ECONOMIC PERFORMANCE OF THE GILL NETTER FLEETS IN THE CENTRAL AREA OF VIETNAM'S OFFSHORE FISHERIES

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Cover picture:

An offshore gillnet vessel

Author: Doan Van Phu

Source: RIMF

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CPUE	:	Catch per Unit Effort
DECAFIREP	:	Department of Capture Fisheries and Fisheries Resources Protection
EEZ	:	Exclusive Economic Zone
FISTENET	:	Fisheries Scientific Technological Economic Information Centre
GSO	:	General Statistics Office
HP	:	Horse power
MOFI	:	Ministry of Fisheries
OLS	:	Ordinary Least-Squares
RIMF	:	Research Institute for Marine Fisheries
STD	:	Standard Deviation
USD	:	United State Dollar
VND	:	Viet Nam Dong

ABSTRACT

The initial results of this study demonstrated that the offshore gillnets fleets in the Central of Vietnam can get high economic efficiency, an offshore gillnet vessel make a margin profit of 10%, the annual income of vessel can reach 51% of gross revenue. The average annual income of a fishing man is much higher than the average personal income on the national scale, corresponding to 156% in 2007. The offshore gillnet fishery could be attracted labour as well as investment in the future. The analysis has demonstrated that a gillnet vessel in the group of vessels with main engine power upper than 90hp has higher annual gross revenue, income, and net profit than the rest group. Impacts of engine power and hull length have also significant for vessel group with smaller 90hp engine power. For improving on economic performance, it is necessary to encourage owners of vessels in group smaller 90hp take more investment to improve vessel's engine as well as hull length. For gillnet vessels in group of larger 90hp, the owners should not concentrate on engine power, the hull length need to be maximized correlative with the current engine capacity, the total gillnets length should be increased. The limitations of this study include a quite small sample because of the data collection is very difficult and costly in the current Vietnam's conditions. The sample does not cover some important indicators such as the marine resources, the changing in market prices of inputs or outputs of the used models, and social-economic indicators (management ability, skipper and crew skills, education and average age of fishing men, and so on).

Key words: offshore gillnet, economic performance, gross revenue, annual income

1. INTRODUCTION

Vietnam located in South East Asia as a sea nation with the Exclusive Economic Zone (EEZ) is more than 1 million km^2; the total sea area is bigger than three times in comparing with the land area. In recent years, the fisheries sector has become one of the spearhead economic sectors in Vietnam's economy with the fast growth rate of development. The fisheries production has been increasing year by year, having exceeded 4 million tonnes in 2007 (4,149,000 tonnes), of which the capture production reached over 2 million tones (GSO, 2007). Total fisheries export volume rose to over 2.2 billion USD in 2003, nearly 2.4 billion USD in 2004, and reached over 3.4 billion USD in 2006 (FISTENET, 2007); gross output of fisheries productions at current prices in 2007 estimated 5.5 billion USD, of which the capture was 1.8 billion USD (GSO, 2007). The fisheries sector has also contributed important roles in food security, job creation, poverty elimination, and development international trade relations (FISTENET, 2006).

Besides the achievements, Vietnam's fisheries sector is also facing several big challenges such as the declining coastal resources, the increase in the total number of fishing vessels and fishing efforts, not enough strength in fisheries management (Son D.M., 2005). Management of the sector towards sustainability is really very necessary. However, management policy should be relied on scientific base including the understanding of how economic performance change and the interaction with fishing effort and its economic efficiency as well.

In the being context of Vietnam's fisheries, development of the offshore fisheries is an important orientation in order to reduce the fishing pressure on the coastal fisheries resources. Since 1997, the Vietnamese government has stared to develop the offshore fisheries by setting up a program in support capital loans to fishermen. The target fishing vessels of this program are all fishing vessels with engine capacity greater than 90 horsepowers. The total offshore fishing vessels have increased rapidly in the period from 1997 up to now, in which the offshore gillnet fishery is an important kind of fishery that received much investment of fishermen. The total number of fishing vessels was 92,628 in 2006. The total number of the offshore fishing vessels was 9,766 in 2000, up to 2006, this number was 20,807 vessels (Hai, 2008; DECAFIREP, 2007). However, in 2005, the total catches of offshore fishery attained just approximate 600,000 tonnes, corresponding to 55% of total potential catch (MOFI, 2005). The total number of gillnet fishing vessels was also increased from 13,714 in 1997 to 20,245 vessels in 2006, in which the gillnet fishing fleets with upper 90 horsepower of main engine capacity was only 847 vessels in 2006 (DECAFIREP, 2007).

The offshore gillnet is a passive gear with the main target species are tunas such as skipjack tuna, frigate mackerel, eastern little tuna, bullet tuna, and also yellow fin tuna, big eye tuna that are high quality and commercial value species (Long, 1999; Son, 2004). Thus, the offshore gillnet fishery is one of high profitable offshore fisheries in Vietnam. However, it is also a risky fishery because its fishing ground is very large, normally in the middle of the South China Sea that takes very long time for fishing journey from home to fishing ground, and also high cost of fishing trips. The weather conditions in the high sea are also the difficulty for the offshore gillnet fishing fleets. Beside, its target tunas are highly migration species, this fleet must to move continuously in wide areas to find fishing ground that is another risk of offshore gillnet fishery. That why, although there are many gillnet vessel can get positive net profit, but there are many others can not meet positive net profit. Hence, assessment of economic performance of the offshore gillnet fleets is necessary for defining what is the best gillnet vessel group? What are the main factors effected on vessel's profit? And how are influences of these factors on vessel's profit?

This study expects presenting the results of economic performance and defining the indicators that can affect to the final profit of gillnet fishing fleets in the Central area of Vietnam's offshore fisheries, and also supporting a scientific basis for fisheries managers to manage and develop the gillnet fishery. Therefore, the main concerns of the study will focus on assessment of economic performance of the gillnet fleets in the Central area of Vietnam's offshore fisheries. The specific objectives are determining the gross revenue, income of vessel, as well as income of fishermen on the offshore gillnet fleets; to assess the impacts of some technical and operational characteristics of vessel on economic performance of the offshore gillnet fleets.

The limitations of this study include a quite small sample because of the data collection is very difficult and costly in the current Vietnam's conditions. The sample does not cover some important indicators such as the marine resources, the changing in market prices of inputs or outputs of the used models, and social-economic indicators (management ability, skipper and crew skills, education and average age of fishing men, and so on). Hence, the final results of this study can not reflect impacts of all inputs expectation; this study describes the initial results of economic performance and impacts of some main technical and operating characteristics on the gross revenue and annual income of the offshore gillnet fleets in the Central area of Vietnam fisheries.

2. THE OFFSHORE GILLNET FISHERY IN THE CENTRAL AREA

2.1. General information

In fisheries researches, Vietnam sea waters are divided into five main areas, including The Tonkin Gulf area (1), Central area (2), Southeast area (3), Southwest area (4), and the Middle Chine sea area (5), see figure 1.

