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Fisheries Subsidies in Tunisia: A Comprehensive Analysis

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***Abstract*— The fishing industry plays a crucial role as a source of income for the coastal population. In order to ensure its development, several incentives and measures have been applied to the fishing sector in Tunisia. In our article, we focused on the evaluation of public policies and we took the case of the bluefish sector, which has benefited from a specific development program. The modeling evaluation of bluefish specially sardines enabled us to analyze the impact of investment, fuel and operating subsidies for exploitation of sardines. It was shown that fuel and investment subsidies have an indirect effect on fishermen's income. Operating subsidies for exploitation of sardines, on the other hand, have a direct effect on fishermen's incomes, and have a social cost. It would therefore be preferable to redirect part of fuel subsidies towards greener, more environmentally-friendly tax reforms.**

***Keywords*— subsidies, blue fish, sustainability, bioeconomy, modeling**

I. INTRODUCTION

Fisheries subsidies are considered as a key issue for trade and sustainable development, given the complex relationship between trade and profit on one hand, and ecological and socio-economic sustainability on the other (e.g. [1]). In 2022, the World Trade Organization (WTO) Agreement prohibited subsidies for Illegal, Unreported, and Unregulated (IUU) fishing, overfished stocks, and unregulated high-seas fleets (e.g. [2]). In Tunisia, the situation in the fisheries and aquaculture sector has become increasingly worrying due to declining fisheries resources and the depletion of fish stocks. Several studies denounce the impact of overfishing and (IUU) fishing on biodiversity (e.g. [3]). It is important to note that other factors may be contributing to this imbalance, including subsidies applied to the fisheries sector. This is why it is interesting to understand the extent to which subsidies encourage the excessive exploitation of these resources. It is true that subsidies have long contributed to economic development and played a valuable social role, but what are the benefits? Therefore, through our article, we will try to provide a comprehensive response to the aforementioned questions. This paper sets out to evaluate the impact of subsidies, focusing specifically on those allocated to the bluefish sector.

II. METHODOLOGY

A. Study area

The selected study area is the Gulf of Gabes region, located in southern Tunisia and it is situated in the eastern part of the Mediterranean Sea. It stretches from Cape Ras Kaboudia to the Libyan border (e.g. [4]).

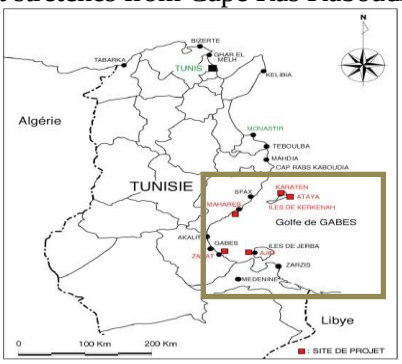

Fig. 1 Study area map's: Gulf of Gabes, Tunisia

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It's a region known for its rich marine biodiversity and economic importance within the Mediterranean basin. It hosts a significant portion of Tunisia's fishing activity, around 49.3% of the national fishing fleet (e.g. [5]). In our research we will focus on the evaluation of the impact of subsidies on bluefish specially *Sardina pilchardus* species. In fact, stock assessments have shown that this species is abundant in this region (e.g. [6]).

B. Bioeconomic model

Understanding the basic issue of fishing subsidies and overcapacity can be facilitated by a fishing model. In this research, we will use a bioeconomic model (e.g. [7]). Assume that the instantaneous profits of individual fishing companies are defined by the function π as follows:

$$\pi = \mathbf{p.Y(e, x) - C (e) -\sigma.Y(e, x) + S(e,Y(e,x))} \quad \mathbf{(1)}$$

Where: Y(e,x) operating function and fishing effort
x biomass of fish stocks
p price of a unit of production
C (e) capture costs
σY(e,x) reflect the opportunity costiIn an Individual Transferable Quota (ITQ) fishery
σ market price of a unit of quota
$S(e,Y(e,x)) = s_0 + s_1.e + s_2.Y(e,x)$ s_0 :flat-rate subsidy, s_1: subsidies for catches, s_2: fishing effort

In our research, we will draw inspiration from Arnason's model. In fact, Tunisian fisheries is not regulated by a quota system, "σ.Y(e, x)," should be equal to zero. The equation that will then be used is as follows:

$$\pi = \mathbf{p.Y(e,x) – C(e) + S(e,Y(e,x))} \quad \mathbf{(2)}$$

However, the approach consists in collecting data either from public institutions or from fisheries research institutions and we identified and calculated others using formulas from the literature. We used 30 observations covering the period 1993-2022 that we integrate into the model by using R software. We found three types of subsidies applied in Tunisian bluefish sector:

- Subsidy related to investments: concerns the modernization new vessels that influences the number of fleets. Therefore, this subsidy "S_{1e}" may have an effect on fishing effort.
- Subsidy related to fuel that have an impact on the costs incurred by fishermen and indirectly influence fishing effort. The fuel subsidies "S_{2e}" may have an effect on fishing effort.
- Subsidy related to operating subsidies for exploitation of sardines "S_{1c}"encourage fishermen to catch more.

