ISSN 1110-0354

Bull. Nat. Inst. Of Oceanogr. & Fish., A.R.E., 2000. Vol. (26): 223 - 239

USING RISK ANALYSIS FOR ECONOMICS OF EGYPTIAN TRAWL FISHERIES IN MEDITERRANEAN WATERS

By

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Key words: Risk margin, Acceptable profit margin, Probabilistic approach, Normal density function, Coefficient of variation, Cumulative distribution function.

ABSTRACT

This study was carried out to estimate minimum levels of profit margin to satisfy an acceptable predetermined risk for investments of fishing trawlers in Mediterranean Eastern- Harbour center in the year 2000, with regard to power-engine capacity as well as fishing grounds of both home fisheries and off- waters.

The reliability of the various deterministic approaches for the prediction of profitability of trawlers is indicated, the probabilistic approach is presented to estimate coefficient of variation (C.V.) of both Revenue and Expenditure factors. Profitability factor (γ) was evaluated so as to satisfy a projected investment at an acceptable degree of risk.

The analysis is based on the assumption that Revenues and Expenditures follow the Normal Density Function. Profitability factor (γ) of fishing vessel was calculated from profitability index (β), the later from Revenues, Expenditures and their coefficient of variation.

This study revealed that high productive and economic indices were shown with small motor trawlers compared to big one for home

fisheries and big trawlers of long-range fisheries compared to that of home fisheries.

Estimated statistical parameters for minimum quantity of future fish catch are found to be very close to corresponding parameters which were already realized by sample trawlers in each group in the year 2000.

It is suggested to re-allocate Egyptian big motor trawlers in EEZ and off-fisheries to: 1) Improve their productive and economic performances. 2) Relief existing fish stocks in Egyptian medium fisheries in the Mediterranean suffering from over exploitation.

INTRODUCTION

Twelve fish landing centers are located alongside Egyptian Mediterranean coast. Eastern-Harbour center in Alexandria governorate is one of the major centers. Its average contribution in Egyptian fish Landing from the Mediterranean was about 30% annually. (Nat. Inst. Oceanogr. & Fish., 1990).

Trawling is the most predominate fisheries in the center; it contributed more than 65% of total gears fish catch such as purse seining, lining and gill-nets. The engine-power capacity of licensed trawler in Eastern-Harbour is ranged from 80 horse power (H.P.) to 230 H.P. (El- Karachily, 1991).

Fishing agreement between Lybian and Egyptian governments allowed a group of Egyptian Trawlers to catch from Lypian fisheries. Power capacity of trawlers working in Lybian fisheries ranged from 200 to 230 H.P.

Marine fisheries are generally characterized by high risk margin and uncertainty affecting quantity as well as value of the expected catch. (Gerhardse, 1963). Risk means future outcomes that can be defined and statistically measured and forecasted. On the other hand, Uncertainty means future outcomes that is un-known and cannot be measured statistically. It should be emphasized, that the cost of design, construction and fitting out of a modern fishing vessel is rather high. This requires a rational procedure for

estimating Revenues and Expenditures so as not to over invest in a fishing vessel to operate in a fishing condition with limited resources, revenues and/or high expenditures. Therefore, the compatibility among Revenues, Expenditures and Initial Investment cost should be very carefully examined so as to ensure an acceptable profit margin. (Shama, M. A., 1990).

Investment decisions on coastal fishing should be based not only on the expected revenues and expenditures but also on their expected variations. It is possible to estimate the minimum required Production/ Revenue to satisfy a projected investment at an acceptable degree of risk. Statistical data should be collected on the various items of revenues and expenditures so as to formulate the variability profiles of all elements affecting both revenues and expenditures.

The analysis of Revenues, Expenditures and Profit obtained from trawl fishing Vessels operating under conditions subjected to elements of Risk and Uncertainties. Profitability of fishing vessel should be based on an acceptable Risk determined from the Uncertainties associated with the parameters affecting both Revenues and Expenditures.

Economic performance of motor fishing boats is measured by total Expenditures (fixed and variable costs), total Revenues and resultant profitability, which is the difference between total Revenues and total Expenditures.