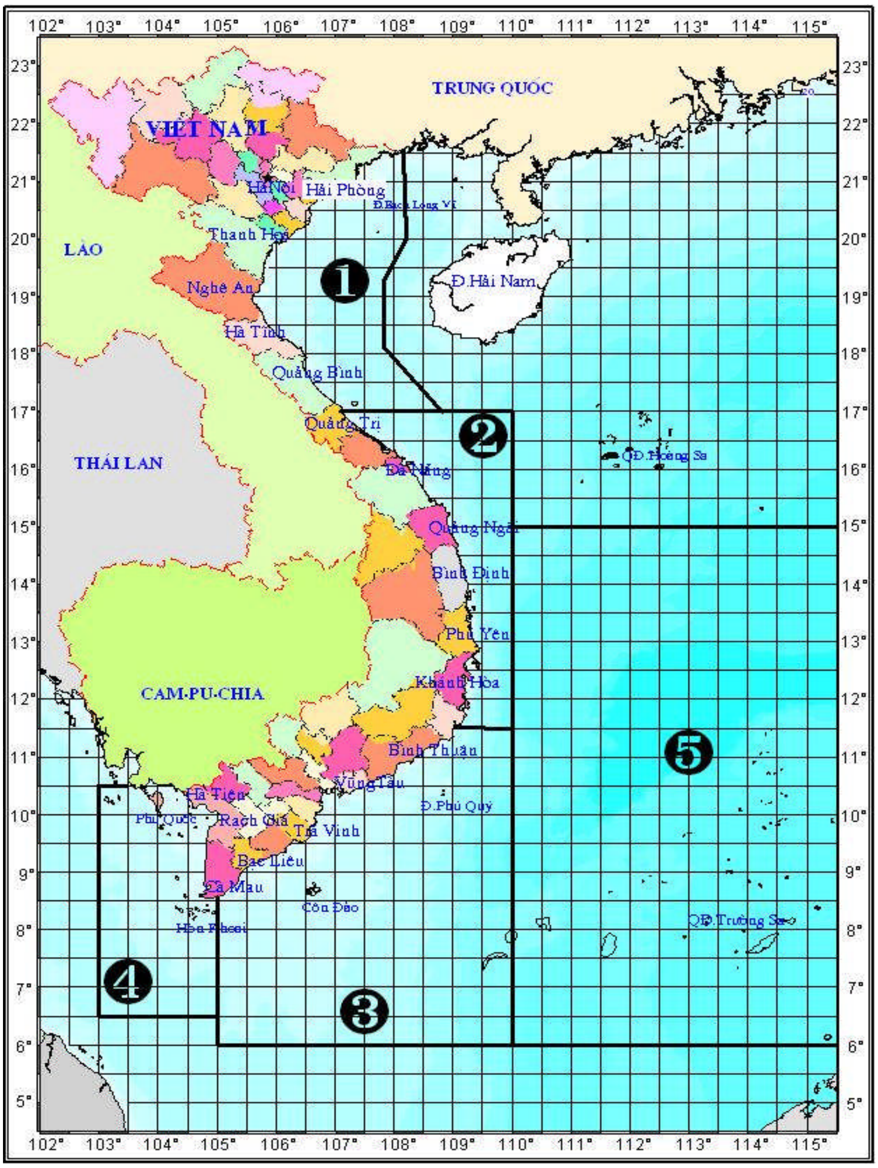

Figure 1. The main areas of Vietnam sea waters (Source: RIMF)

The Central is an area with the narrow continental; the seabed is rough with high depth, from the coast line to 10 nautical miles, the depth is 50 - 100 meters, and reaches to thousands meters at 50 nautical miles far from coast line. The offshore fisheries in this area is a fast growing industry, especially the longliners and gillnetters (Khang, 2007). The total numbers of fishing vessels of the Central area are highest with 34,087 vessels in 2006, corresponding to 37% of total nationwide fishing vessels (table 1).

Table 1. Change in total number of fishing vessels in the period 2000-2006

Area	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Tonkin Gulf	22,355	25,880	27,783	27,878	24,841	25,906	28,039
Central	**34,327**	**31,788**	**29,500**	**30,133**	**33,178**	**34,078**	**34,087**
Southeast	16,148	16,993	17,385	17,763	17,764	18,646	19,517
Southwest	11,153	11,446	11,563	11,896	11,107	11,313	10,985
Overall	**83,983**	**86,107**	**86,231**	**87,670**	**86,890**	**89,943**	**92,628**

(Source: *DECAFIREP*, *2007)*

Since 1997, under the government's program for development of the offshore fisheries, the numbers of fishing vessels with larger 90hp engine power have increased from 9,766 vessels in 2000 to 20,807 vessels in 2006. Total offshore fishing vessels of the Central area were always highest in the number as well as in the increasing rate. In 2000, total number of offshore fishing vessels of the Central area was 4,645 vessels; this number increased to 9,361 vessels in 2006, the increasing rate was 50% (table 2).

Table 2. Change in total number of offshore fishing vessels (with larger 90 hp engine power) in the period 2000-2006

Area	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Tonkin Gulf	941	1,047	1,428	1,909	1,873	2,201	2,181
Central	**4,645**	**6,024**	**6,778**	**7,182**	**8,845**	**9,097**	**9,361**
Southeast	2,063	4,753	5,169	5,419	6,084	5,941	5,957
Southwest	2,117	2,502	2,613	2,793	3,269	3,298	3,308
Overall	**9,766**	**14,326**	**15,988**	**17,303**	**20,071**	**20,537**	**20,807**

(Source: *DECAFIREP*, *2007)*

In parallel with total number, the total engine capacity has also fast growing. In 2000, on the national scale, total engine capacity was 1,385,098 hp, and then this number increased to 2,893,489 hp in 2006. For the Central area, total engine power of offshore fishing vessels was 258,775 hp in 2000, and 576,689 hp in 2006, the increasing rate was 46% (table 3).

Table 3. Change in total engine capacity (hp) of offshore fishing vessels (2000-2006)

Area	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Tonkin Gulf	141,768	149,626	199,513	224,093	229,720	256,800	257,200
Central	**258,775**	**342,373**	**408,951**	**449,483**	**523,900**	**517,879**	**567,689**
Southeast	336,455	593,014	764,030	844,637	972,555	1,000,400	1,065,700
Southwest	648,100	528,240	575,045	674,686	824,600	869,600	1,002,900
Overall	**1,385,098**	**1,613,253**	**1,947,539**	**2,192,899**	**2,550,775**	**2,644,679**	**2,893,489**

(Source: DECAFIREP, 2007)

According to table 2 and 3, we can see that total offshore vessels of the Central area appropriated 45% of total nationwide offshore vessels, but total engine capacity was just about 20% in 2006. This number demonstrates that most of offshore fishing vessels in the Central area were equipped small engine size.

2.2. The gillnet fishery

- *Total number of vessels*

Total number of gillnet vessels on the national scale was 20,245 in 2006, in which the Central area was 5,465 vessels, appropriated 27% (table 4).

Table 4. Total number of vessels in the gillnet fishery (2000-2006)

Area	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Tonkin Gulf	8,591	8,190	5,099	7,289	7,506	7,046	9,418
Central	**7,894**	**3,750**	**3,765**	**3,640**	**4,101**	**3,888**	**5,465**
Southeast	2,843	3,074	3,122	3,071	2,505	2,193	2,808
Southwest	2,870	3,042	3,020	3,256	2,463	2,468	2,554
Overall	**22,198**	**18,056**	**15,006**	**17,256**	**16,575**	**15,595**	**20,245**

(Source: DECAFIREP, 2007)

In general, the gillnet fishery includes many kind of gillnet such as bottom gillnet, drift gillnet (floating gillnet), trammel net, fixed net, flaccid and wet net, and so on. They are also including many engine power groups, mainly less than 20hp group (63%), 20-50hp (20%), and 50-90hp (10%). The number vessels of greater than 90hp are only 6% (DECAFIREP, 2007). Thus, most of small vessels are fishing in the offshore sea waters that demonstrate the offshore gillnet fishery in the Central area is small scale

- *Economic performance*

The gross revenue an annual income of the gillnet fishing vessels in some provinces in the Central area are presented in the table 5. The annual incomes of all vessel groups are quite high. For group of less than 90hp, the annual income appropriated from 52 to 79% of gross revenue. For group of greater than 90hp, the annual income appropriated from 44 to 66% of gross revenue. Thus, the more engine capacity, the more running costs that leads to decreasing in the annual income (DECAFIREP, 2007).

