companies use high-capacity freezer trawlers (>150 GT, Gross Gauge Tonnage), coastal companies use deep sea trawlers medium capacity (between 10 and 150 TGB) and the artisanal fishers use small boats with a capacity of 2 TGB and freezing units on land.

These three categories of operators therefore have very different cost structures. For this reason, each category is treated separately for testing market power. Therefore, we have used the following fixed and variable costs : Fixed costs linked to the capital invested (boat, motor, fishing gear and

navigation equipment) and those linked to work (vessel crew numbers, either paid by wages or fixed shares of vessel income). Variable costs are made up of fuel costs consumed by boat, costs varying with the duration of the trip (fishing days) in particular expenditure on maintenance (engine and gear) and food and costs varying with the level of catches including packaging, small equipment, ice, etc.

The Octopus fishing activity is carried out during two fishing seasons. Offshore fishing operators sell their product directly in the international market (Japan and Europe). Coastal and small-scale fishing operators sell their fresh products at national markets (markets managed by the National Fishing Office, ONP), to freezing units (43 in number) which are responsible for freezing these products for resale in the international market (Japan and Europe).

b- Data used

In order to test the imperfection of the market in relation to anticommons, the starting hypothesis to be tested is the equality of the elasticity of the conjectural variation to zero :

$$H_0: \theta = 0$$

The verification of this hypothesis implies the imperfection of the market confirming the prevalence of anticommons in the Octopus fishery.

Let us also consider for each of the three segments of the Octopus fishery, four main inputs ($i=K,L,E,M$), which are Capital (K), Labor (L), Energy (E) and non-energy intermediate consumption (M) to produce two categories of output ($k=O,F$): Octopus (O) and the group of associated fish (F).

In order to avoid the singularity of the variance-covariance matrix (non-invertibility), an equation of production input demands was eliminated. We have chosen to eliminate the equation for non-energy intermediate consumption (M). The estimation results are independent of the eliminated equation (Christensen and Greene, 1976). By introducing the various restrictions concerning the Translog cost function, we will have to estimate the following system of five equations (Reynès and Yeddir-Tamsamani, 2009):

$$\left\{ \begin{array}{l} S_K = \alpha_K + \alpha_{KK}(\ln w_K - \ln w_M) + \alpha_{KL}(\ln w_L - \ln w_M) + \alpha_{KE}(\ln w_E - \ln w_M) + \beta_{KO}(\ln Y_O - \ln Y_F) \\ S_L = \alpha_L + \alpha_{KL}(\ln w_K - \ln w_M) + \alpha_{LL}(\ln w_L - \ln w_M) + \alpha_{LE}(\ln w_E - \ln w_M) - \beta_{KO}(\ln Y_O - \ln Y_F) \\ S_E = \alpha_E + \alpha_{KE}(\ln w_K - \ln w_M) + \alpha_{LE}(\ln w_L - \ln w_M) + \alpha_{EE}(\ln w_E - \ln w_M) + \beta_{EO}(\ln Y_O - \ln Y_F) \\ P = \frac{C}{Y_O} [\gamma_O + \beta_{KO}(\ln w_K - \ln w_L) + \beta_{EO} \ln w_E + \beta_{MO} \ln w_M + \gamma_{OO} \ln Y_O + \gamma_{OF} \ln Y_F] / \left(1 + \frac{\theta}{\rho}\right) \\ \ln(Q) = \tau + \rho \ln\left(\frac{P}{CPI}\right) + \delta \ln(CPIF) + \varphi \ln(GDP) \end{array} \right.$$

To solve this system of equations, we used the Seemingly Unrelated Regression (SUR) method, which has the advantage of taking into consideration the interdependencies between the residuals of the nonlinear equations estimated simultaneously.

The Lerner index is estimated from the supply equation, which links the price of the output to the marginal cost. This index is equal to the ratio between the elasticity of the conjectural variation and the price elasticity of demand for the output. The estimated value of the elasticity of the conjectural variation, θ , makes it possible to determine the market structure and to highlight the market power of ship-owners, thus confirming the existence of anticommons. This test will be conducted for the three segments of the Octopus fishery.