Aim of Study

This study aims to:

(1) Evaluate Productive and economic performances of fishing motor-boats using trawl nets based in Eastern-Harbour center in Alexandria in the year 2000 and run by private sector according to power-engine capacity as well as fishing grounds (home fisheries and off-waters).

(2) Determine Minimum levels of quantity of fish landing and profit margin to satisfy an acceptable predetermined risk for investments in fishing trawlers by power- engine capacity and fishing grounds.

MATERIAL AND METHODS

The statistical economic approach by (Shama, M. A., 1990) is presented to help making investment decisions in trawl fishing. The relevant measures of profitability are identified and given. The reliability of the various deterministic approaches for the prediction of Profitability of fishing vessels (trawlers) is indicated. The Probabilistic approach for evaluating trawler fishing vessel economics is presented.

This study is concerned mainly with the analysis of Revenues, Expenditures and Profit obtained from trawl fishing vessels operating under conditions subjected to elements of uncertainties. It is known that fishing vessel profitability should be based on an acceptable Risk determined from the uncertainties associated with the parameters affecting both Revenues and Expenditures.

Data needed for the study was gathered from General Authority for Fish Resources Development (GAFRD) and about elements of fishery exploitation and other information on these trawlers has been collected in the year 2000 on questionnaire basis, where boats owners, fishermen and other related personnel have been interviewed by the author.

Sample trawler has been grouped in this study into three groups.

Group I: Trawlers of engine horse-power (H.P.) capacity from 150 to less than 200 H.P. and working in medium range home fisheries (territorial waters).

Group II: Trawlers of 200-230 H.P. that is working in medium range home fisheries (territorial waters).

Group III: Trawlers of 200-230 H.P. that is working occasionally in Lybian fisheries as long-range off-fisheries.

A weighted sample of trawlers in each group has been randomly selected of size 13 boats in the group I, 12 boats in the group II and 15 trips in group III.

Data on elements of fishery exploitation has been collected about each fishing trip for each selected trawler as follows.

Days at sea: It is total days absent from port. it embraces sailing days and actual fishing days.

Fixed costs: It is un-avoidable or over-head costs. It represents money outlay whether a fishing trip is performed or not. It embraces depreciation (body of trawler, engine, winch and gear), maintenance, Fixed Salaries, License fees,....etc.

Variable costs: It is direct or operating costs. It represents money outlay that is related to size of fishing activity. It embraces variable wages, fuel and oil, repairs, packing material, ice, food for crew, marketing and other variable costs.

Quantity of catch: The quantity of catch in k.g. has been collected for each trip according to species composition.

Revenues: It is total quantity fish catch multiplied by its ex-vessel price. Fishing Revenues = Fish catch x whole-sale price

Profitability

Measure of profitability in economic feasibility for decision making for investment in fishing motor boats is given by: (Taylor, G. A., 1968).

$$M = R - E$$

Where:

M = annual profit
R = annual revenue
E = annual expenditure

Statistical Parameters of Revenue

Revenues and Expenditures are not deterministic values as the parameters affecting both are subject to elements of uncertainties.

Annual revenues depend on the composition of species, catch volume and ex-vessel price of each species. (Shama, M.A., 1989). It is evident that in fishing operations, the annual revenues are very unpredictable and rough estimates are always used for the expected catch volume.

The annual revenue "R" is given by :

$$R = Q.C.$$

where :

Q = annual fish production, k.g.
C = average price per k.g. of fish produced

Since Q and C are statistically independent, and could be assumed to follow the normal density function, the revenue "R"also follows the normal p.d.f.: (Meyer, P.L., 1965)

$$\text{i.e} \qquad R = \bar{N}(\bar{R}, \sigma_R)$$

where :

$$\bar{R} = \bar{Q} \times \bar{C}$$

$\bar{X}$ = mean value of x, x = Q , C
σ_x = standard deviation of x, x = Q , C

Statistical Parameters of Expenditure

The annual expenditure "E" is given by: (Shama, M.A., 1989)

$$E = E_F + E_V$$

Where:

E_F =sum of all annual fixed cost items
E_V = sum of all annual variable cost items

Analysis of cost elements show that the annual fixed cost "E_F" depends almost totally on the capital investment cost of the ship, whereas the annual variable cost element "E_V " depends on the fishing trip cost, value of catch, exploitation time, engine power, competency of the crew, etc. [10]

Therefore, the statistical parameters of the annual expenditure "E" could be estimated as follows:

$\bar{E} = \bar{E}_F + \bar{E}_V$ F,V statistically independent,
$\sigma_E \approx \sigma_{EV}$

where: σ_X = standard deviation of x, x = E, E_V.

