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Abou Ciré Ball, Elimane Abou Kane, Patrice Brehmer

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A comparative economic analysis of industrial fisheries targeting small pelagic fish in Mauritanian waters: Free license versus charter regime

Abou Ciré Ball[1] | Elimane Abou Kane[1,2,3] | Patrice Brehmer[4]

[1]Laboratory of Social and Economic Studies, Institut Mauritanien de Recherches Océanographiques et de Pêches, IMROP, Nouadhibou, Mauritanie

[2]Unité de Recherche Macroéconomie, Croissance et Développement, Faculté des Sciences Juridiques et Economiques, Laboratoire Environnement, Santé et Société (LE2S), Université de Nouakchott, Nouakchott, Mauritanie

[3]Observatoire Economique et Social des Pêches, Ministère des Pêches et de l'Économie Maritime, Nouakchott, Mauritanie

[4]IRD, Univ Brest, CNRS, Ifremer, Lemar, CSRP, SRFC, Dakar, Senegal

Correspondence
Elimane Abou Kane, Observatoire Economique et Social des Pêches, Ministère des Pêches et de l'Économie Maritime, Nouakchott, Mauritanie.
Email: enamilekane@gmail.com

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Abstract

Industrial fisheries targeting small pelagic fish have significant socio-economic implications for North West African countries. This study examines the economic performance of fleets operating in Mauritania's exclusive economic zone under the free license and chartering systems. Using national production data from 1989 to 2010 and economic indicator ratios from European pelagic fishing vessels, we assess the economic performance of pelagic fisheries over one decade. Our findings show that vessel characteristics have rapidly evolved, with free-licenced vessels having a higher average fishing capacity than chartered vessels. The nominal number of free licenses increased from under 8% in 1995; the year of free licencing began in Mauritania, to over 80% in 2010. The estimated average economic output for 2000–2010 was US$ 231 million, with free licenses contributing over 80% of the total turnover (US$ 187 million). Vessels operating under free licenses made a greater contribution to wealth creation than the chartering regime. Foreign ship owners generated US$ 40.7 million (22%) in income, while chartering yielded US$ 3.6 million (8%). However, the chartering regime was more fiscally advantageous, contributing over 68% of pelagic fisheries tax revenues (estimated at over US$ 29 million). The small pelagic fishery has been subject to a system of total allowable catches and

fishing quotas since 2015. This study provides insights into the economic dynamics of the small pelagic fishery, informing decision-making and potential strategies to enhance the sector's performance and overall economic impact.

KEYWORDS
economic performance, fishing quotas, inclusive regulation, industrial fisheries, total allowable catches

1 | INTRODUCTION

Small pelagic fish stocks in the Canary Current Large Marine Ecosystem are key resources (Bocar et al., 2018; Braham et al., 2014; Thiaw et al., 2017) that extend over the entire coastal zone of the Atlantic (western) (Figure 1) (Diogoul et al., 2021). This region includes the continental shelves of southern Morocco, Mauritania, Senegal, the Gambia and Guinea Bissau, where there is an East Border Upwelling System (EBUS) favourable to the fisheries (Auger et al., 2016; Ndoye et al., 2017). The United Nations Conference on the Law of the Sea (UNCLOS) defined the principle of exclusive economic zones (EEZs), which extend up to 200 nautical miles from each country's continental shelves (ONU, 1982). UNCLOS recognizes the exclusive sovereignty of coastal states over resources in these areas. Since the coastal countries of the Western Sahara do not have the technical capacity to exploit all their resources, a framework of bilateral agreements has been signed to allow foreign vessels to fish in Mauritanian waters (Bertignac et al., 2012; Schaefer, 1954) based on negotiations between Mauritania and other countries, and the European Union (EU) (Kaczynski, 1989; Kane, 2009).

Over the past decades, small pelagic fishing has developed intensively in West Africa (Chavance, 2002). Although fishing effort has increased significantly (Baldé et al., 2019, Baldé et al., 2022; Diankha et al., 2017), the

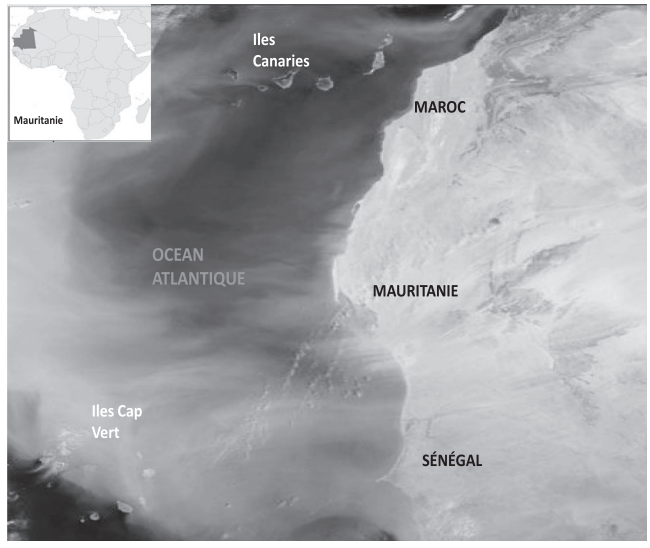

FIGURE 1 Location of Mauritania in West Africa and the main coastal areas of the Atlantic Sahara inside the Canary Current Large Marine Ecosystem (CCLME) where numerous small pelagic fleets operate (including Senegal, Gambia, Mauritania and Morocco). The image shows a strong wind dust event. *Source*: Map adapted from Google Earth imagery

