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Economic trends of industrial double-rig bottom trawlers in Southeastern Brazil

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ABSTRACT

This work presents an analysis of the economic performance of pink-shrimp trawlers in Rio de Janeiro, Brazil, evaluating the temporal trends and factors determining total costs and profitability. The period comprised three years, and data from seven vessels were used in each year. Total costs were composed of variable costs, fixed costs and depreciation costs, and the economic performance was accessed considering multiple indicators. Total costs structure showed a similar composition between the crew share and fuel cost, following by vessel maintenance and commercial costs. Variation of cost items and total costs per trip were not statistically different between years. Economic performance analysis revealed that vessels exhibited considerable yearly variation for the evaluated indicators. Two vessels were loss-making in a given year, and the remaining presented variable but positive profitability. Strong positive correlation between gross revenue, commercial, labor, and fuel costs, and another strong inverse correlation between economic indicators and vessel costs were revealed. Cluster analysis suggested that profitability and costs were not associated with vessel capacity. Negative profitability was not associated with revenue or running costs; instead, it arose from vessel costs, highlighting the economic consequences of an old and obsolete fleet. This fact stresses the necessity of vessel´s modernization based on replacement policies to enhance product quality, price and profitability.

1. Introduction

Commercial fisheries provide food, generate employment, and income for the population by exploiting natural resources [1]. Despite its ancient history, fisheries economic data is scarce underestimating fisheries importance to Gross Domestic Product (GDP) [2]. The latest available official data in Brazil estimated that fishing contributed about 0.15% to the GDP in 2007 [1], suggesting its minor importance to the country, under a strictly economic perspective [3]. However, from a social prospect, fisheries and aquaculture involve about 3.5 million people along the production chain in Brazil [1].

Ussif and Sumaila [4] defined an economically overexploited fishery resource as one that does not generate profit due to an excessive fishing effort. Nevertheless, the total costs of capture and ex-vessel prices may vary from year to year, influencing earnings [5–7]. Public policies acting on the sector also determine current and future fishery activity [3]. Thus, information on the economic and biological components of fisheries is necessary for business planning and management.

Lery et al. [8] argued that most developing countries do not regularly collect primary data on the costs and benefits of fisheries. Such is the case in Brazil where data collection is sparse and time-limited [9–16]. This problem is less of an issue in developed countries, perhaps due to the compulsory collection [7]. The assessment of fisheries economic performance is necessary to determine its economic viability and to evaluate the socioeconomic impacts of management and public policies on the fishing industry [5,6,17]. Additionally, this information may be used for the development of bioeconomic models [18] and fisheries extension programs [19].

Bottom trawlers show high operating costs and variable profitability worldwide [7,11,13,20–22]. The double-rig bottom trawl is a valuable fishery in the south and southeastern Brazil, ranking second highest in volume landed in 2012 [23–25]. The fishery is the second largest in Rio de Janeiro, reaching about 10,000 t landed in 2012 [23]. Most industrial vessels have the license for capturing pink-shrimp [26] but target multiple species. Shrimps are most valuable and seasonally exploited off the coast of Rio de Janeiro by local industrial and small-

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scale trawlers, and trawler fleets from other states [27–29]. Studies on the biological status of exploited stocks indicated a decline in the catch rate of pink-shrimp since the late 1980s, suggesting stock depletion and declining profitability [27]. As a consequence, vessels expanded their fishing areas to target other abundant or valuable species including Argentine hake (*Merluccius hubbsi*), monkfish (*Lophius gastrophysus*), squid (*Doryteuthis* spp.), flounders (*Paralichthys* spp.), codling (*Urophysis brasiliensis*, *U. mystacea)*, pink cusk-eel (*Genypterus brasiliensis*) and Uruguayan lobster (*Metanephrops rubellus*) [29,30]. These fishes or shellfishes, together with Pink-shrimp (*Farfantepenaeus paulensis*, *F. brasiliensis*) and goatfish (*Mullus argentinae*, *Upeneus parvus*), are the most valuable landed resources and main components of revenues from the double-rig trawler fleet, which vary seasonally depending on pink-shrimp and other resources availiability [23].

This work presents an analysis of the economic performance of pink-shrimp double-rig trawl vessels in Rio de Janeiro, evaluating the temporal trends and factors determining the total costs and profitability of their activity. Public policies applied to the sector and their potential impact on profitability will be discussed. Considering the scarcity of information for the region, locally and globally, the economic analysis of this fleet may broaden our understanding of fleet economic dynamics to support future regulation agendas.