C. Scenario's simulation

Having defined the parameters, we will now specify the links between the different parameters using equation (2) of the model. We must first define the reference situation to compare the different scenarios. The model's responses will be studied according to the changes made to the various subsidies (Table 1).

TABLE I
SPECIFICATIONS OF THE SCENARIOS

Scenarios	Fishery	Cost	Landing price	Subsidy S_{1e}	Subsidy S_{2e}	Subsidy S_{1c}
Reference scenario	Free access to the resource	Constant	Constant price	Exists + constant	Exists + constant	Exists + constant
Scenario 1	Free access to the resource	Constant	Constant price	Exists + constant	Non-existent	Exists + constant
Scenario 2	Free access to the resource	Constant	Constant price	Exists + constant	Exists + 20% reduction	Exists + constant
Scenario 3	Free access to the resource	Constant	Constant price	Non-existent	Exists + constant	Exists + constant
Scenario 4	Free access to the resource	Constant	Constant price	Exists + 20% reduction	Exists + constant	Exists + constant
Scenario 5	Free access to the resource	Constant	Constant price	Exists + constant	Exists + constant	Non-existent
Scenario 6	Free access to the resource	Constant	Constant price	Exists + constant	Exists + constant	Exists + 20% decrease
Scenario 7	Free access to the resource	Constant	Constant price	Non-existent	Non-existent	Non-existent
Scenario 8	Free access to the resource	Constant	Constant price	Exists + 20% reduction	Exists + 20% reduction	Exists + 20% reduction

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III. RESULTS AND DISCUSSION

A. Analysis of the situation with and without subsidies

We first started by comparing between the situation of reference and the situation without subsidy. This situation was translated at the level of the Scenario 7.

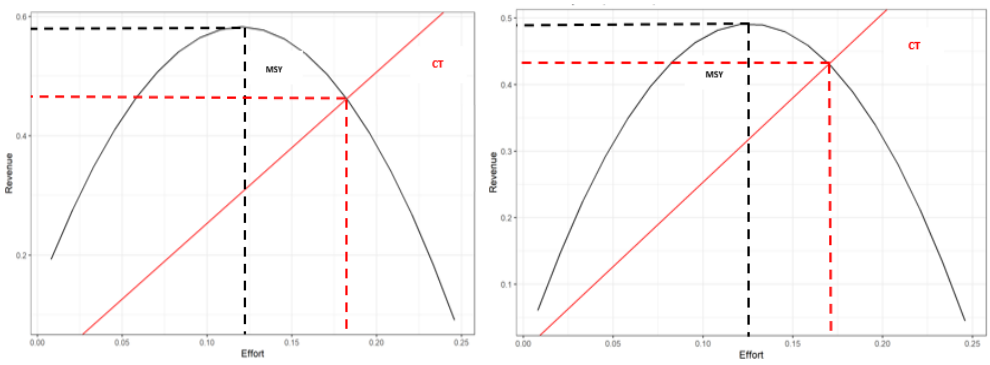

Fig. 2 Comparison between the situation with subsidies (a) and without subsidies (b)

In Fig. 2 we see that there is a variation in the cost curve, an increase in total costs. A second variation is detected at the level of revenue which has decreased. We see that for the situation where the Government does not give subsidies to blue fish fishermen, the bioeconomic equilibrium will change: costs will be higher than revenue. The Maximum Sustainable Yield (MSY) reference point have been affected by the situation of absence of subsidies granted by the Government. We can conclude that fishing subsidies are essential for blue fish fishermen due to the impact on their income.

B. Effect of a variation in "S_{2e}" fuel subsidies

To further detail, we introduce the results obtained by the model during the different scenarios. We will take the first two scenarios which studied the effect of a variation in the "S2e" fuel subsidies (elimination or reduction of 20%).