The mean value of Annual expenditure could be estimated using available data from similar vessels operating under similar fishing conditions. The cost of capital could be assessed using published data on the prices of similar fishing vessels.

Statistical Parameters of the Profit Margin.

The profit margin "M" is given by:

$$M = R\text{-}E > 0$$

Therefore, the statistical parameters of "M" should be derived from the statistical parameters of both "R" and "E".

It is evident that the calculation of M and σ_M depends on the estimation of R, E, σ_E, σ_R. Since R and E are functions of several other parameters: (Bolotin, V. V., 1968).

$R = R(x_1, x_2, \ldots x_n)$, and $E = E(y_1, y_2, \ldots y_m)$

The mean and variance of "R" and "E" can be approximated using linear Functions as follows:

$\bar{R} = R(\bar{x}_1, \bar{x}_2, \ldots \bar{x}_n)$ and $\bar{E} = E(\bar{y}_1, \bar{y}_2, \ldots \bar{y}_m)$

$$\sigma^2_R = \sum_{j=1}^{n} (\hat{c}\, R/\hat{c}\, x_j)^2 . \sigma^2_{xj}$$

$$\sigma^2_E = \sum_{j=1}^{n} (\hat{c}\, E/\hat{c}\, y_j)^2 . \sigma^2_{yj}$$

It is evident that Annual Revenues and Expenditures are interrelated in so far as crew share & competency are concerned. This interrelationship depends on various factors; among them are Management Policy, Incentive Schemes, Condition of Vessel, etc. To take all these factors into account in the determination of the statistical parameters of the Profit Margin, will make the

problem a very complex one. However, it is possible, under certain conditions, to assume that Revenues and Expenditures are statistically independent, without seriously affecting the results and conclusions.

Assuming that both "R" and "E" follow the Normal distribution, then the margin "M" also follows the Normal distribution, see Fig. (1), i.e.:

$$M \equiv N(\bar{M}, \sigma_m)$$

where $\bar{M} = \bar{R} - \bar{E}$

$\sigma^2_M = \sigma^2_R + \sigma^2_E$ R,E statistically independent.

Hence, the probability of making a loss "P_L" is given by, see Fig. (1)

$$P_L = P(R < E) = P(M < 0) = \int_{-\infty}^{0} p_M(m)\, dm$$

In order to simplify the calculation of "P" assume the following:

$$\beta = \bar{M} / \sigma_M \qquad \gamma = \bar{R} / \bar{E}$$

Then

$$P_L = 1 - \varphi\{(\gamma - 1) / \sqrt{\gamma^2 . v^2_R + v^2_E}\}$$

where: $v_x = \sigma_x / \bar{x}$, $x = R, E$

v_x = coefficient of variation of x, $x = R, E$

The variation of "P_L" with the profitability factor, " γ " and the coefficients of variation of Revenue and Expenditure, i.e. v_R and v_E is shown in Figs. (2, 3), for R = Normal and E = Normal.

Using the concepts given in reference (Shama, M.A., 1981), the average revenue required to satisfy an expected annual expenditure and an acceptable degree of risk could be estimated from the following equation:

$$\bar{R} \geq \bar{E}\ \{1 + \sqrt{\gamma^2 . v^2_R + v^2_E}\ . \varphi^{-1}\}\ (1 - P_L)$$

Where: $\varphi(x)$ = cumulative distribution function

From this average Revenue, the required annual quantity of fish landing could be estimated and then evaluated for justified possible investment.