profitability of pelagic fisheries has decreased over the past 20 years (Ba et al. 2017, 2022). In Mauritania, the fisheries sector contributes about 6% of GDP (IMROP, 2014; Ould Taleb Sidi, 2013). Despite a few descriptive studies of pelagic industrial fishing activities in the EEZ (Josse, 1987; Labrosse et al., 2010), the management of Mauritanian pelagic fish resources remains poorly understood.

Access to this resource is based on several Mauritanian laws (Ould et al., 2011) in which pelagic fishing may be carried out by (i) vessels authorized through a chartering system, (ii) vessels authorized by a free license system and (iii) vessels authorized under an agreement between Mauritania and one or more partner States.

The two most important access regimes in industrial pelagic fishing today are the charter and the license regimes (free or under fishing agreements). Before 1994, chartering contracts were used to promote bilateral agreements between Mauritania and the government of a foreign country to set up joint ventures (Kane, 2009). Since 1995, chartering has been defined as a legal contract between a Mauritanian operator and a foreign owner of a fishing vessel (MPEM, 2000). Licenses are considered contracts that allow any foreign vessel to exploit resources in Mauritania under an agreement between a foreign individual or a country or group of countries (e.g., the EU) and Mauritania (RIM).

The importance of pelagic fishing industry relies on catches off the coast of Mauritania, which mainly targets the stocks of Carangidae (*Trachurus trachurus*, *Trachurus trecae* and *Caranx rhonchus*), Clupeidae (*Sardinella aurita*, *Sardinella maderensis* and *Sardina pilchardus*), Scombridae (Scombercolias), Engraulidae (*Engraulis encrasicolus*) and Trichiuridae (*Trichiurus lepturus*). These catches account for more than 80% of the catch in Mauritania (FAO, 1995; Labrosse et al., 2010; Ould Taleb Sidi Mohamed Mahfoudh, 2005). The EU fleets operating from 1995 to 2012 under the fisheries agreements with Mauritania are integrated into the system of free licenses (Labrosse et al., 2010). These fleets belong mainly to the Netherlands, France, Great Britain, Sweden, Germany, Lithuania, Latvia, Estonia, Malta and Cyprus. Other fleets belong to Russia, Ukraine, Belize, Ghana, Panama, Marshall Islands, Saint Vincent and the Grenadines. These fishing fleets use trawlers that target small pelagic fish throughout their spatial distribution.

The small pelagic fishing sector contributes to Mauritania's economic and human development (IMROP, 2014). A lack of information in this area may lead to insufficient consideration of the management needs of small pelagic when making budgetary trade-offs.

Even more glaring is the lack of information on the socio-economic performance that the sector could potentially achieve with better management. This is a real constraint to the promotion of more ambitious policies to allow the sector to realize its full potential in contributing to economic development.

For some years, most developing countries have been engaged in proactive policies to promote the integration of the sector into the national economy. In Mauritania, however, these fisheries development policies do not seem to take sufficient account of the challenges and needs of the sector, due partly to a lack of data and information on the current role and potential of the fisheries sector for economic growth.

The problem addressed in this article concerns the economic contribution of industrial small pelagic fishing to the tax revenue of Mauritania. Quantifying the economic impact of fishing units under different access regimes allows us to examine two key issues of concern: first securing the revenue from the fisheries and, second, ensuring the economic sustainability of the fisheries sector, especially in light of current economic conditions and the structural challenge posed by significant increases in energy prices. This article aims to answer the following question: How can the implementation of the two pelagic fisheries access regimes contribute to the national policy of sustainable management of fisheries in Mauritania? The main objective of this paper is to conduct a comparative economic assessment of the different access regimes for pelagic industrial fisheries in Mauritanian waters.

2 | MATERIALS AND METHODS

Statistical data on industrial fishing operating in Mauritania were obtained from fishing vessel logbooks from 1989 to 2010. The database contains the characteristics of the ships (engine power, gross tonnage, age and length) classified

by chartering or free license regime and information on the number of sailors on board. Declarations of catches and fishing efforts from fishing logbooks were provided by the Delegation for the Surveillance and Control of Fisheries at Sea (DSPCM, currently the National Coast Guard of Mauritania). This institution inputs the data and transmits them to the Mauritanian Institute for Oceanographic Research and Fisheries (IMROP), which integrates them into its database. Data on unit prices of captured species were also collected at the Mauritanian Marketing Company (SMCP), covering the period from 1989 to 2010.