The data relating to the quantities and the price of Octopus are published in the annual reports of the administrations in charge of managing fishing activities. These include in particular : La Mer en Chiffres, Activity Reports and reports of the Biological Watch Commission as well as the statistics published on the website of the Department of Maritime Fisheries, www.mpm.gov.ma ; As well as the Statistical Reports on coastal and artisanal fishing in Morocco published by the National Fisheries Office (www.onp.ma). These data are also available on a monthly basis in FAO reports (Globefish Commodity Update, Cephalopods, FAO). The prices are recorded in Dirhams (Dh) and the quantities in Kilograms.

The various costs are estimated from field surveys of fishermen or boat owners. They are evaluated in terms of expenses per boat in relation to : Insurance, repairs and financial charges in Dh per year, as an estimate of the value of the ship, crew costs of the ship in Dh per month or per day for artisanal boats, fuel costs in Dh per litre and the intermediate consumption of the ship (total value per boat and per trip in Dh, expenses in terms of food, engine and gear maintenance, packaging, ice, small equipment, etc.)

The price indices are used to estimate the price of the ship and the price of intermediate consumption. The ship price index is equal to the ratio between the value of expenses for insurance, repairs and financial charges divided by the value of the ship's TGB. The intermediate consumption price index is equal to the total value of expenditure divided by the number of days at sea for the boats.

The data used in the econometric estimation represent 93 boats including: 31 offshore freezer boats, 31 coastal boats and 31 artisanal boats. We also used the boat commissioning data in order to be able to extract the capacity units of the boats in terms of TGB.

IV- RESULTS

The analysis of the correlation matrices of the three segments of the Octopus fishery revealed a strong correlation between the wage, w , and the output, Y , of artisanal segment (Figure 1). We have therefore eliminated the salary for the artisanal segment. This will avoid the problems related to the multi-collinearity of the variables. The linear equations, of the shares of inputs and of the demand for output, are globally significant, their adjusted R^2 are high except for the coastal segment where the R^2 of the S_K equation is abnormally negative (Table 3). With regard to the nonlinear supply equation, P , the normality of the residuals is respected. The Shapiro-Wilk test gives probabilities, p -value, well above 5%. The non-correlation of the residuals is deduced from the error correlation graphs (Figure 2).

The majority of the estimated parameters of the system of equations are significantly different from zero at the 1% and 5% threshold. The values of the elasticity of conjectural variation and the price elasticity of demand for output are significant at the 1% level. The income elasticity of demand for output is also significant at the 1% level, but the elasticity of substitution of demand for output is not significant. Relating to the parameters of the input share equations, which will be used to calculate the elasticities of the demand for inputs, they are for almost all of them significant.

The elasticity of conjectural variation reflects the operator's anticipation of the proportional change in the output at the market level, in response to the proportional change he exerts on his own output. It is equal to -0,7401, -0,6839 and -0,7294 respectively for the offshore, coastal and artisanal segments (Table 4). We can derive the value of the Lerner index which is the ratio between the elasticity of the conjectural variation and the elasticity of demand for output, $L = \frac{\theta}{\rho}$, it is equal to -0.9968, -0.9965 and -0.9997 respectively for offshore, coastal and artisanal segments. The price and income elasticities of output demand for the three segments are reported in Table 5.