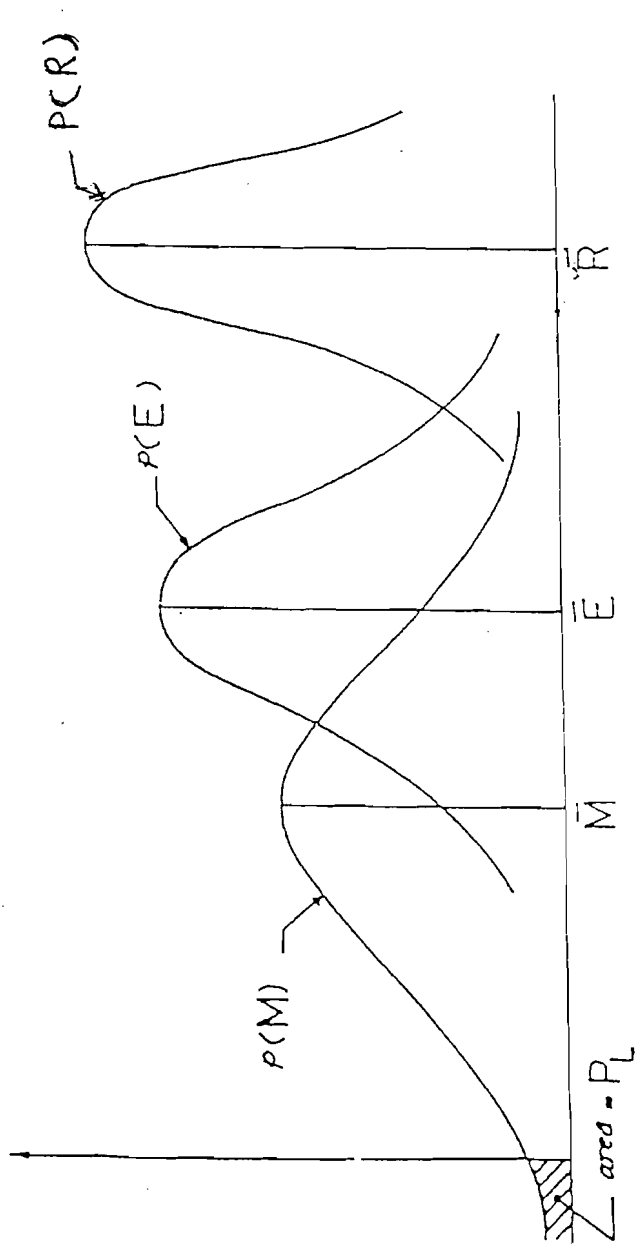

Fig. (1): ***Hypothetical curves of Revenue "R", Expenditures "E" and the resultant Profit "M" following the Normal distribution and the Probability area of making a loss "P_L"*** [1]