In the Mauritanian exclusive economic zones (MEEZ), fishing vessels operate under three types of regimes. These are the acquisition regime for Mauritanian units in the framework of mixed companies operating under Mauritanian law, the Charter regime, which allows a Mauritanian operator to charter a foreign fishing vessel, and lastly the free license regime, dedicated to fishing vessels operating in the framework of fisheries agreements. The two most important access regimes in industrial pelagic fishing are the charter regime and the license regime (free or by agreement). Chartering is defined as a legal contract between a Mauritanian operator and a foreigner who owns a fishing vessel (MPEM, 2000). Licenses are considered contracts that allow a foreign fishing vessel to exploit fisheries resources in Mauritanian waters under an agreement between Mauritania and a foreign individual, country or group of countries (e.g., EU). The acquisition regime for industrial fishing was not implemented in the period under study. The information collected for the studied regimes covers budget revenues from access rights, insurance costs in Mauritania and salaries of Mauritanian fishermen. Data from the Central Bank of Mauritania on the exchange rate for the period 1989–2010 made it possible to convert the ouguiya (UM), Mauritania's national currency, into the US dollar (US$). As the cost data for foreign pelagic industrial units were incomplete, we used average ratios from proxy data from 2008 to 2016 for the EU fleet (Denmark, Ireland, Lithuania and the Netherlands), which had similar characteristics as other foreign fishing vessels operating in Mauritanian waters. Based on these ratios, we calculated the socio-economic indicators (Table 1). We developed a comprehensive framework for assessing the key indicators that underpin the performance of the industrial small pelagic fishing vessel in Mauritania. These indicators elucidate the intricate web of economic factors that contribute to the operations and outcomes of fishing activities within this domain. At the core of our analysis are the Wages and Salaries of Crew, encapsulating the monetary recompense extended to crew members engaged in fishing operations. This encompasses both Mauritanian crewmembers and the associated insurance component—Wages of Mauritanian I (Insurance). The latter pertains to the financial outlays directed towards insurance coverage, safeguarding fishing operations, vessels, equipment and personnel from unforeseen contingencies. This holistic approach mitigates risk and reinforces the operational resilience and sustainability of the industry. The dimension of Unpaid Labour Value emerges as a significant parameter, encapsulating expenditures related to sustenance

TABLE 1 List of economic indicators of performance used and their associated formulae, applied over the period 2000–2010 for pelagic industrial vessels operating in Mauritanian waters

Indicators	Formulae
Wages and salaries of crew	Ratio Wages and salaries of crew × T
Wages of Mauritanian I	Ratio Mauritanian I × T
Unpaid labour value	Ratio Unpaid labour value × T
Energy costs	Ratio Energy costs × T
Repair & maintenance costs	Ratio Repair & maintenance costs × T
Other variable costs	Ratio Other variable costs × T
Other non-variable costs	Ratio Other non-variable costs × T
State recipe + charterer Profit	Ratio State recipe + charterer Profit × T
Annual depreciation costs	Ratio Annual depreciation costs × T
Profit Foreign Ship-owner	Ratio Profit Foreign Ship-owner × T

Source: Authors.
Abbreviations: I, insurance; T, turnover.

and well-being during fishing endeavors, including provisions such as food, water and beverages, which contribute to the overall human consumption aboard the vessel. Energy Costs come to the forefront as an essential facet, encompassing expenses incurred for fuel and energy that powers the fishing vessels, thereby propelling their operations. Repair and Maintenance Costs are also included, addressing the financial commitments associated with the upkeep, repair and servicing of fishing vessels and equipment. This category is pivotal in ensuring the operational longevity and efficiency of the vessels. Intricately interwoven within this framework are the Other Variable Costs, reflecting the dynamic nature of expenses related to bait, fishing gear, packaging and other materials intrinsically linked to catching and processing fish. Contrasting this dynamism are the Other Non-Variable Costs, embodying fixed expenses such as administrative costs and licencing fees, which remain steadfast regardless of fluctuations in fishing operations. The economic canvas is further enriched by the inclusion of State Revenue + Charterer Profit, a composite indicator reflecting both governmental income from licencing fees, taxes and contributions tied to fishing, as well as the financial returns of entities chartering vessels for fishing endeavors. Annual Depreciation Costs are a vital constituent, acknowledging the gradual reduction in asset value over time due to a multitude of factors, including wear and tear, technological obsolescence and general ageing, thus facilitating the allocation of capital expenditure over the asset's lifespan. Lastly, Profit for Foreign Ship-owners underscores the financial gains accrued by foreign vessel owners who operate under licenses or charters in Mauritanian waters, contributing to the intricate tapestry of economic interactions within the industry. These multifaceted indicators collectively underpin our comprehensive economic analysis, aimed at elucidating the nuances of the Free License and Charter Regime fishing approaches. This analysis is predicated on the fundamental operating accounts of fishing vessels. The juxtaposition of these indicators between the two regimes enables a comparative assessment. Thus, the meticulous definition of these indicators becomes an imperative prelude to our overarching endeavour, as it lays the foundational groundwork for a comprehensive and insightful exploration of the economic dimensions at play within the Mauritanian small pelagic fishing industry.