Table 5. General economic performance of the gillnet fishery in the Central area

Province	Engine group (hp)	Gross revenue (mill.VND)	Annual income (mill.VND)	Income / Revenue (%)
Quang Ngai	20-49	375	234	62
	50-89	302	159	53
	>89	496	217	44
Binh Dinh	20-49	748	417	56
	50-89	954	517	54
	>89	1,130	553	49
Phu Yen	<20	122	86	70
	20-49	362	287	79
	50-89	476	339	71
Khanh Hoa	<20	37	25	69
	20-49	376	225	60
	50-89	645	334	52
Ninh Thuan	<20	90	48	53
	20-49	479	283	59
	50-89	555	358	64
	>89	700	464	66

(Source: DECAFIREP, 2007)

- *Catch rate and target species*

The average of catch per unit effort (CPUE) of the offshore gillnet vessels was very various by time series, with decreasing trend, ranging from 28 to 35 kg/km of gillnet length. The main target species of the offshore gillnet fishery is tuna, the total catch of this species ranged from 56% to 79% of total catch of fishing trip, in which skipjack tuna contributed from 47 to 68% of total catch (Son, 2004).

- *Fishing ground*

The fishing grounds of offshore gillnet fishery are based on the main point of the tuna distribution which are the high migration species. In general, the fishing grounds of offshore gillnet fishery are very large, covered the offshore area in Vietnam's sea waters (see figure 1).

- *The current management policy*

The offshore fishery in the Central area is a new industry that was started developing since the middle of the last decade; now, it is still "open-access" situation. The government has still encouraging programs in development of this fishery. In the being context of Vietnam's fisheries, the inshore fisheries is collapsing, development of the offshore fisheries is an important orientation in order to reduce the fishing pressure on the coastal fisheries resources. At the same time for supporting programs, the government has also carried out many researches in marine resources in order to provide the fishing ground forecast to every fisher. However, the issue of sustainable development has been considered.

3. MATERIAL AND METHOD

3.1. Research area selection

The Central area is selected because this area has an important position as a main point of the Vietnam's fisheries. The offshore gillnet fleets in this area have the same vessels structures, the same fishing grounds, the fish market prices are relatively homogeneous. Therefore, there are some assumptions for running the econometric models such as the marine resources are stable for all vessels; the market prices are the same for all inputs or outputs of the econometric models. In the other hand, the data sources for the Central area have the best advantages for this study.

3.2. Data

The data used in the study is collected from data sources of the project "research the scientific bases for adjustment the fishing fleets' structure of Vietnam fisheries" which are implementing by Research Institute for Marine Fisheries (RIMF). This cross sectional data was collected by direct interview method between vessel owner and RIMF's officer.

The information of the gillnet fishing fleets was collected in 2007 (interviewed in 2008) as a annual data, including vessel technical characteristics, total catch and revenue, variable cost, labour cost, and total fixed cost per year. Total number of sample was 58 offshore gillnet vessels in three provinces in the Central area, including Da Nang (27 observations), Binh Dinh (20 observations), and Khanh Hoa (11 observations), *see appendixes 1&2*.

3.2. Economic performance indicators definitions

Gross revenue is defined as the total value in monetary of all fishing products or total catch with the landed price. In the other hand, gross revenue is a representative indicator of total catch of a fishing vessel. It is total of average gross revenue of the fishing boat in the year or gross annual vessel revenue that was calculated by the total of the average vessel trip revenue times the number of trips in the year 2007 (Long, 2008; Kim Anh T.N., 2006).

Income is an important indicator of economic performance; it is the difference between gross revenue and total variable costs, except labour cost (Long, 2008). In Vietnamese fisheries, total variable costs using to calculate income excluding labour costs that mean, in this case, income of fishing vessel includes labour payments.

Variable costs of a gillnet fishing vessel include payments for fuel, preservation (ice), provisions (food, soft drink …) , labour, and others such as minor repairs, home port… Fixed costs of a gillnet fishing vessel include fixed assets depreciation, payments for loan interest, insurance, tax, and major repairs. The variable costs are depended on each fishing trip that are calculated as the average fishing trip variable costs multiplied with total fishing trips in the year. The fixed costs are annual payments of vessel-owner (Long, 2008; Kim Anh T.N., 2006).

Gross value added is a value that describes the difference between income and fixed costs (without depreciation and interest). Gross cash flow is specified by the gross revenue minus all expenditure, except fixed assets depreciation and interest loan payment. Net profit is defined by the gross revenue minus total costs (Long, 2008).

The economic performance indicators definitions used in this study correspond with researches on fisheries in Vietnam (Long, 2008; Kim Anh T.N., 2006), in the South East Asia region (Tietze, 2005; Tietze, 2001), and in industrialized countries (Action, 2006; Flaaten, 1995; Long, 2008; Tietze, 2001).

The general definitions can be summarized as follows:

$$\textbf{\textit{Income}} = \textit{Gross revenue} - \textit{Variable costs (except labour cost)}$$

$$\textbf{\textit{Gross value added}} = \textit{Income} - \textit{Fixed costs (except depreciation and interest)}$$

$$\textbf{\textit{Gross cash flow}} = \textit{Gross value added} - \textit{Labour costs}$$

$$\textbf{\textit{Net profit}} = \textit{Gross revenue} - \textit{Variable costs (with labour cost)} - \textit{Fixed costs}$$

3.3. Data analysis

Collected data was processed in some software as Excel, Shazam (SHAZAM, 2001). The study considers using some statistic testing methods to test the independent variables and uses the statistic method to present the results of gross revenue, income, net profit, available costs as well as the other costs of the vessel.

The final economic performance of the offshore gillnet fleets is understood as the net profit of vessel production in the year that is defined by the difference between gross revenue and total cost of vessel in the year. This thesis focus on defining average gross revenue, income of vessel as well as fishermen, and also to assess the effects of some main technical and operational characteristics indicators of the vessel on its gross revenue and income. Concerning data sources, this study selects a suitable method for analyzing economic efficiency and productivity of the offshore gillnet fleets that is the ordinary least-squares (OLS) econometric production models. In this case, we consider using the multiple regression analysis to describe the relations between dependent variables and independent variables.

The general functional form as below (Tim Coelli, 2005):

$$Y_i = f(X_1, X_2, X_3,\ldots,X_k,) \qquad (*)$$

The dependent variables are gross revenue and income of a fishing boat. The independent variables, in this case, include some main technical and operational characteristics such as hull length, engine power, total length of net, total fishing day in the year, and crew size.

The dependent variable *R* denotes total catch of all fishing trips of a fishing boat in the year, and variable *I* is total income of a fishing boat in the year. In fact, gross revenue and income might be affected by many factors. However, due to limitation of data, we choose some main factors as above. The independent variables have impacts on *R* and *I*, they have also interactive or multicorinality. Thus, when we start with flexible translog functional form, the general function (*) can be written as follows (Tim Coelli, 2005):

The revenue function (*Model 1*):

$$\begin{aligned}\ln R = \alpha_0 + \alpha_L \ln L + \alpha_{LL} \ln L^2 + \alpha_E \ln E + \alpha_{EE} \ln E^2 + \alpha_N \ln N + \alpha_{NN} \ln N^2 \\ + \alpha_D \ln D + \alpha_{DD} \ln D^2 + \alpha_C \ln C + \alpha_{CC} \ln C^2 + \alpha_{LE} \ln L \ln E \\ + \alpha_{LN} \ln L \ln N + \alpha_{LD} \ln L \ln D + \alpha_{LC} \ln L \ln C + \alpha_{EN} \ln E \ln N \\ + \alpha_{ED} \ln E \ln D + \alpha_{EC} \ln E \ln C + \alpha_{ND} \ln N \ln D + \alpha_{NC} \ln N \ln C \\ + \alpha_{DC} \ln D \ln C + \varepsilon_R\end{aligned}$$

The income function (*Model 2*):

$$\begin{aligned}\ln I = \alpha_0 + \alpha_L \ln L + \alpha_{LL} \ln L^2 + \alpha_E \ln E + \alpha_{EE} \ln E^2 + \alpha_N \ln N + \alpha_{NN} \ln N^2 \\ + \alpha_D \ln D + \alpha_{DD} \ln D^2 + \alpha_C \ln C + \alpha_{CC} \ln C^2 + \alpha_{LE} \ln L \ln E \\ + \alpha_{LN} \ln L \ln N + \alpha_{LD} \ln L \ln D + \alpha_{LC} \ln L \ln C + \alpha_{EN} \ln E \ln N \\ + \alpha_{ED} \ln E \ln D + \alpha_{EC} \ln E \ln C + \alpha_{ND} \ln N \ln D + \alpha_{NC} \ln N \ln C \\ + \alpha_{DC} \ln D \ln C + \varepsilon_I\end{aligned}$$

Where, R is gross revenue and I is income of fishing vessel in the year; L is the hull length (m); E is the main engine power (hp); N is the total gillnet length (m); D is total fishing days of vessel in the year (day); C is the number of fishing men in the vessel, including the captain (person); and ε_R and ε_I are the random error terms.