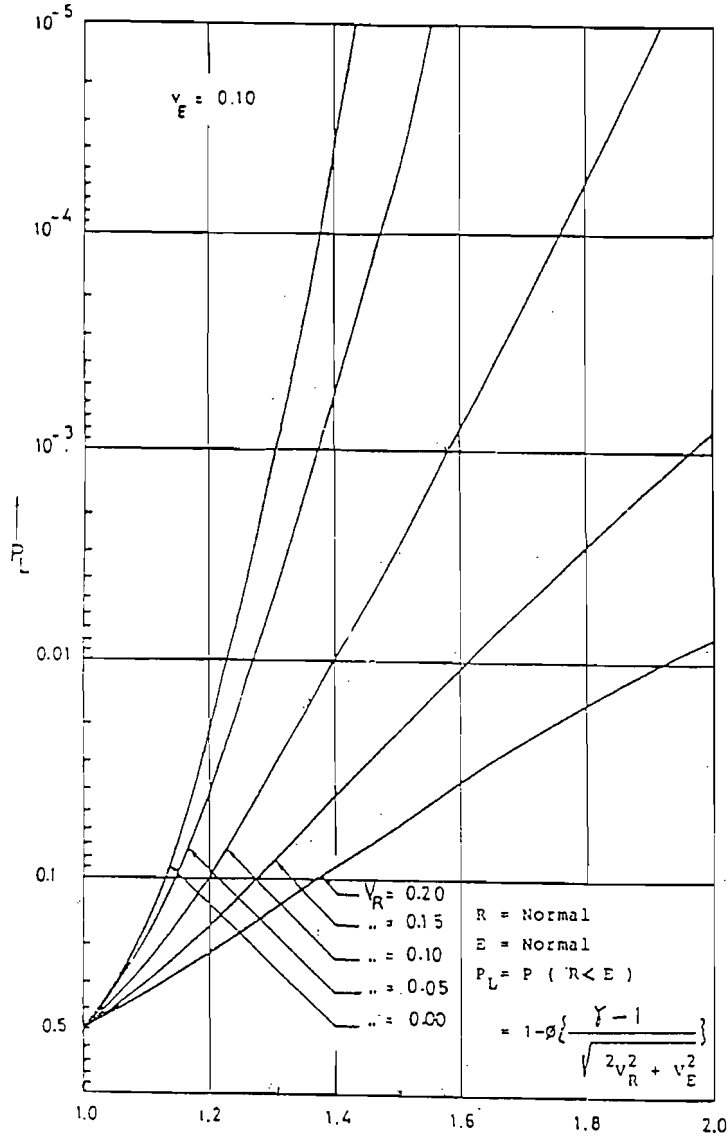

Fig. (2): *The variation of "P_L" with the profitability factor " γ " and the coefficients of variation"C.V." of Revenue" v_R "and Expenditure" v_E ".*

$v_E = 0.10$

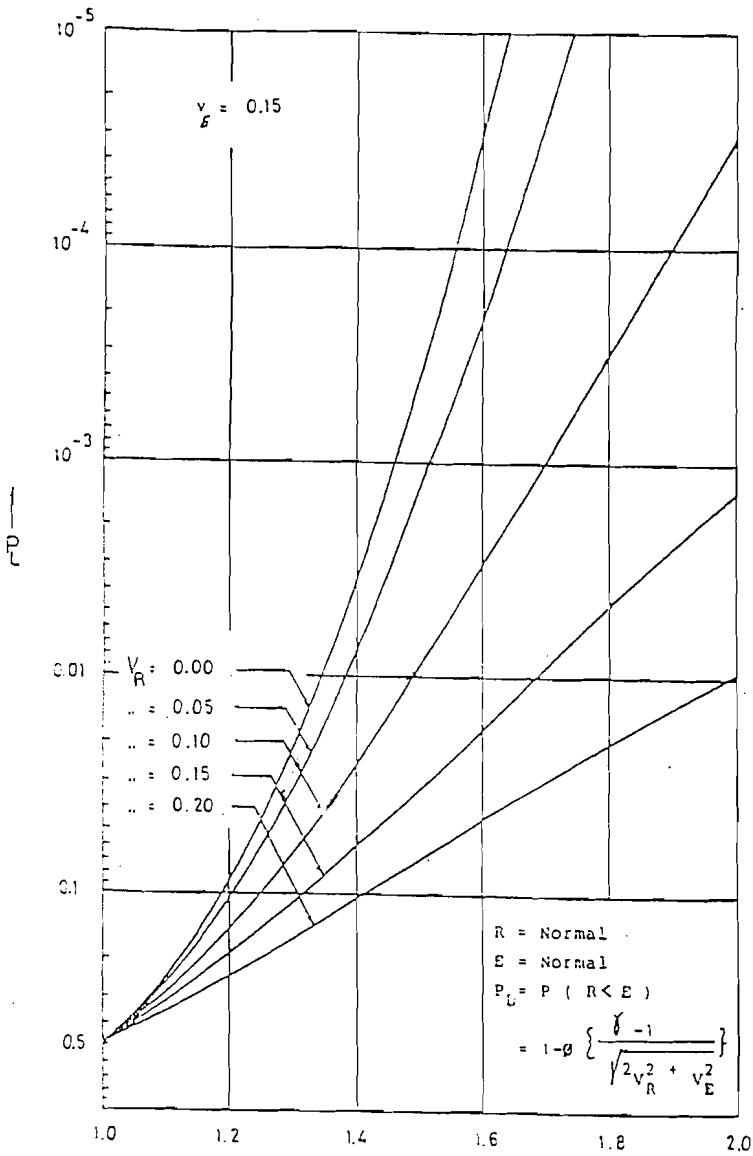

Fig. (3): *The variation of "P_L" with the profitability factor " γ " and the coefficients of variation"C.V." of Revenue" v_R "and Expenditure" v_E ".*