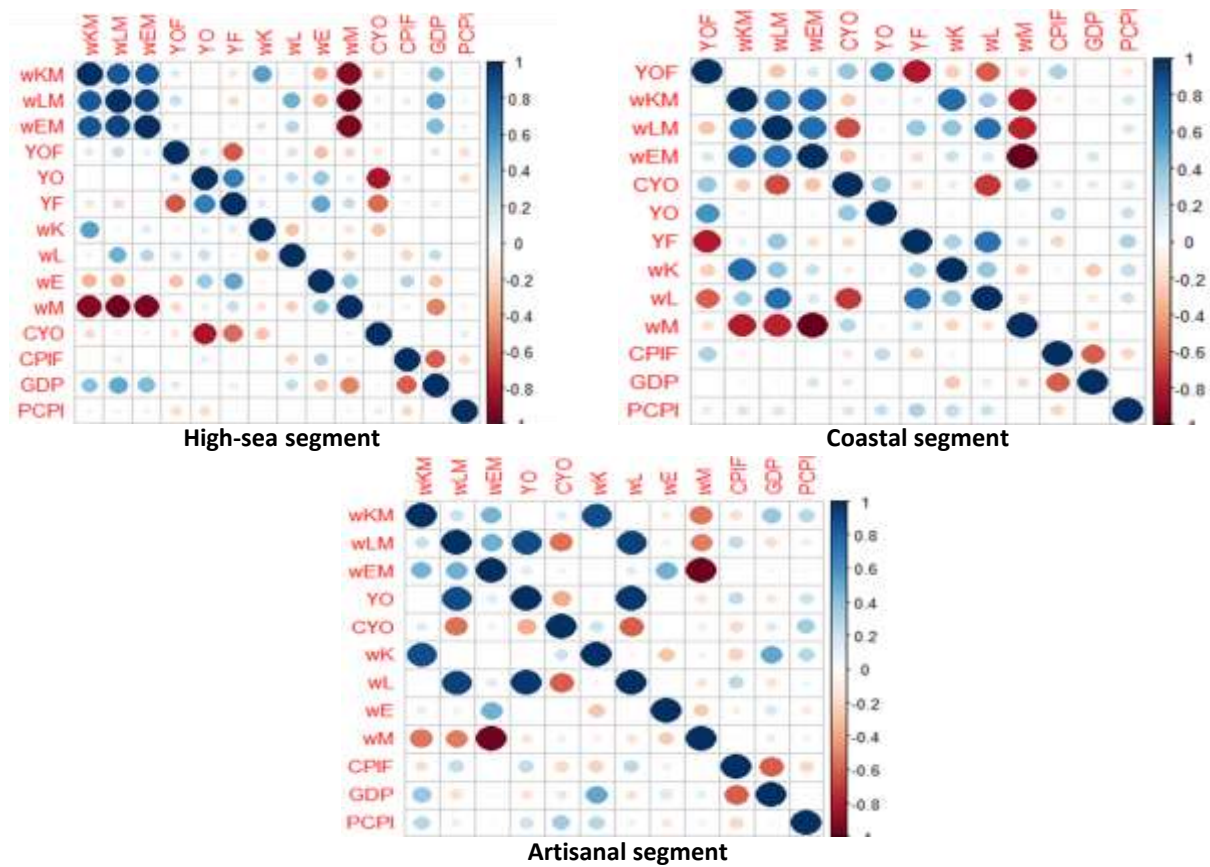
The direct price and cross-price elasticities of demand for inputs are expressed by the following formulas (Brendt and Wood, 1975 and Reynès and Yeddir-Tamsamani, 2009):

$$e_{ii} = \frac{\beta_{ii}}{s_i} + s_i - 1 \quad \text{et} \quad e_{ij} = \frac{\beta_{ij}}{s_i} + s_j \quad \text{given } i, j = K, L, E \text{ et } M \quad \text{and} \quad e_{ij} = e_{ji}$$

The values of these elasticities are summarized in Table 6.

The results obtained from this system of equations also make it possible to assess the sensitivity and variation of economies of scale. These variations are equal to 0.0977, -0.0541 and 0 respectively for the offshore, coastal and artisanal segments.