Using the Shazam econometric package (SHAZAM, 2001) to assess the models, we test for significance of parameters estimated of two models. Applying *F-test* to verify the null hypothesis that the interactive terms have significant effects on *R* and *I.* This method is also used to test another null hypothesis that the terms of second order have significance effects on *R* and *I.* Based on the *F*-test statistic value or p-value of *F*-statistic probability we can conclude the interactive terms and the second order terms effect on *R* and *I* significantly or not (R. Carter Hill, 2007). If the interactive terms and the second order terms also have not significance effects, we can remove them all from two models, then the models become another functional forms that are Cobb-Douglas production form (Tim Coelli, 2005), and can be rewritten as:

$$\ln R \text{ or } \ln I = \alpha_0 + \alpha_L \ln L + \alpha_E \ln E + \alpha_N \ln N + \alpha_D \ln D + \alpha_C \ln C + \varepsilon \quad (**)$$

The random error terms ε_R and ε_I in two models are tested by some various methods such as Jarque-Bera test for the normality of the errors, Breusch-Pagan-Godfrey and Koenker-Bassett tests for the heteroscedasticity of the errors. For omitted repressors' and/or wrong functional form, we used Ramsey-Reset test. White's procedure will apply for correcting for heteroscedasticity (Long et.al., 2008; Shazam, 2001; R.carter Hill, 2007).

For detail the results of model 1 and model 2, the data set was divided into two subsamples, group of vessels with engine size less than 90hp, and group of vessels with engine size greater than 90hp. Hence, we have four more submodels. All steps of analysis in the submodels were the same in the model 1 and model 2.

4. EMPIRICIAL RESULTS

4.1. Economic performance indicators

The main technical characteristics of offshore gillnet collected in three provinces of the Central fishing area include hull length, engine power, the total gillnet length, total fishing days in the year, and average number of fishing men on a vessel. They are described in the table 6.

Table 6. Economic performance indicators of collected offshore gillnetters in 2007

Indicators	Mean	STD	Min	Max
Hull length (m)	16.2	2.2	12.0	21.4
Engine power (hp)	103.5	87.2	25.0	400.0
Gillnet length (m)	13,636.7	3,640.9	6,720.0	21,000.0
Total fishing days/year (day)	201.9	41.8	120.0	300.0
Crew (person)	9.5	1.7	6.0	13.0
Income/person (mill.VND)	20.2	13.1	6.3	64.2
Gross revenue (mill.VND)	**822.0**	**450.5**	**215.6**	**2,711.5**
Variable costs (mill.VND)	405.5	195.9	128.5	1,169.6
Income (mill.VND)	**416.5**	**277.9**	**75.5**	**1,541.9**
Labour cost (mill.VND)	201.0	145.1	37.8	771.0
Fixed costs (mill.VND)	**132.2**	**68.5**	**26.6**	**450.7**
Depreciation (mill.VND)	87.2	47.8	11.6	331.0
Loan interest (mill.VND)	9.3	16.8	-	59.4
Insurance cost (mill.VND)	3.4	3.9	-	20.3
Vessel and gear cost (mill.VND)	32.3	16.2	10.0	90.0
Gross value added (mill.VND)	**380.8**	**267.5**	**60.5**	**1,481.6**
Gross cash flow (mill.VND)	**179.8**	**125.2**	**22.8**	**710.7**
Net profit (mill.VND)	**83.3**	**95.1**	**- 82.3**	**405.3**

According to table 6, the average hull length of gillnet fleet sample was about 16.2m, ranged from 12.0 to 21.4m. Main engine capacity observer very different from 25 to 400 horsepower (hp); with a mean of 103.5 hp. Total gillnet length was also very various, the minimum of gillnet length was 6,720.0m and the maximum length was 21,000.0m, the average of gillnet length was 13,636.7m. Total fishing days in the year 2007 of offshore gillnet collected ranged from 120 to 300 days, with a mean of 201.9

days, corresponding to 6.7 months in the year 2007. Each offshore gillnet vessel have an average 9.5 fishing men, ranged from 6 to 13 persons, noted that this number included the captain (table 6).

The most important economic performance indicators of collected offshore gillnet fishing fleets in 2007 was also presented in the table 6. The average annual indicators such gross revenue, income, gross value added, gross cash flow, and net profit, were positive. The average gross revenue of an offshore gillnet vessel in the year 2007 was about 822.0 million VND – corresponding to 51,377 USD (1USD ≈ 16,000VND in 2007); however, this value was also very various with large ranged between 215.6 million VND (13,475USD) and 2,711.5 million VND (169,469USD). Although an offshore gillnet vessel could got high gross revenue, its variable costs were also very high. The average total variable costs (except labour cost) of an offshore gillnet vessel was about 405.5 million VND (25,345USD) in the year 2007, corresponding to 49% of gross revenue. Beside, other costs of an offshore gillnet vessel as labour cost and fixed cost were 201.0 and 132.2 million VND, appropriated 24% and 16% of gross revenue.

Total average income in 2007 of an offshore gillnet vessel after less all variable costs (without labour cost) was 416.5 million VND (26,032USD), with lowest of 75 million VND (4,721USD) and highest of 1,542.9 million VND (96,369USD). The average gross value added and gross cash flow were 380.8 and 179.8 million VND. Net profit of an offshore gillnet vessel was 83.3 million VND (5,206USD); however, this value was very different with a wide range from -82.3 to 405.3 million VND.

The table 6 also demonstrates that the average income of a fishing men was vey various with a range between 6.3 million VND (391USD) and 64.2 million VND (4,015USD), and the mean of 20.2 million VND (1,259USD).

In comparing some main economic performance indicators between different vessel groups by engine power, we can see the results in the table 7. We got some important points in these results; group of vessel with engine capacity greater than 90 hp has much better economic performance indicators than group of engine size less than 90 hp. Especially, group of engine size ranging from 90 to 140 hp got the highest net profit with 101.5 million VND, though most of its economic performance indicators were not higher than group of engine capacity greater than 140hp. In the group of engine size greater than 140hp, although it's gross revenue and income were highest (1,134.8 and 571.5 million VND, respectively), all most their costs were much higher than others groups (table 7).

Table 7. Economic performance indicators of collected offshore gillnetters by engine capacity group (2007)

Indicators	**<90hp** (N=28)	**90-140hp** (N=20)	**>140hp** (N=10)
Hull length (m)	15.0	16.8	18.2
Engine power (hp)	48.6	101.3	261.5
Gillnet length (m)	11,580.6	14,838.5	16,990.0
Total fishing days/year (day)	185.9	220.3	210.4
Crew (person)	8.5	10.2	10.7
Income/person (mill.VND)	16.6	22.3	25.7
Gross revenue (mill.VND)	**622.5**	**945.0**	**1,134.8**
Variable costs (mill.VND)	307.4	464.0	563.3
Income (mill.VND)	**315.1**	**481.0**	**571.5**
Labour cost (mill.VND)	151.7	231.0	278.9
Fixed costs (mill.VND)	**98.0**	**148.5**	**195.6**
Depreciation (mill.VND)	64.1	95.3	135.9
Loan interest (mill.VND)	5.6	10.2	17.8
Insurance cost (mill.VND)	1.8	4.4	5.9
Vessel and gear cost (mill.VND)	26.5	38.5	36.0
Gross value added (mill.VND)	**286.8**	**438.1**	**529.7**
Gross cash flow (mill.VND)	**135.1**	**207.0**	**250.8**
Net profit (mill.VND)	**65.4**	**101.5**	**97.1**

4.2. Regression analysis and econometric specifications

As presented before, we have two econometric models for gross annual revenue and income of collected offshore gillnet vessel in the Central area of Vietnam. The regression analysis results for two models are presented in the table 8 and 9.