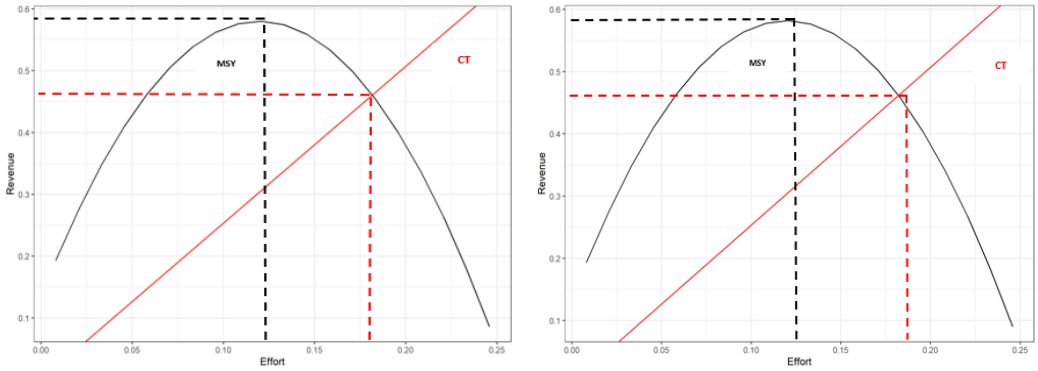

Fig. 3 Scenario 1: elimination S_{2e} subsidies (a) Scenario 2: 20% reduction S_{2e} subsidies (b)

Fig. 3 shows an impact on the cost curve and a variation of the MSY and the bioeconomic equilibrium. While the complete removal of fuel subsidies has a measurable impact on fishing effort and sustainability metrics, a 20% reduction appears too modest to significantly influence outcomes. This suggests that gradual or partial reductions in fuel subsidies may not be effective on their own in steering the sector toward sustainability.

C. Effect of a variation in investment subsidies "S_{1e}"

To study in detail the effect of a variation in investment subsidies "S_{1e}", we will take scenarios 3 and 4

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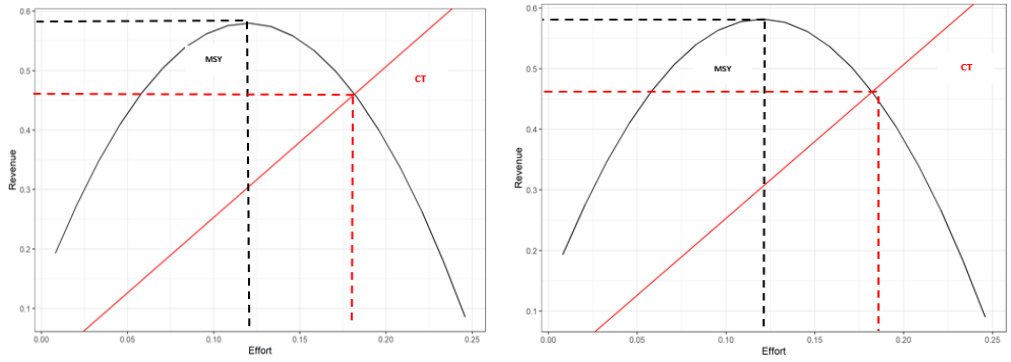

Fig. 4 Scenario 3: elimination S_{1e} subsidies (a) Scenario 4: 20% reduction S_{1e} subsidies (b)

Similarly, Fig. 4 show there is an impact on the cost curve and a variation in the MSY and the bioeconomic equilibrium. As a result, investment subsidies lead to an increase in fishing effort and a decrease in stocks. We see that these subsidies have a relatively smaller impact than fuel subsidies.

D. Effect of a variation in operating subsidies for exploitation of sardines "S_{1c}"

As for the effect of operating subsidies for exploitation of sardines"S_{1c}" we will detail scenarios 5 and 6

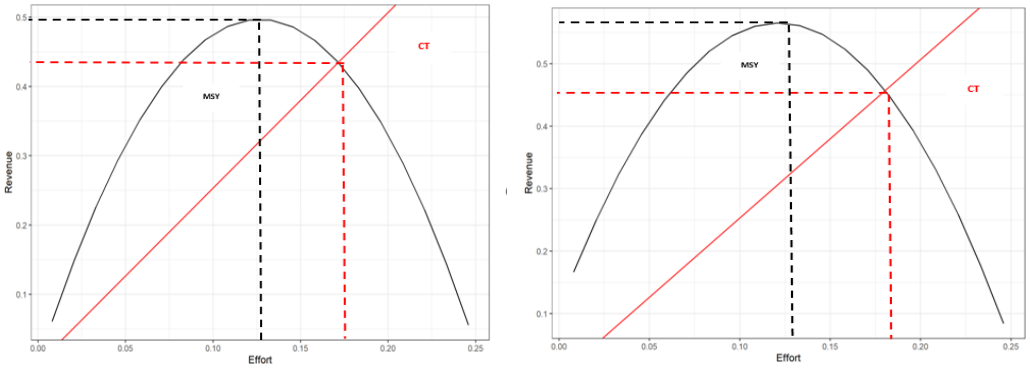

Fig. 5 Scenario 5: elimination S1c subsidies (a) Scenario 6: 20% reduction S1c subsidies (b)