Figure 1: Correlation of variables by segment of the Octopus fishery



Variable designation

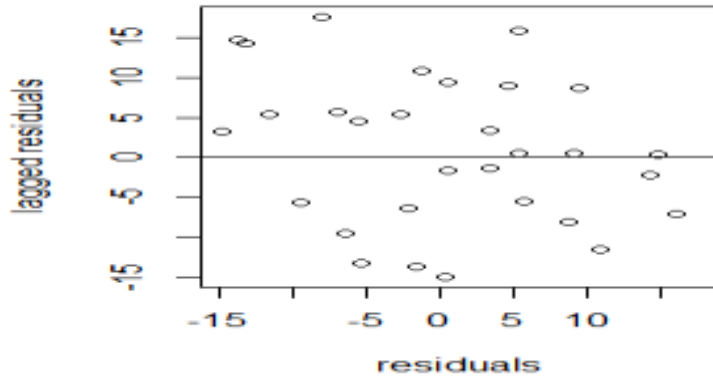
- | | | |
|----------------------------------|----------------------------------|-----------------------|
| w_K : $\ln(w_K)$ | w_{LM} : $\ln(w_L) - \ln(w_M)$ | CY_0 : C/Y_0 |
| w_L : $\ln(w_L)$ | w_{EM} : $\ln(w_E) - \ln(w_M)$ | $CPIF$: $\ln(CPIF)$ |
| w_E : $\ln(w_E)$ | Y_0 : $\ln(Y_0)$ | GDP : $\ln(GDP)$ |
| w_M : $\ln(w_M)$ | Y_F : $\ln(Y_F)$ | $PCPI$: $\ln(P/CPI)$ |
| w_{KM} : $\ln(w_K) - \ln(w_M)$ | Y_{OF} : $\ln(Y_0) - \ln(Y_F)$ | |

Table 3: Adjusted R^2 , coefficients of determination of the three segments of the Octopus fishery

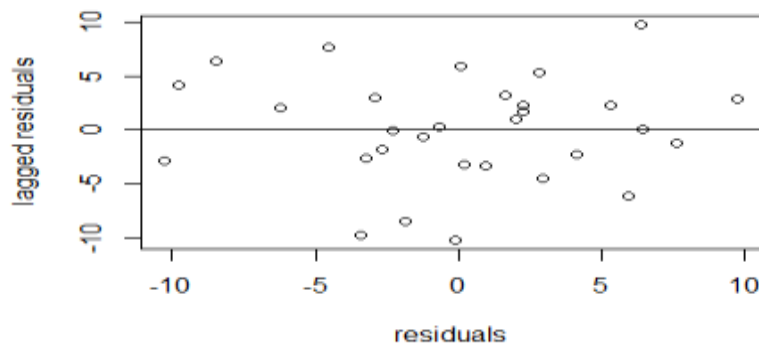
Equations	High-sea segment	Coastal segment	Artisanal segment
S_K	0.6079	-0.3158	0.5616
S_L	0.8662	0.46	0.4457
S_E	0.542	0.3061	
Q	0.5275	0.5275	0.5275
P	$W = 0.973$ $p\text{-value} = 0.604$	$W = 0.979$ $p\text{-value} = 0.796$	$W = 0.988$ $p\text{-value} = 0.978$

Figure 2: Graphs of the error correlation of the three segments of the Octopus fishery

High-sea segment



Coastal segment



Artisanal segment

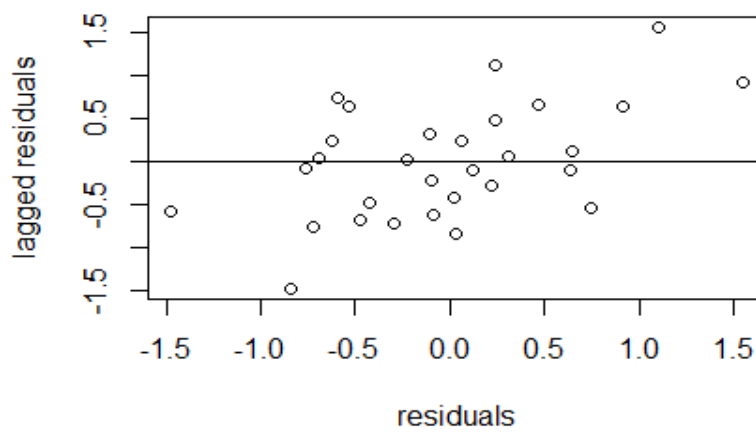


Table 4: Estimated parameters of the input demand share equations of the three segments of the Octopus fishery