The models for revenue:

In regression processing, the results of F-test for parameters significance show that the interactive terms in the model have not significance effects, F-test statistic 0.46 with 10 and 37 degrees of freedom (p-value of F-statistic probability was 0.90), that why we have removed the interactive terms in the model for gross revenue. Beside, the results of F-test also shows that the second order terms should be removed from the model, F-test statistic 1.80 with 5 and 47 degrees of freedom (p-value 0.13). Thus, the final econometric model for gross revenue has become a Cobb-Douglas production function (Tim Coelli, 2005).

Table 8. Parameters estimated of the model for gross revenue (model 1)

	Estimated coefficient	***t-value***	***Whites t-value***
α_0	1.5886	0.797	0.695
α_L	1.1013	2.374 *	3.133 *
α_E	-0.0028	-0.036	-0.038
α_N	0.4844	1.951 **	1.999 *
α_D	0.2641	1.166	1.015
α_C	1.2777	3.557 *	4.418 *
R^2	0.78		
F-statistic	36.70		

** Significant at the level of 5%*
*** Significant at the level of 10%*

According to the table 8, we can see that the main technical characteristic hull length has a significance effect on gross revenue. The hull length parameters are positive and statistically significant at the level of 5% that means an offshore gillnet vessel revenue increases with the hull length. If others variable are kept constant, gross revenue will increase 1.1013 million VND when the hull length increased one horsepower. Beside, the total gillnet length has also significance effect on gross revenue with positive coefficient and statistically significant at the level 5%. Estimated coefficient was 0.4844 demonstrates that if the gillnet increases one unit in total length, gross revenue will increase an amount as 0.4844 million VND in the condition others variables keeping constant. Another parameter has also significance effect that was the average number of fishing men on an offshore gillnet vessel; the crew size got a positive coefficient 1.2777 with statistically significant at the level 5% that means gross revenue increases with the number of crew on vessel (table 8).

The table 8 also demonstrated that beside three parameters has significance effects on gross revenue, another parameters have not significance effects that were the engine capacity, total fishing days in the year, and free coefficient α_0. That means the changing in engine size and total fishing days have not affect the changing in gross revenue of an offshore gillnet vessel.

The results of Jarque-Bera test for the normality of the error term mentioned that the random error term ε in the model for gross revenue was normal distribution. Breusch-Pagan-Godfrey and Koenker-Bassett tests for the heteroscedasticity of the errors also indicated that heteroscedasticity problem did not occur in this model. The final model for gross revenue was quite a good functional form (see appendix 4).

The model for income:

Similarly with the model for gross revenue, the results of *F*-test for parameters significance also indicated that the interactive terms and the second order terms have not significance effects on income of an offshore gillnet vessel; the value of *F*-test statistic for the interactive terms was 0.63 (with 10 and 37 degrees of freedom, *p*-value 0.77) and *F*-test statistic value for the second order terms was 0.93 (with 5 and 37 degrees of freedom, *p*-value 0.48). Then, we have removed the entire interactive terms and the second order terms from the econometric model for income function.

From the table 9, the results of White's procedure shows that there are two parameters have significance effects on annual income of an offshore gillnet vessel, they were the hull length and crew size. The hull length got a positive coefficient and statistically significant at the level 5%, it may make sense to say that the annual income of an offshore gillnet vessel increases with hull length, keeping others parameters constant, if hull length increases one unit, annual income will increase an amount of 1.0758 million VND. For crew size, it also got a positive coefficient and statistically significant at the level 5%; then, the offshore gillnet vessel can get more income if the crew size increased. Opposite with previous case, in the model for income, parameter total gill net length has not significance effect on income that means if the vessel continued investing more in gear, the annual income will not change. The same results with other parameters as engine size, total fishing days in the year, and free coefficient α_0 (table 9).

Table 9. Parameters estimated of the model for income (model 2)

	Estimated coefficient	*t-value*	*Whites t-value*
α_0	2.1904	0.715	0.532
α_L	1.0758	1.510**	2.156*
α_E	-0.0462	-0.382	-0.347
α_N	0.4479	1.174	1.153
α_D	-0.1360	-0.391	-0.313
α_C	1.8953	3.435*	4.011*
R^2	0.63		
F-statistic	17.80		

** Significant at the level of 5%*
*** Significant at the level of 10%*

The same with previous model, the results of Jarque-Bera test for the normality of the error term mentioned that the random error term ε in the model for annual income was normal distribution. Breusch-Pagan-Godfrey and Koenker-Bassett tests for the heteroscedasticity of the errors also indicated that heteroscedasticity problem did not occur in this model. The final model for annual income was quite a good functional form (see appendix 5).

Beside two main econometric models for gross revenue and income as presented above, we considered to see more four submodels for revenue and income of an offshore gillnet vessel in two groups, one for group of vessel with engine size less than 90hp (28 observations), one for group of vessel with engine size greater than 90hp (30 observations).

The submodel 1: for revenue of vessel group with engine size less than 90hp

Estimated parameters of the submodel for revenue of vessel group with engine size less than 90hp were presented in the table 10. An important point just finds in the results that engine capacity has significance effect on revenue of an offshore gillnet vessel in the group of less than 90hp. Meanwhile, the total gillnet length has not significance effect. Beside, the hull length has also affected with statistically significant at the level of 10%. Similarly with previous models, the average of crew number on the vessel has affected the annual revenue of this vessel group (table 10).

The submodel 2: for income of vessel group with engine size less than 90hp

We got the same results in the submodel 2, engine power and crew size were two parameters have significance effects on the annual income of vessel group with engine size less than 90hp. Then, the hull length and total gear length have not affected significantly (table 11).

Table 10. Parameter estimated of the model for gross revenue of <90hp group (submodel 1)

	Estimated coefficient	***t-value***	***Whites t-value***
α_0	1.6434	0.558	0.604
α_L	1.2980	1.427	1.975**
α_E	0.2348	0.886	2.056*
α_N	0.1661	0.427	0.482
α_C	1.5981	2.985*	4.634*
α_D	0.4189	1.288	1.374
R^2	0.81		
F-statistic	18.95		

** Significant at the level of 5%*
*** Significant at the level of 10%*

Table 11. Parameters estimated of the model for annual income of <90hp group (submodel 2)

	Estimated coefficient	*t-value*	*Whites t-value*
α_0	4.0786	1.043	1.261
α_L	0.8688	0.719	0.964
α_E	0.4247	1.207	2.480*
α_N	-0.0115	-0.022	-0.027
α_C	2.4923	3.504*	5.922*
α_D	-0.1558	-0.361	-0.417
R^2	0.76		
F-statistic	13.91		

** Significant at the level of 5%*
*** Significant at the level of 10%*

The submodel 3: for revenue of vessel group with engine size greater than 90hp

In the submodel 3, for vessel group with engine size greater than 90hp, the changing in engine capacity has not affected gross revenue; parameters have significance effects on revenue included the hull length, total gillnet length, and crew size (table 12).

The submodel 4: for income of vessel group with engine size greater than 90hp

Parameters have significance effects on income of vessel group with engine size greater than 90hp included the hull length and crew size. Engine capacity and total length of gear have not affected significantly (table 13).