2. Materials and methods

2.1. Data availability

Cost structure and economic performance analysis used data from nine licensed double-rig bottom trawlers targeting pink-shrimp from Niterói, Rio de Janeiro state, Brazil. The study covered three annual productivity cycles: C1 – June/2011–May/2012; C2 – June/2012–May/2013; C3 – June/2013–May/2014. Each cycle corresponded to the end and beginning of the closed pink-shrimp season.

The nine vessels represented 13% of the licensed fleet operating in the state [26] and belonged to three firms. Data for the entire study period was available for five vessels, for C1 and C2 for another two vessels, and for C3 alone for the remaining two. For each production cycle, seven vessels were analyzed simultaneously, representing 10% of the fleet. Table 1 summarizes vessels' physical characteristics.

Vessel owners provided accountability books of incomes (gross revenues) and outflows (costs). Records were kept on a monthly basis (one account). Each account covered one to four fishing trips. A total of 190 accounts and 433 fishing trips were analyzed. Vessel owners provided additional information to adjust cost items to elements of study categories, and for tangible assets, including the book value of the vessel, electronic equipment and fishing gear on the 2011 year basis. All this information constituted the database.

All nominal values (actual price in a given year) were converted to real values using the General Price Index - Internal Availability (IGP-DI) to account for inflation over a given time-period. Monthly IGP-DI data were taken from Fundação Getúlio Vargas [31]. Monetary values in Brazilian Reais (R$) were converted into US dollars (US$) using the exchange rate for May 2014 (US$1.00 = R$2.22). All values in this study are expressed in real May 2014 US$.

2.2. Total fishing costs structure

The total fishing cost analysis followed the nomenclature and indicators proposed by Tietze et al. [21] and Pinello et al. [17]. Costs and indicators were calculated overall and for each vessel, and compared between annual cycles.

Total costs were formed by the sum of total operating costs and capital costs. Operating costs were composed by the sum of variable costs and fixed costs. Variable costs reflect catch and fishing effort, and include: labor costs (crew shares, labor rights, shore workers and insurance), running costs (fuel, lubricant, ice and water, food, other crew supplies, commercial costs, harbor dues, operation of fuel subsidies, telephone and coastal radio fees, monthly VSM fees), and vessel costs (repair and maintenance of the vessel, fishing gear and electronic equipment). Commercial costs included a commission of 10% (on average) of gross revenue, paid to the respective sales agent, fish transport to the wholesale market, ice, boxes and wholesale market fees. The fixed costs include monthly class representation fees, vessel insurance, and annual license fees for the vessel and vessel owner.

Depreciation costs was used to express the capital costs. Since all analyzed vessels were more than 25 years old, all were technically depreciated. The depreciation cost was calculated by the linear method as proposed by Tietze et al. [21], which considers a rate of 2% per year for vessels after the end of their theoretically useful life, 4% for motors and 6.7% for electronic equipment. Opportunity cost of capital was considered as a constant rate of 5.5%, which represents a 5-year average (2010–2014) of the nominal long-term interest rate [7,32]. The use of a constant rate for the opportunity cost of capital would avoid most of the problems the use of interest rates carry [7]. This indicator, a proxy of productivity, reflects the rate of return on capital compared to an alternative activity and was used as a benchmark for NPM and RoFTA evaluation (see below) [7,17]. Investments were not included in the analysis.

A PERMANOVA (a multivariate permutational analysis of variance) based on a standardized dissimilarity matrix of Euclidean distances and a significance level of $p < 0.05$ was used to assess differences between annual total cost and variable costs per trip. This method is designed to deal with non-parametric data, and consider all costs components simultaneously [33,34]. For testing homogeneity of dispersion of variable between annual cycle, as grouping factor, the PERMDISP test was applied ($p < 0.05$) [33,34].

Table 1
Physical characteristics of industrial pink-shrimp double-rig trawlers of Niterói harbor, Rio de Janeiro, Brazil. CV – coefficient of variation (%).

Vessel	Length (m)	Gross tonnage	Engine power (HP)	Year of construction	Storage capacity (t)	Hull material
1	20	59	240	1969	15	Iron
2	21	70	400	1969	20	Wood
3	19	89	375	1986	25	Iron
4	23	78	290	1969	20	Wood
5	20	81	325	1972	30	Iron
6	20	41	267	1970	14	Wood
7	22	73	325	1971	14	Wood
8	20	47	320	1970	20	Wood
9	20	59	350	1968	23	Wood
Mean	21	66	321	1975	20	
CV (%)	6	24	16	1	27	
Median	20	70	325	1970	20	

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