The elimination of the subsidies to encourage the exploitation of sardines have an effect on the revenue curve so a significant effect on the income of fishermen. For the 20% reduction in "S_{1c}" we have noted a decrease in income. The variation of this subsidy has a direct effect on the income of fishermen.

E. Effect of removing and reduction "S_{1e}" "S_{2e}" "S_{1c}"

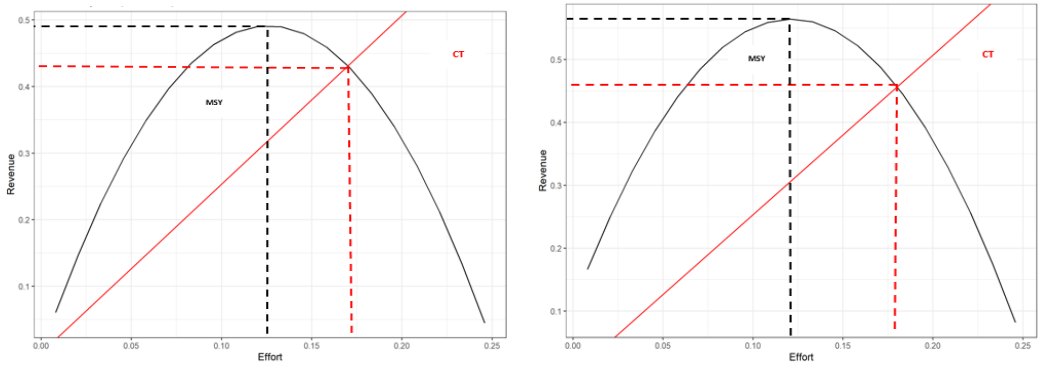

Fig. 6 Scenario 7: elimination all subsidies (a) Scenario 8: 20% reduction all subsidies (b)

Fig. 6 show that the elimination of all subsidies resulted in a slight change in the slope of the total cost curve. Regarding income, we notice that it has decreased considerably. Eliminating all subsidies has a considerable effect on fishermen's income. The 20% decrease in all subsidies led to a variation in the effort at

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point MSY as well as a slight change in the equilibrium point. A slight change in the slope of the total cost curve. We have, moreover, noted a decrease in income. The variation in these subsidies impacts the income of fishermen.

F. Bioeconomic model as decision support tool

The analysis of the eight scenario sheets highlights the direct impact of operating subsidies for exploitation of sardines on fishermen's income. The effect of these subsidies directly affects fishermen's profits. Regarding fuel and investments subsidies, they had a slight impact on the cost curve. In fact, these subsidies have been described as fishing effort subsidies. (e.g. [8]) Chaboud et al 2014 performed a simulation of the decrease in unit cost led to an increase in fishing effort. It's highlighted the potential impact of fuel and investment subsidies that lead to an increase in fishing effort as well as a decrease in fish stocks, in our case sardines. We can conclude that in the long term these subsidies do not improve economic results if the effort is not regulated. Furthermore, the Tunisian government should have focused more on catch subsidies. Similarly, a study conducted on the effects of fisheries policies concluded that supporting fishermen through fuel subsidies was very costly for governments, it's around USD 5.4 billion in 2015 (e.g. [9]). This model has certainly contributed to an assessment of the impact of these subsidies, but it has certain limitations. Therefore, a more in-depth study integrating all factors would allow for a more comprehensive analysis.

IV. CONCLUSIONS

Fisheries subsidies remain a multifaceted policy, capable of driving both ecological collapse and socio-economic progress. The WTO Agreement represents a critical step toward sustainability. In Tunisia, targeted subsidy programs like the bluefish development initiative aim to enhance socio-economic outcomes but face challenges in balancing economic growth with ecological sustainability. After analyzing the results, we can have some recommendations. In case of investment subsidies, we should raise the premium for sustainable development and to be more specified to blue fish. About fuel subsidies, we have to review the mechanism by adopting a quota system based on average consumption per boat. For Operating subsidies for exploitation of sardines, we can maintain as they have a direct impact on fishermen's income.

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