In this work, the DEA (Data Envelopment Analysis) method was applied to the pelagic fishing fleet. The DEA method is often used in the marine fisheries sector to measure the technical performance or economic efficiency of the fleet (Le Floc'h & Simon, 2006; Kirkley & Dale, 1999; Lindebo et al., 2006; Pascoe & Tingley, 2006; Tingley et al., 2003). Turnover or production value was calculated by multiplying the average selling price (P_i) of small pelagic fish (i) by the total quantity (Q_i) (price data from the Mauritanian fish marketing company and production data from fishing logbooks):

$$CA = \sum_i P_i Q_i \quad (1)$$

where P_i is the average unit price of pelagic species caught and Q_i is the total quantity of species 'i'.

All other indicators were calculated by multiplying the turnover by the ratio of the indicator calculated on the proxy data (Table 1).

In this study, the focus is primarily on comparing the Gross Profit from Estimated Total Revenues (GPETR) of the two access regimes. To do this, we will determine the Turnover (T), the Salary Costs (SC), the Variable Charges associated with the fishing activity (VC), the Annual Fixed Costs (AFC) and the income of the ship owners. Proxy data were used, which enabled us to calculate ratios (Table 1) representing the absolute value of each indicator on the turnover of this proxy data. After arriving at these ratios, we take the turnover of the actual data and multiply it by the ratio of each indicator.

3 | RESULTS

3.1 | Characteristics of pelagic industrial vessels

The characteristics of small pelagic fishing fleets operating in Mauritanian waters across three distinct periods: 1989–1995, 1996–2005 and 2006–2010, encompassing both the free license and charter regimes allow interesting

comparative analysis (Table 2). Evident from the data is a substantial change in vessel attributes, notably observed in the free license fleet, which exhibited notable growth in vessel size, age and power. The length of vessels within the free license fleet remained consistent at 128 m from 1989 to 1995 and then decreased to 124 m from 1996 to 2010. By contrast, the charter fleet saw a similar trend with vessel lengths at 124 m from 1989 to 1995 and a decrease to 126 m from 1996 to 2005, which remained constant thereafter. Moreover, vessel age demonstrated a notable reduction in the free license fleet, from an average of 15 years in 1989–1995 to 23 years in 2006–2010. Conversely, the charter fleet experienced a more gradual decline in vessel age, from an average of 34 years in 1989–1995 to 25 years in 2006–2010. The GRT for the free license vessels increased from 4382 to 5766 between 1989 and 1995, further rising to 6418 from 2006 to 2010. Additionally, the power of these vessels surged from 4824 to 4896 kW during 1996–2006. In stark contrast, the charter fleet, though experiencing advancements, displayed a more gradual rise in GRT (4687 to 5455) and experienced fluctuations in power, ranging from 4453 to 4304 kW during 1996–2010. These compelling data highlight the remarkable growth in technical capacities of the free license fleet, especially after 1996, underscoring its pivotal role in shaping the modernization trajectory of the Mauritanian small pelagic fishing industry.

Between 1989 and 1995, the number of pelagic industrial vessels that operated under the charter regime was 65 on average (Figure 2). Three distinct periods for shippers/charters are revealed: (1) the first phase with a low number of fishing vessels, 1989–1995; (2) five years of increasing vessel amount from 1995 to 1999; and (3) a new steady phase from 1999 to 2009. From 1995, there was a gradual decline of this regime following the crisis in the countries of Eastern Europe, which were the only countries operating under this regime in the Mauritanian area (Ould Taleb Sidi & Mahfoudh, 2001). However, a recovery plan provides for the privatization of several public enterprises, which has been accompanied since 1994 by the introduction of a liberalization process in the fisheries sector (Dia Abdou et al., 1998).

Before the 1994 liberalization, few free licenses were activated in the MEEZ (Figure 2). Free license vessels over 100 m in length accounted for only 8% of the number of all pelagic industrial fleets before 1995. Since then, the sharer of pelagic fisheries vessels under free licenses has increased to 56% between 1996 and 2005 and then to 82% between 2006 and 2010 (Figure 2).

3.2 | Economic performance of industrial small pelagic fishing

The estimated annual average turnover of the pelagic fishing industry in Mauritania was US$ 231 million in the decade 2000–2010 (Table 3). The free license of the small pelagic fishing industry has contributed more heavily to the creation of the total gross wealth than the charter regime. The free license represents 187.4 million US$ of the turnover (81%), which was more than four times higher than the charter contribution estimated at 44 million US$, accounting for 19%.

TABLE 2 General characteristics of pelagic industrial fishing vessels (1989–2010) of the two pelagic fisheries access regime (free license and charter)in the age of the vessel (in year), length (m), averaged gross register tonnage (GRT) and in power (kW)

	1989–1995		1996–2005		2006–2010	
Parameter	Free license	Charter	Free license	Charter	Free license	Charter
Age of vessel (year)	15	34	22	24	23	25
Length (m)	128	124	124	126	124	124
Average gross register tonnage (GRT)	4382	4687	5766	5455	6418	5685
Average power (kW)	4824	4453	4876	3784	4896	4304

Source: Authors, based on the Database of the Mauritanian Fisheries Research Center 'IMROP' (IMROP, 2014).