Table 12. Parameters estimated of the model for gross revenue of >90hp group (submodel 3)

	Estimated coefficient	*t-value*	*Whites t-value*
α_0	3.0603	1.060	0.866
α_L	1.2057	2.362*	3.423*
α_E	-0.0782	-0.719	-0.646
α_N	0.7146	2.281*	2.492 *
α_C	0.9130	1.966**	2.870*
α_D	-0.2547	-0.730	-0.710
R^2	0.68		
F-statistic	10.03		

** Significant at the level of 5%*
*** Significant at the level of 10%*

Table 13. Parameters estimated of the model for annual income of >90hp group (submodel 4)

	Estimated coefficient	*t-value*	*Whites t-value*
α_0	3.0161	0.585	0.441
α_L	1.3062	1.433	2.274*
α_E	-0.1724	-0.888	-0.814
α_N	0.8277	1.480	1.461
α_C	1.2126	1.462	1.742**
α_D	-0.6860	-1.101	-0.915
R^2	0.45		
F-statistic	3.96		

** Significant at the level of 5%*
*** Significant at the level of 10%*

5. DISCUSSION

5.1. Economic performance indicators

The empirical results indicated that the average gross revenue of a vessle sample in the year 2007 was 822.0 million VND - corresponding to 51,377 USD. Comparing with another offshore fishery as longliners in the same area, the gross revenue of an offshore gillnetter was much higher than an offshore longliner; a longliner vessel could get about 35,968 USD in 2004 (Long et.al., 2008), meanwhile, a gillnet vessel got 42,196 USD in 2004 and 53,542 USD in 2005 (Kim Anh, et.al., 2006), and from this study 51,377 USD in 2007 (1USD≈15,800 VND in 2004 and ≈16,000 VND in 2007). This value shows that the offshore gillnet fishing fleet in the Central area may be a high economic efficiency. The target species of offshore gillnetters are tunas, with high commercial economic value such as skipjack tuna, frigate mackerel, eastern little tuna, bullet tuna, and also yellow fin tuna, big eye tuna (MOFI, 1996). The market of those species is quite stable with high prices (FISTENET, 2007). Thus, the offshore gillnet fishery could get a high gross revenue.

However, the same situation with offshore longline fishery in Vietnam, the offshore gillnet fleets are also a risky fishery (Long et.al., 2008). Though an offshore gillnet vessel could get high gross revenue, its operating costs was also very high. The variable costs appropriated about 49% of gross revenue, included the payments for fuel, lubricant, ice, food, and others. The main fishing grounds of offshore gillnet vessel are very far from the coast, normally in the middle of the South China Sea that takes very long time for fishing journey from home to fishing ground. Beside, the target tuna species are one of high migration species, the main point of fishing grounds are very difficult to specify (Son, 2004), then the offshore gillnet vessel must go so far to define the best places for operating. That may be considered as a main reason lead to high cost of fuel and lubricant for fishing trips. The average labour cost is also quite big, 201.0 million VND per year (12,561USD), corresponding to 24% of gross revenue. Normally, this value was calculated by 50% of gross revenue after less all variable costs. In fact, the variable costs increased with gross revenue. Thus, the labour cost will always be high. Kim Anh, et al. (2006) had also mentioned that the proportion of labour cost was approximately 18 to 20% of gross revenue of an offshore gillnet vessel in 2004 and 2005. Addition, the average fixed costs was 132.2 million VND, corresponding to 16% of gross revenue, mainly depreciation with 87.2 million VND. The depreciation of an offshore gillnet vessel was calculated by annual average approach of total value in monetary of a fixed asset at bought time divided to its estimated lifespan. The annual vessel depreciation includes hull, engine, equipments and fishing gear, in which the fishing gear depreciation was largest. With average 13,636.7 m of gillnet length, the annual depreciation of fishing gear exceed 66.7 million VND. Thus, with high variable costs and fixed costs, the net profit of an offshore gillnet vessel was just about 10% of gross revenue. This value of an offshore gillnet vessel in the same area were 09% in 2004 and 10% in 2005 (Kim Anh et.al. ,2006). Comparing with other offshore fishery, net profit of an offshore longliner was about 12% of its gross revenue (Long et.al., 2008). Therefore, the final economic performance of an offshore gillnet vessel in the Central area was lower than the average net profit of an offshore gillnet vessel in overall Vietnam sea waters with 16.2% of gross revenue (Hai, 2008). However, net profit of an offshore gillnet vessel in the Central area was still higher than others inshore fishery and others industries of the national economy, and reached the best FAO standard (Hai, 2008; Tietze, 2005).

Another point in the empirical results, the average income of an offshore gillnet fishing man was 20.2 million VND (≈1,259USD) in the year 2007. This value was higher than an offshore longliner in the same area (917.7USD per capita in 2004) (Long et.al., 2008), and much higher than the average personal income on the national scale, USD 554.6 per capita in 2004 and USD 590 in 2005 (Kim Anh et.al., 2006), and USD 809 in 2007 (IMF, 2007). Hence, the offshore gillnet fishery could be attracted the labour if this industry have a clear development plan in the future.

Inside of vessel sample, we can see that gross revenue, income, and net profit of vessel group with engine size greater than 90hp were much higher than the rest group. This point may guide the vessel owners could be expanded the main engine capacity in order to improve their economic efficiency. However, in the technique term, the main engine size has recommended in the Central area ranging from 135 to 200hp (Long, 1999).

In summary, based on the empirical results of economic performance indicators of the offshore gillnet fleet in the Central area, we can see that the offshore gillnet fishery have some main indicators which may help the fisheries managers to form a program for expansion this fishery. However, what are factors impacts significantly on the economic performance of the offshore gillnet fleets? This issue may be answered in the next discussion.

5.2. Impacts of some main technical and operating characteristics on revenue and income

Technical and operating characteristics of the vessel can be specified as proxies of vessel fishing efforts that were also considered as a bundle of inputs for econometric production models (Long, 2008; Salvanes, 1994; Squires, 1999). All parameters in the models were the technical and operating characteristics. Normally, there is usually a strong relationship between vessels parameters such as hull length, engine capacity, and crew size; the multicolinearity may occur in our models. However, in Vietnam's fisheries realty, the vessel engines were often salvaged from used cars engines or other used vessel engines. They were used widely and not rare correlation with the hull length. There was 88.7% of fishing vessels that fitting the used engines, in which 41.9% were used car engines (MOFI, 2005). Beside, the number of fishing men per fishing vessel were also not fitted the hull length size because we have not regulation or standard for this issue. The correlation of hull length (L) with engine power (E) and crew size were 0.55 and 0.63. The correlations of other parameters also mentioned that the multicoliearity was not big problem in our models. Thus, the empirical results could be analyzed for the outputs of the models.

The model for gross revenue:

As presented in the empirical results, parameters have significance effect on annual gross revenue of the offshore gillnet vessel were the hull length, total gillnet length, and the crew size. The results of model 1 indicated that gross revenue of an offshore gillnets vessel increases with the hull length. In fact, the hull length related clearly with space for fishing products preservation, fishing gear storage, and fishing men activities. Meanwhile, total fishing gear length and number of fishing men were also two factors which could be affected revenue of the vessel. If the hull length increases, the vessel owners could be invested to get more gillnet length with enough storage area. An average offshore gillnet vessel have four or five holds for ice and fishing products preservation. The number of holds or storage area will be increasing when the hull length is expanded. The vessel could be took more fish and others products that related to total catch or total revenue may be increased. However, in the technique term, the hull length size has recommended for offshore gillnet vessel in the Central area ranging from 17 to 20 m (Son, 2004).