Parameters	High-sea segment			Coastal segment			Artisanal segment		
	Valeurs estimées	t-student	p-value	Valeurs estimées	t-student	p-value	Valeurs estimées	t-student	p-value
a1	0.12878*	2.6359	0.00941	0.58503*	3,040	0,00286	0,20047*	2,7759	0,0065
a2	0.03503*	7.1369	6.0067 e-11	0.03107	1,7524	0,08205	0,03191*	6,3783	4,669 e-09
a3	-0.02767*	-4.5315	1.312 e-05	-0.0692*	-3,4872	0,00066	-0,02422*	-3,8986	0,00017
a4	0.00039	0.0522	0.95847	0.07686**	2,5346	0,01243	-0,01606*	-3,3029	0,0013
a5	0.01352**	2.163	0.032369	-0.0433*	-3,180	0,00184	0,75015*	6,131	1,4888 e-08
a6	-0.5149*	-4.5907	1.0288 e-05	-0,4776	-1,405	0,16241	0,08168*	5,9766	3,0404 e-08
a7	0.18837*	12.7157	0.0000	0,31897*	6,0237	1,6148 e-08	-0,01702**	-2,3311	0,02162
a8	-0.11509*	-7.1475	5.6828 e-11	-0,13334*	-2,6356	0,00941	0,33592	1,8631	0,06519
a9	1.34407*	8.9323	3.5527 e-15	0,10548	0,2179	0,82784	-0,17301	-1,6427	0,10338
a10	0.13132*	5.8151	4.4473 e-08	-0,03085	-0,4105	0,6821	0,02294	1,0838	0,28088
a11	-0.03881*	-2.6041	0.01028	0,086*	4,0686	8,1226 e-05	-0,7294*	-5,7454	8,7185 e-08
a12	-0.88452**	-2.2096	0.02888	1,199**	2,2615	0,02538	0,72962*	5,7453	8,7221 e-08
a13	-0.00429	-0.8635	0.38947	-0,04025**	-1,9911	0,04855	-2,819 e-06	-2,283 e-05	0,99998
a14	0.09766**	2.2234	0.02791	-0,05406**	-2,3035	0,02282	0,2295	1,455	0,14859
a15	-0.0207	-1.3993	0.16411	0,00369	0,2771	0,78216	0,45828*	2,9607	0,003783
a16	-0.74007*	-6.1794	7.6865 e-09	-0,68386*	-5,5307	1,6639 e-07			
a17	0.74241*	6.1806	7.6398 e-09	0,68624*	5,5316	1,6572 e-07			
a18	-8.792 e-05	-0.0007	0.99943	-7,2214 e-06	-5,676 e-05	0,99995			
a19	0.23511	1.5494	0.12371	0,02147	0,1372	0,89106			
a20	0.46211*	3.0778	0.00254	0,33248**	2,1725	0,03162			

* parameters significatif at 1% level,

** parameters significatif at 5% level.

Table 5: Price and income elasticities of demand for the output of the offshore, coastal and artisanal segments

	High-sea segment	Coastal segment	Artisanal segment
Price elasticity of output demand	0.7424	0.6862	0.7296
Revenue elasticity of output demand	0.4621	0.3325	0.4583
Conjecturale variation elasticity	-0.7401	-0.6839	-0.7294

Table 6: Direct price and cross-price elasticities of demand for inputs from the offshore, coastal and artisanal segments

High-sea segment				
	Capital, K	Labour, L	Fuel, E	Intermediate expenditure without Fuel, M
Capital, K	-0.2655	-0.1294	0.4103	-0.0254
Labour, L	-0.1294	-0.1306	0.1397	0.0071
Fuel, E	0.4103	0.1397	-0.2673	0.0796
Intermediate expenditure without Fuel, M	-0.0254	0.0071	0.0796	-0.2964
Coastal segment				
	Capital, K	Labour, L	Fuel, E	Intermediate expenditure without Fuel, M
Capital, K	-0.8877	0.0172	0.7771	0.1565
Labour, L	0.0172	0.3434	0.0212	-0.0146
Fuel, E	0.7771	0.0212	-0.8237	0.5450
Intermediate expenditure without Fuel, M	0.1565	-0.0146	0.5450	-0.4744
Artisanal segment				
	Capital, K	Carburant, E	Intermediate expenditure without Fuel, M	
Capital, K	-0,1139	0,2055	-0,0916	
Carburant, E	0,2055	-0,0543	0,0452	
Intermediate expenditure without Fuel, M	-0,0916	0,0452	-0,3099	