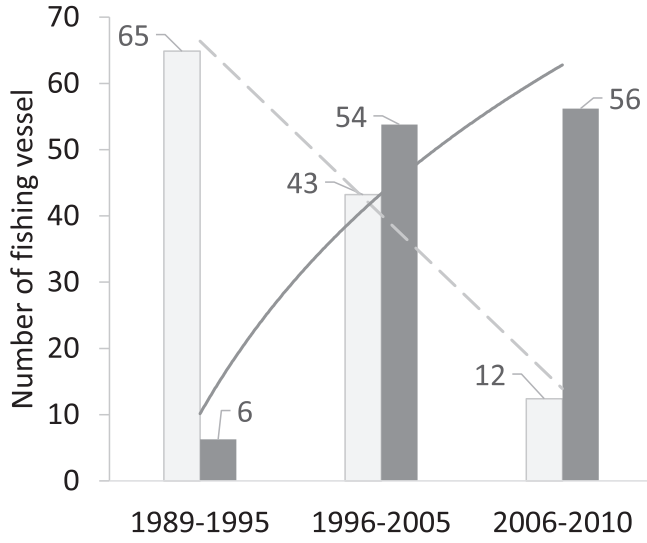

FIGURE 2 Change to small pelagic industrial vessels operating in the Mauritanian waters from 1989 to 2010 based on access regime: free license (grey dark) versus shipper/charter (grey) (*Source*: IMROP, 2014). Lines: linear regression for both access regimes (solid line: exponential regression $R^2 = 0.89$ for the free license. Dashed line: linear regression $R^2 = 0.99$ for charters). *Source*: Authors, based on data from IMROP (2014)

TABLE 3 Comparative analysis of total turnover for small pelagic fisheries by access system (Free License and Charter) during the average period 2000–2010

Indicators	Free license (US $)	Charter	Free license (%)	Charter	Total fleet (US $)	Free license (%)	Charter
Turnover	187 033 335	44 000 001	100	100	231 033 336	81	19
Wages and salaries of crew	33 899 786	3 055 557	18	7	36 955 343	92	8
Mauritanian Insurance	4 823 123	1 770 323	3	4	6 593 446	73	27
Unpaid labour value	702 579	n/a	0	n/a	702 579	100	00
Energy costs	17 732 600	9 493 444	9	22	27 226 043	65	35
Repair & maintenance costs	16 836 810	4 943 116	9	11	21 779 926	77	23
Other variable costs	11 409 106	9 628 171	6	22	21 037 277	54	46
Other non-variable costs	20 115 491	2 704 566	11	6	22 820 058	88	12
State recipe + charterer profit	15 211 142	7 469 678	8	17	22 680 819	67	33
Annual depreciation costs	25 536 916	1 314 156	14	3	26 851 072	95	5
Profit Foreign Ship-owner	40 765 783	3 620 990	22	8	44 386 773	92	8
Total Mauritanian recipe	9 240 001	20 034 265	21	11	29 274 266	32	68

Source: Authors, based on the database of the Mauritanian Fisheries Research Center (IMROP, 2014).
Abbreviation: n/a, not available.

Analyses of each regime indicate that the intermediate consumption amount was 47 million US$ for free licenses, or 25% of their turnover, of 187.4 million US$, and those of the charter regime were 24 million US$, or 55% of their turnover of 44 million US$.

The comparison of the economic performance of each segment to wealth creation is based on the gross value added (GVA) generated by the two systems (Figure 3). It is obvious that in absolute terms, the contribution of vessels under a free license was more important. Nevertheless, in relative value, we note that the salaries of Mauritanian sailors and their insurance represent 4% of the turnover for chartering, while for a free license, these charges were only 3% of their turnover. Compared to the salaries of Mauritanian sailors, those of the foreigners were eight to nine times higher. In addition, the gains of the Mauritanians were 17% of the turnover of the charter (Table 3). In this proportion, 10% was for the Mauritanian charterers, while those with the free licenses were only 8% of their turnover. The profit of foreign was 40.7 million US$ (22%) for the free license regime, and for the charter, it was only 3.6 million US$ (8%).

Markets for the sale of catches are traditionally at the heart of the choice of commercial strategies and fishing tactics (van Putten et al., 2012). It is essential to recognize that these fish hold a pivotal role in enhancing food security, acting as a significant source of proteins and essential nutritional elements, accessible at affordable prices for African populations with limited purchasing power (Dème et al., 2023).