Gillnet is one kind of passive gear. Their targets species are big pelagic fish, mainly tuna species, are the high migration species. Thus, the total gillnets length related to total catch or gross revenue. In general, if the total gillnets length increases, total catch may increase that lead to gross revenue increasing. In specific, the results of submodel 1 indicated that the total gillnets length has not significance effect on revenue of vessel group with engine size less than 90hp. The reality gillnets length may reach over capacity of vessel in this group. Meanwhile, inside this group, engine size has affected significantly on revenue. Hence, for group of vessel with engine size less than 90hp could be improved engine size, but not increased total gear length. Opposite way, in group of vessel with engine greater than 90hp, the results of submodel 3 shows the vessel owners could be improved the gillnets length but not invested more in engine capacity.

Labour cost do not depend on the number of crew on fishing vessel, it upon directly provision costs in the total variable costs. The vessel owner could be hired more fishing men in order to improve production efficiency such as increasing number of fishing hauls per trip, bester fishing products preservation… that leads to increasing in revenue. However, in reality, the crew share is not equal to everyone because the current system based on different position on the vessel such as the captain, engine chief, gear chief, and general crew. Thus, the more crews, the income per capita will be decreased.

The model for income

The empirical results of model 2 indicated that the hull length and crew size were two parameters which have significance effects on income of an offshore gillnet vessel in Central area. The same explanations with the models for gross revenue, the annual income of an offshore gillnet vessel increases with the hull length and the number of fishing men on vessel. However, for group of vessel with engine size less than 90hp, the changing in hull length has not affected significantly, but engine size has significance effect (see submodel 2). Thus, the vessel owners of this group should be expanded vessel’s engine size in order to increase the annual income.

Parameters have not significance effects on annual income of an offshore gillnet vessel including total gillnets length and total fishing days in the year. In fact, the more gillnets length, the more running costs that leads to increasing in variable costs. However, in the other hand, the more gillnets length, the gross revenue may increase. Thus, the changing of total gillnets length has not affected significantly on the annual income of an offshore gillnet vessel.

The same situation in both models for revenue and income, total fishing days in the year have not significance effects. In general, for offshore gillnets fishery, duration of fishing trip depend on the moonlight time. In the moonlight time, most of gillnet vessel stop their fishing operation and come back home port. However, the average of trip duration also depends on the weather condition, that leads to the total fishing days in the year for offshore gillnets fishery are not stable. Moreover, duration of fishing trip in the data set included the time for moving to find the best place for fishing operation. Hence, the more fishing days in the year effect on increasing of running costs, the gross revenue or income may increase or not, that means total fishing days in the year have not affected significantly on gross revenue or income of an offshore gillnet vessel in the Central area of Vietnam’s fisheries.

Note that all above analysis with an assumption that the market prices of all inputs or outputs were the same for all vessels and stable for whole Central area.

6. POLICY IMPLICATION AND CONCLUSION

This study is still including a few limitations as lack of the marine resources information, the changing in prices, social-economic indicators (management ability, skipper and crew skills, education and average age of fishing men, and so on), limit of total vessels sample. However, the initial analyzed results could demonstrate sketchy knowledge of economic performance of the offshore gillnet fishery in the Central area. Based on the empirical results of economic performance indicators and analyzed impact of some main technical and operating characteristics on gross revenue, annual income of 58 offshore gillnet vessels in the Central area in 2007, we have some conclusion and implication for management and development the offshore gillnet fishery in this area.

6.1. The offshore gillnets fleets in the Central of Vietnam can get high economic efficiency, an offshore gillnet vessel make a margin profit of 10%, the annual income of vessel can reach 51% of gross revenue. The average value in monetary of gross revenue, annual income, net profit of an offshore gillnet vessel are higher than an offshore longliner. The average annual income of a fishing man is much higher than the average personal income on the national scale, corresponding to 156% in 2007. For those reasons, the offshore gillnet fishery could be attracted labour as well as investment. Fisheries administrators should carry out more researches in this fishery for planning and development in the future.

6.2. The analysis has demonstrated that a gillnet vessel in the group of vessels with main engine power upper than 90hp has higher annual gross revenue, income, and net profit than the rest group. Impacts of engine power and hull length have also significant for vessel group with smaller 90hp engine power. Hence, for improving on economic performance, it is necessary to encourage owners of vessels in group smaller 90hp take more investment to improve vessel's engine as well as hull length. For gillnet vessels in group of larger 90hp, the owners should not concentrate on engine power, the hull length need to be maximized correlative with the current engine capacity, at the same time, the total gillnets length should be increased.

6.3. With the current crew share system, the vessel's owners want more crews for increasing their economic performance, but the more crew, the less income per capita. To assume responsibility for the income of the fishing men, the fisheries managers should be assigned the maximum number of crew for each hull size.

6.4. In Vietnam, the offshore gillnet fishery is “open-access” situation, but this fishery has still highly positive revenue and net profit, meanwhile in the inshore fisheries, there are many vessels can not meet profit. For this reason, the number of offshore gillnet vessels will be increased in the near future, then the gross revenue will be decreased that may lead to the collapse of the offshore fisheries. Therefore, it is necessary to set up a long-term program for the offshore gillnet fishery, development in the number of vessels must base on marine resources status.

6.5. The initial results of this study are still limited that needs to continue carrying out in the next time with more samples as well as adding others parameters, especially the resources and social-economic variables. Expanding of the offshore fishery must be harmonized between economic performance and sustainable development of the nature resources that is an important goal of the Vietnam’s fisheries sector.

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APPENDICES

Appendix 1. Technical and operating characteristics of collected vessels in the Central area. Information of the year 2007. Source: RIMF, 2009

ID	Registration	Province	Hull length (m)	Engine power (HP)	Gillnet length (m)	Total fishing days	No.of labours (per vessel)	Income per capita (.000VND)
1	ĐNa90278TS	Đà Nẵng	18.0	270	15600	150	10	15860
2	ĐNa90378TS	Đà Nẵng	17.5	150	16120	209	10	29255
3	ĐNa90397TS	Đà Nẵng	17.3	125	16500	228	10	36060
4	ĐNa90379TS	Đà Nẵng	19.8	150	18200	178	10	29465
5	ĐNa90118TS	Đà Nẵng	17.0	120	15750	170	10	37880
6	ĐNa90009TS	Đà Nẵng	20.0	90	20350	216	10	42330
7	ĐNa90180TS	Đà Nẵng	19.3	90	15120	198	10	28925
8	ĐNa90025TS	Đà Nẵng	18.8	90	19250	209	10	59185
9	ĐNa90352TS	Đà Nẵng	19.0	90	16380	192	10	32380
10	ĐNa90305TS	Đà Nẵng	21.4	380	16000	207	10	42455
11	ĐNa66596TS	Đà Nẵng	16.0	66	13500	168	10	27270
12	ĐNa6678TS	Đà Nẵng	16.5	60	15300	180	10	23475
13	ĐNa6457TS	Đà Nẵng	15.8	60	15080	175	11	19041
14	ĐNa1406TS	Đà Nẵng	17.5	60	15400	198	10	19325
15	ĐNa66681TS	Đà Nẵng	18.0	60	16146	176	10	25650
16	ĐNa66444TS	Đà Nẵng	17.0	66	16200	195	10	34860
17	ĐNa67798TS	Đà Nẵng	16.9	60	12380	216	10	34720
18	ĐNa77059TS	Đà Nẵng	15.0	70	13900	300	10	36000
19	ĐNa6532TS	Đà Nẵng	18.0	60	14040	180	10	23265
20	ĐNa6714TS	Đà Nẵng	17.6	60	15340	165	10	27475
21	ĐNa90144TS	Đà Nẵng	20.0	250	18900	242	11	21268
22	ĐNa46619TS	Đà Nẵng	15.5	45	9180	272	8	9840
23	ĐNa90159TS	Đà Nẵng	19.5	120	13680	264	13	21027
24	ĐNa90328TS	Đà Nẵng	18.0	90	14700	240	11	18436
25	ĐNa90104TS	Đà Nẵng	15.5	90	11400	264	13	16908
26	ĐNa36589TS	Đà Nẵng	14.7	33	7500	160	8	14125
27	ĐNa90224TS	Đà Nẵng	17.8	90	11400	264	10	13820
28	BĐ98381TS	Bình Định	18.0	340	17280	276	11	18782
29	BĐ2451TS	Bình Định	18.2	90	18200	275	10	6850
30	BĐ2055TS	Bình Định	16.0	60	15600	200	10	11200
31	BĐ0363TS	Bình Định	12.0	30	6720	210	7	7693
32	BĐ7195TS	Bình Định	14.0	30	9520	147	6	6294
33	BĐ7895TS	Bình Định	13.5	26	12000	144	8	7500
34	BĐ7811TS	Bình Định	15.4	39	12000	170	7	8571
35	BĐ7793TS	Bình Định	15.0	25	12000	144	7	8571