We can also estimate the proportional change in the shares of the inputs demanded as a result of changes in their prices (table 7).

Table 7: Variation in shares, S_i , following a variation in input prices for the three segments of the Octopus fishery

Input shares	High-sea segment	Coastal segment	Artisanal segment
SK	0.6832	0	0.8485
SL	0.4591	0.6553	---
SE	0.3125	0	0.0962
SM	0.5854	0.301	0.5772

V- DISCUSSIONS

The direct price elasticities of demand for inputs are very high for the coastal segment. This is due to the fact that operators in the coastal segment are not dependent on Octopus. The Octopus catch represents a small percentage in their total catches and their Octopus quota is the lowest compared to the other segments. These elasticities are lower for the artisanal segment in comparison with the offshore segment because the catches of the offshore fishing boats are composed of Octopus and other associated fish (cephalopods and groundfish) while the artisanal boats only catch the Octopus. The artisanal segment is therefore much more dependent on Octopus. The sign of the elasticities is negative except for the case of labour for the coastal segment. In fact, work is remunerated in the case of coastal fishing by shares of the gross operating result and not by real wages.

The majority of cross-price elasticities have a positive sign. They are low except for Capital-Fuel and Fuel-Intermediate consumption. This indicates that an increase in the price of fuel will push ship-owners to invest much more in technology in order to improve the catchability of boats and reduce fuel consumption. This is much more evident from coastal and offshore fishing owners. In addition, in the case of coastal fishing, the boats tend to increase the duration of their trip in order to maximize their catches, which will result in an increase in expenditure on intermediate consumption. Generally, offshore fishing vessel owners place more importance on the crew and invest less in the repair or renewal of vessels; this is why the Labor-Capital elasticity is negative.

The price elasticity of demand for Octopus is positive and varies between 0,68 and 0,74 for the three segments of the Octopus fishery. These values mean that the demand for Octopus in the Japanese market is inelastic. It is significantly less inelastic when it comes to Octopus from offshore fishing. The highest elasticity was recorded in the case of the offshore segment. The positive sign of this elasticity does not conform to the predictions of the theory. This sign can be explained in relation to the scarcity of the resource and the high demand in the Japanese market. The quantities of Octopus produced (seasonal quotas) are entirely absorbed by the Japanese market even if the price would increase. This is consistent with the character of strong (or perfect) inelastic demand for Octopus which is the main ingredient of a famous traditional recipe in Japan (very strong demand).

The elasticity of conjectural variation often varies between 0 and 1 depending on the market structure. A conjectural variation equal to 0 corresponds to a market in pure and perfect competition, while in the case of a monopolistic market, it takes the value of 1. Values between 0 and 1 reflect the situation of a

market oligopolistic. However, the elasticity of conjectural variation can take negative values between -1 and 0. There is an interval in which a positive conjectural variation in prices implies a negative conjectural variation in quantities (Kamien and Schwartz, 1983). Riordan (1985) also demonstrated that the conjectural variation is dynamic and can take negative values, and this, based in his analysis on the imperfection of the information of the firms and on the evolution of the demand for the market. According to this author, a firm thought that an increase in its output could induce a decrease in the market price, which led competing firms to believe that demand would decrease and therefore they would decrease their future output.

The elasticity of conjectural variation for the three segments of the Octopus fishery is negative and ranges between -0,74 and -0,68. These values are different from zero and close to one in absolute value. Which means that the structure of the Octopus market is an oligopoly. The economic operators in the Octopus fishery acted in collusion thus leading to an imperfection of the Octopus market.