The examination of average prices across the two decades enables the identification of noteworthy trends (Figure 4). Commencing from a modest baseline in the early 1990s, nominal average prices for small pelagic species exhibited a gradual increase of 0.19% annually during the 1989–2010 period, reflecting the integration of pelagic

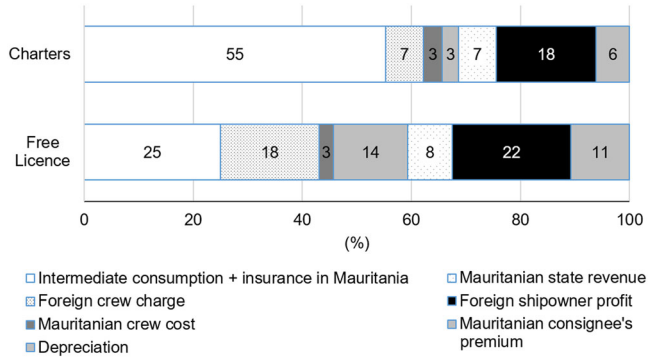

FIGURE 3 Breakdown of average total revenue according to the type of access regime (i.e., free license and charter) in the waters off Mauritania from 2000 to 2010. *Source*: Authors, based on data from IMROP (2014)

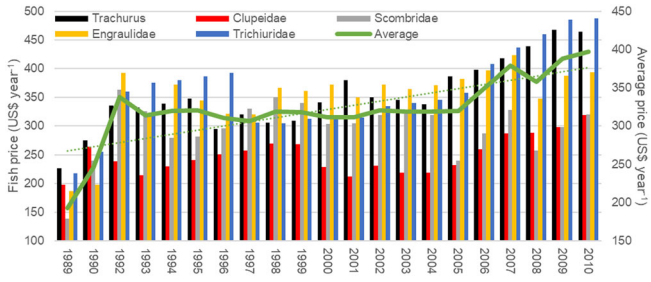

FIGURE 4 Annual average prices (expressed in US$ per tonne) for different types of small pelagic fish in Mauritania over two decades (1989–2010). *Source*: Authors, based on data from 'Société Mauritanienne de Commercialisation du Poisson' (in English Mauritanian Fish Marketing Company; abbreviation: SMCP) (SMCP, 2012) [Colour figure can be viewed at wileyonlinelibrary.com]

species into the global market (Touron-Gardic et al., 2022). It is important to note, however, that the annual growth rates for average prices in tonnes per species group vary. Specifically, *Trachurus trachurus* saw a growth rate of 0.18%, Clupeidae experienced a rate of 0.13%, and Trichiuridae demonstrated a more pronounced growth rate of 0.21% (Table S1).

During the study period in Mauritania, the Scombridae and Engraulidae present distinct patterns, marked by more notable price escalations. Scombridae exhibited a robust annual growth rate of 0.28%, indicative of significant market dynamics and increased demand over the observed years. Similarly, engraulidae showcased a substantial yearly increase of 0.26%, underscoring the evolving economic and market factors influencing these species.

In summation, the comprehensive analysis of the average prices of small pelagic species over this two-decade span not only provides insights into their market dynamics and economic significance but also underscores the varying growth trajectories among different species groups. This examination further highlights the role of these species in sustaining food security and nutritional accessibility, thereby contributing to the broader socio-economic landscape of the region (Dème et al., 2023; Touron-Gardic et al., 2022).

4 | DISCUSSION

Before 1989, Mauritania's policy of capturing the fishing rent was based on the 'domiciliation of catches' (Kane, 2009). The implementation of this policy has facilitated the promotion of chartering agreements for fishing vessels to establish joint ventures (Kaczynski & Fluharty, 2002; Le Manach et al., 2013). The flag States' governments actively participate in developing Mauritania's fisheries sector by assisting in research, training, infrastructure development, credit, surveillance and supporting small-scale fishing through the supply of equipment, among other means (Kane, 2007). This cooperation involved a large number of countries from every continent: Libya, Egypt, Algeria, Greece, Ghana, China, South Korea, Cuba and particularly the Soviet bloc (e.g., USSR, Romania, Ukraine, Poland and German Democratic Republic). Despite some positive aspects of chartering agreements, the review carried out between 1979 and 1994 concluded that this type of cooperation had been a total failure (Kane, 2007). The chartering policy was proving to be insufficient to achieve its stated objectives. Between 1990 and 1994, the sector suffered continuous job losses due to the bankruptcy of numerous onshore factories following the closure of more than 40% of the national fleet under the charter.

Chartering did not allow the sector to be adequately integrated into the national economy, and it only served to reinforce intensive over-exploitation by foreign fleets, further entrenching Mauritania's dependence on foreign shipping. This failure coincided with the upheaval in the international environment caused by the collapse of the Berlin Wall in November 1989 and the announcement of the official disappearance of the Soviet Union in December 1991. The events of this global crisis disrupted the chartering policy, which was primarily reliant on Soviet vessels.

In 1993, Mauritania returned to a policy of structural adjustment, which allowed the privatization of several productive sectors (Dia Abdou et al., 1998). As part of this, a recovery plan was provided for the privatization of several state-owned fishing companies. This was accompanied by the introduction of a process of liberalization and decentralization, which gave considerable weight to the development of free licenses. From 1994 onwards, the fisheries management measures introduced by the Mauritanian authorities re-established the free license system. It was from this period onwards that the exploitation of small pelagic fisheries developed rapidly in the Sahara Atlantic (Kaczynski & Fluharty, 2002; Le Manach et al., 2013).