$v_E = 0.15$

Analysis of Profitability Factor

The profitability factor " γ " could be separated into two factors: (Shama, M.A., 1981).

$$\gamma = \gamma_R \cdot \gamma_E$$

where: γ_R revenue factor

γ_E expenditure factor

The revenue factor, γ_R , takes account of all factors having adverse effects on annual revenues such as lower catch rates, reduced exploitation time, low quality species, bad weather, etc. The expenditure factor " γ_E " takes account of all factors having adverse effects on expenditures such as frequent breakdowns, high maintenance and repair costs, etc.

Using the assumption given in reference (Ang, A. and Carnell, C.A., 1974), we have:

$$\sqrt{\sigma^2_R + \sigma^2_E} \sim 0.75 (\sigma_R - \sigma_E)$$

Then: $\gamma_R = 1 / (1 - 0.75 \beta V_R)$ $\gamma_E = (1 + 0.75 \beta V_E)$

Therefore, for an acceptable degree of risk, β, and coefficients of variation V_R and V_E, the Revenue and Expenditure factors γ_R and γ_E could be estimated. Then the profitability factor could be also evaluated as follows:

$$\gamma = (1 + 0.75 \beta V_E) / (1 - 0.75 \beta V_R)$$

The variation of γ with β, V_E and V_R are given in the following table: (Shama, M.A., 1990).

V_R	V_E	γ		
		β		
		2	3	4
0.1	0.1	1.353	1 .581	1.857
	0.2	1 .529	1.871	2.286
0.2	0.1	1 .643	2.227	3.25
	0.2	1 .857	2.636	4.00

It is evident that investment decisions could be based on estimating mean values and variability of annual revenues and costs together with an acceptable degree of risk. From these estimates, the minimum revenue required to justify the projected investment in coastal fishing could be evaluated.

The assessment of an acceptable degree of risk and ranges of variations of Revenues and Expenditures could be based on the analysis of available data obtained from the operating fishing fleet.

RESULTS

Table (1) shows productive and economic indices calculated for performance of sample trawlers in Eastern- Harbour in the year 2000, the average fish catch of one trip was 674.5, 1049.8 and 7409.3 kg for groups I, II and III respectively.

Mean days at sea of one trip was 4, 4.7 and 18.9 day for groups I, II and III respectively.

Mean number of fishermen of one trip was 8, 11 and 14 fisherman for groups I, II and III respectively.

Mean catch per day at sea was 168.6, 223.4 and 392.0 kg for groups I, II and III respectively.

Mean catch of horse-power per day at sea was 1.10, 0.98 and 1.63 kg for groups I, II and III respectively.

Mean catch of fisherman per day ay sea was 21.1, 20.3 and 28.0 kg for groups I, II and III respectively.

Mean Net income of horse- power per one day at sea was 2.90, 2.67 and 6.00 L.E. for groups I, II and III respectively.

Mean Net income of fisherman per one day at sea was 63.50, 52.24 and 92.15 L.E. for groups I, II and III respectively.

Table (1): Productive and Economic Indices Calculated for Performance of Sample Trawlers in the year 2000.

Study sample / H.p.	Units	150-	200 – 230	
		13 boats Territorial waters	12 boats Territorial waters	15 Trips Long range fisheries
Items		**I**	**II**	**III**
No. of trips		296	181	15
Total annual catch	k.g.	199640	190010	111140
Mean catch/trip	k.g.	674.5	1049.8	7409.3
Mean days at sea/trip	day	4	4.7	18.9
Mean no. of fishermen/trip	man	8	11	14
Mean catch/day at sea	k.g	168.6	223.4	392.0
Mean catch/H.P./day at sea	k.g.	1.10	0.98	1.63
Mean catch/fisherman/day at sea	k.g.	21.1	20.3	28.0
Mean net income/H.P/day at sea	L.E.	2.90	2.67	6.00
Mean net income/fisherman/day at sea	L.E.	63.50	52.24	92.15

Source: Collected and calculated from GAFRD,2000 and table (2).