In the case of the Octopus fishery, the scarcity of the resource and the quota system recommended in the management of this fishery can explain the sign of the elasticity of the conjectural variation. Each fishing operator will anticipate a reduction in the quantities offered by the other operators when it increases its quantity or in the case of an increase in its share of the global quota. The greater the quantity caught by one operator, the less are the quantities caught by the other operators, because of the externalities linked to the stocks and the high operating costs. In addition, since the overall quota is limited, the increase in the share of an operator means the decrease in the shares of others.

From the estimate of the conjectural variation and the Lerner index, which have values close to 1 in absolute value, we can see that the Octopus market is prone to collusion. It is therefore an oligopolistic market characterized by interdependent actors, so that the policies followed by some affect the behaviour of others. This market imperfection thus confirms the hypothesis of the existence of anticommons effects in fishing and more particularly in the case of the Octopus fishery. Costs in fishing depend on the variability of resource flows and the number of boats (costs related to searching resources and congestion). Fishing operators seek to eliminate competition and maintain their high market shares, in order to impose the decisions of the Marine Ministry. They can therefore form a coalition and hold market power. Indeed, the Octopus fishery is characterized by a high concentration of supply in the hands of a limited number of operators who own a large number of boats. They succeeded in imposing their decisions on the management of this fishery.

This study has made it possible to test empirically the existence of problems linked to anticommons in the fishing sector. An anticommons situation can lead

to high implicit costs in relation to fragmented and dispersed decisions, especially in the absence of coordination. This situation can induce the failure of the markets and tend towards a tragedy of the anticommons characterized by ineffective use of resources.

Indeed, fishing is a sector that is likely to manifest the effects of anticommons. Decisions on fishery management are taken by ministerial departments in collaboration with private partners. The interdependencies between these institutions can generate very high transaction costs and induce failures in the management of resources that can lead to complete inhibition of the use of these resources. The establishment of better coordination between the various actors involved and the strengthening of coordination channels can constitute an alternative to this situation. The integration of anticommons in the decisions of economic agents can guide and improve the economic policies of emerging economies. Consequently, it reduces the risk of market failure and increases investment and development opportunities.

CONCLUSION

The management of fishery resources in Morocco is based on the system of non-transferable quotas. This mode of management involves several interdependent actors and highlights interconnected decisions. The Octopus fishery is an example where the divergence of stakeholder interests and their interference has had an impact on resource sustainability. Indeed, the management policy pursued by the government has not been able to restore the fall in stocks and restore the economic and social situation of this fishery.

This study analysed the Octopus fishery management process in relation to coordination. She focused on the situation of the anticommons and its implications for coordination and economic policies. The imposition of powerful private actors in the process of managing the Octopus fishery, having acted in collusion, has led to the failure of several management measures and the overexploitation of the resource. Thus, the position of some offshore shipping companies aimed at maintaining their market power has induced very high implicit private and social costs leading to inefficient exploitation of the resource.

The anticommons model was used as a reference to explain the consequences of an anticommons situation and the problems associated with the tragedy of the anticommons in the case of the Octopus fishery in Morocco. An empirical test of the structure of the market was carried out on the data collected relating to the fishing activity of the boats of the three segments of this fishery with the aim of verifying the hypothesis of the imperfection of the markets, thus confirming the existence of an anticommons situation in the Octopus fishery. We

estimated the Lerner index and the conjectural variation to verify the existence of market power and the effect of monopolistic competition.

The results of this study confirm the prevalence of anticommons in the fishery sector in Morocco. The elasticity of the conjectural variation close to one shows the oligopolistic nature of the Octopus market with a marked level of monopolistic behaviour by the large shipping companies. The value of the Lerner index close to one also highlights the presence of market power exercised by these Companies and the consequences of their collusive action. As a result, fishing operators have endured private and social costs in relation to continued overexploitation of resources and imperfect coordination. Stocks have fallen, financial, social and economic crises have affected most components of the fishing sector, thus limiting opportunities for development and innovation.

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