A new fisheries agreement with the EU, in line with existing policies on access rights and Mauritanian legislation, was implemented in September 1995. However, Mauritania has maintained the system of chartering the exploitation of small pelagic through Mauritanian executives to maximize income from fishing and increase the economic and social benefits of the fisheries sector (Kane et al., 2022; Vallée et al., 2009). Until 2012, access to industrial pelagic fishing in Mauritanian waters was characterized by two access regimes: chartering and free licenses. Measuring the economic results of activities under these two regimes was a necessity for fisheries management (FAO, 1995; Kane

et al., 2022). The pelagic fleet has diversified considerably; both in terms of vessel size and catch volume. Catches declared by these fleets have increased spectacularly over the last 15 years, rising from less than 300 000 t in 1994 to more than one million tonnes in 2010, a 3.5-fold increase. This trend has been attributed to a significant increase in effective fishing efforts under the free license regime (Ould et al., 2011).

The evaluation of economic performance made it possible to assess the contribution of each access regime to industrial fishing for small pelagic. The average annual turnover of industrial pelagic fishing was estimated at 231 million US$ for the period 2000–2010. The comparison shows that free licenses have made a significant contribution to the gross wealth of pelagic units, 81% more than chartered vessels. Most of the difference can be explained not only by the large number of vessels under free licenses but also by the lower impact of their fuel expenditure, which is 25%, whereas for chartered vessels, it represents 55% of intermediate consumption (Bal, 2012). The utilization of subsidized fuel from Las Palmas significantly influenced the profitability of free-license vessels, a factor highlighted by Belhabib (2019). This scenario underscores a crucial aspect of economic viability, indicating that a substantial portion of industrial fishing operations focused on small pelagic fish could potentially face challenges in sustaining profitability without the subsidies they receive. Charter vessels have been the most affected by the increase in fuel prices in Mauritania since the early 2000s. There are numerous difficulties in the comparison of the performances of different regimes regulating access to small pelagic fishery resources in Mauritania (Bal, 2012) mainly linked to the search for data on the cost structures of the vessels, which is a common problem in this type of exercise. The economic data are incomplete and heterogeneous, and the comparability of the regimes is weakened by the multiplicity of uncontrolled factors. The literature on similar cases is also limited, as industrial operators are reluctant to share economic data.

Our comparison of the two systems showed that the profitability of the free license system was higher in absolute terms in the case of Mauritania. This can be attributed to the technical performance and subsidies provided to vessels under the free license system compared to chartering. Furthermore, the results indicate that if chartering clauses were applied to the free license regime, Mauritania could have significantly benefited from the rent derived from the exploitation of small pelagic resources. However, when it comes to variables of the operating costs of fishing units, using proxy data based on fishing effort can often be challenging. This is because the fishing power of vessels is multi-dimensional, with a high level of substitutability between its components.

Additionally, its definition over the period studied was continuously evolving due to the technical progress in vessels. Subsequently, the Mauritanian government faces an uncomfortable dilemma in regulating access to small pelagic resources based on free license and charter fishing efforts. If they decide to control only part of the determinants of fishing power, they generally condemn themselves to have limited control. The conventional solution is to further restrict the only easily controllable component of the fishing effort, which is fishing time. This solution, which leads to what is known as 'derby fishing' (Waters, 2001), has major drawbacks in terms of economic efficiency, working conditions and product quality. While the Mauritanian fisheries management authorities attempt to conduct exhaustive checks on the fishing power of industrial pelagic vessels, this effort may incur significant management costs. Moreover, it has the disadvantage of freezing the technical structure of the fishing fleets disregarding economic rationality.

In terms of methods for capturing fishing income, Mauritania is committed to introducing binding control mechanisms to regulate access by adopting administrative-type instruments (chartering and non-transferable free licenses). This choice is in line with the methods used in the field of resource conservation. However, this type of instrument has some drawbacks when it comes to regulating access, which has led a large number of countries to adopt economic instruments. Iceland, New Zealand, Australia, Canada and the countries of the EU have played a pioneering role in this regard. Administrative instruments are often criticized for their rigidity and limited incentivizing power, as they struggle to foster individual interest in conserving the common resource (stewardship).

Since 2012, the Mauritanian government has reviewed its management by making changes to the legal regime with the introduction of a new policy, the Sustainable Fisheries Management and Development Strategy (original in French: Stratégie d'Aménagement et de Développement Durable des Pêches) in 2015–2019. This strategy now introduces fishing quota concessions to be granted either to a national regime or to a foreign regime (IMROP, 2014; Kane et al., 2022). The adoption of this system of individual catch quotas also puts an end to the chartering and free license regimes.

In Mauritania, the 2012 transition to economic instruments for regulating access to resources involved the adoption of non-transferable individual rights systems rather than taxation. Several factors contributed to this shift, including the resistance of fishing companies to the introduction of a proportional tax on fisheries income, which they perceived as belonging to them. Regulating access using a tax poses technical difficulties as well, especially in determining the tax rate in relation to the resource Similar to administrative methods, the main drawback of taxation is that it fails to incentivize fishing operators to take an interest in conserving the resource. On the other hand, a system of transferable individual rights can fulfil this role, as the access rights held by a fisherman are recognized to have an explicit monetary value, listed on their company's balance sheet, similar to their boat. This value depends on the state of fish stocks, which is likely to encourage the holder to closely monitor the situation of their Maximum Sustainable Yield. The issue of Maximum Economic Yield must also be considered from this perspective, as demonstrated by the Dutch example of the 'co-management groups' established to improve ITQ management. This type of fisheries management, using individual transferable quotas (ITQs), has been advocated in several countries (Grafton, 1996).