Table (2): Statistical Parameters Required for quantity of Fish Landing and Profit Margin to Satisfy Risk for Investment in Fishing Trawlers by Engine Capacity (H.P.) and Fishing Grounds.

Parameters / H.p.		150- Territorial waters	200 – 230 Territorial waters	Long range fisheries
		I	II	III
Mean Revenues/boat/year	(L.E.)	147581	152165	-
Mean Revenues/trip	(L.E.)	-	-	71200
Mean Expenditures/boat/year	(L.E.)	101314	111430	-
Mean Expenditures/trip	(L.E.)	-	-	46871
Profitability Index "β"		2.585	2.160	2.854
Profitability factor "γ"		1.481	1.387	1.545
Expected annual fish landing	(k.g.)	15318	15851	-
Expected trip fish landing	(k.g.)	-	-	7595
Minimum catch /day of sea	(k.g.)	171	227	399

VR = 0.01 VE = 0.01 Risk = 0.0001

Source: Collected and calculated from questionnaire data.

Weighted whole-sale price of catch 9.61 L.E./k.g.

Table (2) shows statistical parameters required to estimate the minimum quantity of fish landing to satisfy a projected investment at an acceptable degree of risk equal to (0.001) and co-efficient of variation equal to (0.10) for each of Revenues and Expenditures in each of the studied groups.

Mean Revenue of boat for one year was 147.581 and 152.165 thousand L.E. for groups I and II respectively. Mean Revenue for one trip was 71.200 thousand L.E. for group III.

Mean Expenditure (Fixed – Variable Costs) of boat for one year was 101.314 and 111.430 thousand L.E. for groups I and II respectively. Mean Expenditures of one trip was 46.871 thousand L.E. for group III.

Minimum quantity of fish catch of day at sea was 171, 227 and 399 kg for groups I, II and III respectively.

DISCUSSION

The relevant measures of profitability are identified and given. The reliability of the various deterministic approaches for the prediction of profitability of fishing vessels indicated (Shama, M.A., 1990), tches' Revenues was estimated in this study to satisfy a projected investment at an acceptable degree of risk.

In this study small motor trawlers, less than 200 horse-power, that working in the medium range home fisheries exhibited high productive and economic indices compared to those calculated from big motor trawlers. This result was agreed with (El-Karachily,1991 and Cryony, 1992). On other hand, comparable indices calculated for big motor trawlers working in long-range off-fisheries were high as well encouraging expansion of such fisheries by other big trawlers.

In this study coefficient of variation (C.V.) of both Revenues and Expenditures of 0.10 and acceptable degree of risk 0.001 were following the normal density function, consequently these statistical parameters were used to estimate the future performance of small and big trawlers working in Egyptian

Mediterranean fisheries. Estimated statistical productive and economic parameters for minimum quantity of future fish catch are found to be very close to corresponding parameters which were already realized by sample trawlers performance in each group in the year 2000. Particularly for small boats in home fisheries and for big boats in long-range off fisheries.

Egypt was one of the first states to extend its Jurisdiction on Exclusive Economic Zones (EEZ) in Mediterranean waters, therefore, and according to results of the study it is suggested to re-allocate a group of Egyptian big motor boats to work in EEZ, as well as in off-waters of neighbor Arab countries as Lybia and Tunisia in accordance with bilateral relations with Egypt.

Such re-allocation of Egyptian big motor trawlers in EEZ and off-fisheries will: 1) Improve their productive and economic performances. 2) Relief existing fish stocks in Egyptian medium fisheries in the Mediterranean suffering from over exploitation.

Experimental fishing by National Institute of Oceanography & Fisheries (NIOF) research vessels and conducting stock assessment studies for estimating fish stocks potential in Egyptian EEZ waters on the Mediterranean will be necessary to encourage big motor boats owner to work in new EEZ.

ACKNOWLEDGEMENT

I am deeply thankful to Allah, by the grace of His Almighty, this work was possible.

I would like to express my deepest thanks to **Prof. Dr. Mohamed A. Shama**, Professor of Marine Engineering Department, Faculty of Engineering, University of Alexandria for his great help in understanding the method used in this study.

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