The experience of countries that have adopted this system for collecting rents and managing access to fishery resources indicates that, in the majority of cases, the most delicate issue is that of the initial allocation of rights. Here too, the issue is essentially one of planning policy, with reference in principle to current social standards in terms of equity. Even if, from a technical point of view, the initial allocation does not condition the effectiveness of a mechanism based on transferable rights, setting up such a mechanism is politically difficult in the absence of a minimum consensus on this issue. This consideration most often leads governments to initially allocate rights free of charge, based on fishing history (grandfathering). This type of operation is often likened to 'privatizing the resource'. This interpretation seems to be based on confusion between the resource itself and the sharing of the income from it among the various users. In an ITQ system, for example, individual quotas are typically defined as permanent percentages of a Total Allowable Catch (TAC), which is periodically revised by the fisheries management department based on scientific advice from the Mauritanian Institute of Oceanographic Research and Fisheries. Foreign operators, therefore, do not own the resource but hold the right to a concession to exploit, under defined conditions, a certain percentage of the resources that the Fisheries Department opens up to fishing. This transferable right of use may itself have a greater or lesser degree of liquidity and legal certainty, making it similar to a right of ownership.

This management system appears to be more satisfactory as it can generate additional revenue to meet the financial needs of the sector, including funds to strengthen fisheries management and institutional capacity building. Moreover, it is expected to enhance the monitoring and control of pelagic fleets while preventing conflicts with national fleets over target species and fishing grounds. Additionally, it has the potential to increase the economic utilization of underexploited stocks and may contribute to improve the use of landed fish through onshore processing.

A comparative analysis of the implementation of ITQs should be conducted to assess the contribution of fisheries to the national economy, focusing on the case study of small pelagic fisheries. The economic evaluation of performance faces significant challenges, including the inherent complexity of the two new systems (national and foreign) and the ability to identify all operating costs. Moreover, difficulties arise in integrating interdisciplinary research used to characterize the new ITQ regulation systems, as well as the necessity to collect data on operating costs and to define the scope of economic evaluations of the fishing units.

5 | CONCLUSION

The analysis of small pelagic fisheries in MEEZ reveals a significant shift from the chartering system to the free license regime in terms of landed value. The revenue generated from free licenses has surpassed that of chartering since 1996, accounting for an average of 81% of the total value of all industrial small pelagic fisheries during the first decade of 2000. While the catches from the chartered segments contribute less than 20% of the volume, they still play a substantial role in the total revenue of pelagic fisheries (2000–2010, over 20 million MRU in revenue [68% of the total revenue]). It is important to note that segments with larger fishing capacity, in terms of the number of

vessels, achieve better economic results in terms of added value. The proportion of free licenses increased significantly, reaching over 80% of the total number of pelagic vessels between 2006 and 2010, compared to less than 8% before 1995. However, despite the significant contribution of free licenses to the overall revenue of small pelagic fisheries, there are challenges associated with the costs of these segments. Annual refit costs, depreciation costs, wage costs and diesel consumption costs constitute a substantial portion of the turnover, which hampers the profitability of the sector. Although the number of vessels under charter has decreased over the years, it has not substantially reduced the revenue generated by this system.

From a fiscal standpoint, the chartering system is subject to more stringent fiscal management measures as compared to free licenses. While free licenses dominate the small pelagic fisheries sector in terms of sales, charter licenses generate higher revenue rates, accounting for 68% of the total pelagic revenue for the period 2000 to 2010. The decline in charter licenses since 1996 can be attributed to changes in management measures and the method of tax revenue collection. The implementation of new fisheries management measures in 2012, including access to pelagic fisheries, brought changes to the sector. While implementing an ITQ system in Mauritania presents certain technical challenges related to surveillance and enforcement by authorities, it undeniably aligns with the intention to promote the sustainability of pelagic fisheries resources. This is because Mauritanian fishermen are directly incentivized to take an active interest in conserving the resource due to their ownership of transferable fishing rights, which have explicit monetary value and are listed on their company's balance sheets. With the enactment of the Fisheries Act in 2015, the policy and institutional framework for access regimes underwent significant revisions. The introduction of a national regime and a foreign regime based on Total Allowable Catches and fishing quotas aims to generate additional revenue to meet the financial needs of the sector, including strengthening fisheries management and institutional capacity building. This new arrangement also seeks to enhance the monitoring and control of foreign pelagic fleets, prevent conflicts with national fleets and promote the economic utilization of underexploited pelagic stocks, including onshore processing. To increase income from fishing, further economic studies are necessary. Exploring the potential of exploitation by national and foreign regimes, as well as the development of industrial processing and landings, is a potential strategy to increase Mauritanian government revenues.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID


Patrice Brehmer https://orcid.org/0000-0001-8949-9095

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