36	BĐ7520TS	Bình Định	14.0	35	10200	120	7	8571
37	BĐ8710TS	Bình Định	12.5	35	7200	150	8	8750
38	BĐ7163TS	Bình Định	14.0	36	9000	150	8	6250
39	BĐ7252TS	Bình Định	13.9	50	9600	180	8	13500
40	BĐ7515TS	Bình Định	13.0	35	9000	180	7	7143
41	BĐ7124TS	Bình Định	14.7	60	9000	144	6	8333
42	BĐ7842TS	Bình Định	13.8	35	12000	180	8	8750
43	BĐ7062TS	Bình Định	13.0	90	9000	180	8	6250
44	BĐ2381TS	Bình Định	15.0	155	15000	172	10	8000
45	BĐ9109TS	Bình Định	16.0	110	12000	200	9	7778
46	BĐ7803TS	Bình Định	13.9	90	9600	200	8	7500
47	BĐ7631TS	Bình Định	14.0	90	9600	225	7	8571
48	KH96427TS	Khánh Hoà	14.4	140	16200	180	9	14778
49	KH96266TS	Khánh Hoà	15.9	120	16800	225	11	18682
50	KH96399TS	Khánh Hoà	14.9	90	16740	200	12	24583
51	KH9154BTS	Khánh Hoà	18.5	340	21000	240	12	64246
52	KH9040TS	Khánh Hoà	18.1	120	17360	250	12	20508
53	KH3903TS	Khánh Hoà	12.4	55	7200	300	9	7639
54	KH7444TS	Khánh Hoà	13.5	45	8450	210	8	33647
55	KH0933TS	Khánh Hoà	15.9	180	15000	250	12	17114
56	KH5886TS	Khánh Hoà	14.0	65	10800	190	8	18264
57	KH96482TS	Khánh Hoà	18.0	400	16800	180	11	11050
58	KH96399TS	Khánh Hoà	14.9	90	16740	225	10	23039

Appendix 2. Economic performance of collected vessels in the Central area. Information of the year 2007. Source: RIMF, 2009

ID	Registration	Variable costs (.000VND)	Labour costs (.000VND)	Insurance costs (.000VND)	Interest costs (.000VND)	Vesel & gear costs (.000VND)	Depre-ciation (.000VND)	Gross revenue (.000VND)
1	ĐNa90278TS	453400	158600	3000	0	40000	125470	770600
2	ĐNa90378TS	594000	292550	4000	0	45000	94922	1179100
3	ĐNa90397TS	557200	360600	3000	0	45000	121375	1278400
4	ĐNa90379TS	478300	294650	4000	50000	50000	155067	1067600
5	ĐNa90118TS	446800	378800	4000	0	45000	118157	1204400
6	ĐNa90009TS	607200	423300	4000	0	50000	138773	1453800
7	ĐNa90180TS	600600	289250	4000	0	45000	102600	1179100
8	ĐNa90025TS	567600	591850	4000	0	50000	132590	1751300
9	ĐNa90352TS	540000	323800	3000	0	45000	125637	1187600
10	ĐNa90305TS	620900	424550	4000	0	45000	131250	1470000
11	ĐNa66596TS	454800	272700	4000	0	40000	108921	1000200
12	ĐNa6678TS	496400	234750	3000	0	46000	112674	965900
13	ĐNa6457TS	411400	209450	3000	0	30000	103115	830300
14	ĐNa1406TS	475200	193250	3000	36000	45000	102900	861700
15	ĐNa66681TS	413900	256500	3000	24000	37000	119042	926900
16	ĐNa66444TS	518800	348600	4000	24000	40000	92384	1216000
17	ĐNa67798TS	531600	347200	0	0	40000	22424	1226000
18	ĐNa77059TS	795500	360000	3000	0	40000	104249	1515500
19	ĐNa6532TS	462000	232650	0	0	39000	85647	927300
20	ĐNa6714TS	381700	274750	4000	20000	30000	110185	931200
21	ĐNa90144TS	490600	233950	3000	0	25000	131804	958500
22	ĐNa46619TS	408960	78720	1400	21000	35000	57036	566400
23	ĐNa90159TS	616800	273350	3000	0	25000	105897	1163500
24	ĐNa90328TS	518400	202800	3000	0	30000	115876	924000
25	ĐNa90104TS	499200	219800	3000	0	25000	89720	938800
26	ĐNa36589TS	214000	113000	2000	0	15000	53611	440000
27	ĐNa90224TS	423600	138200	2000	30000	15000	89769	700000
28	BĐ98381TS	514800	206600	4500	0	25000	138523	928000
29	BĐ2451TS	528000	68500	4500	21240	25000	86629	665000
30	BĐ2055TS	341000	112000	1000	0	25000	60786	565000
31	BĐ0363TS	216300	53850	0	0	15000	11606	324000
32	BĐ7195TS	140070	37765	0	0	15000	13548	215600
33	BĐ7895TS	134100	60000	0	0	20000	56660	312000
34	BĐ7811TS	157000	60000	6000	10000	20000	45817	320000
35	BĐ7793TS	159600	60000	6000	10000	20000	47008	300000
36	BĐ7520TS	160800	60000	0	0	10000	38515	312000
37	BĐ8710TS	177000	70000	0	0	20000	27410	380000

38	BĐ7163TS	128500	50000	0	0	10000	49950	275000
39	BĐ7252TS	196500	108000	0	0	40000	33352	412500
40	BĐ7515TS	169200	50000	0	0	10000	48615	276000
41	BĐ7124TS	159600	50000	0	0	10000	48665	264000
42	BĐ7842TS	345000	70000	0	0	30000	46692	540000
43	BĐ7062TS	204000	50000	0	15000	20000	54225	475000
44	BĐ2381TS	362200	80000	5000	0	20000	69770	660000
45	BĐ9109TS	320000	70000	3000	0	30000	55575	550000
46	BĐ7803TS	330000	60000	0	0	20000	46958	525000
47	BĐ7631TS	196500	60000	0	0	10000	49823	360000
48	KH96427TS	414000	133000	5400	50000	60000	99910	680000
49	KH96266TS	414000	205500	6200	30000	70000	97567	825000
50	KH96399TS	445000	295000	11000	58000	50000	85011	1035000
51	KH9154BTS	1169600	770950	20288	59400	40000	330972	2711500
52	KH9040TS	695800	246100	15768	0	90000	102941	1188000
53	KH3903TS	142000	68750	0	0	15000	63108	279500
54	KH7444TS	190650	269175	600	0	30000	71547	729000
55	KH0933TS	363260	205370	0	14400	50000	85400	774000
56	KH5886TS	224580	146110	7000	12000	15000	59891	516800
57	KH96482TS	585900	121550	11000	54000	20000	95772	829000
58	KH96399TS	356220	230390	10000	0	20000	87160	817000

Appendix 3. The correlations of independent variables. Hull length (L), Engine power (E), Gillnet length (N), Crew size (C), Total fishing days (D)

CORRELATION MATRIX OF VARIABLES - 58 OBSERVATIONS

L	1.0000				
E	0.55229	1.0000			
N	0.78615	0.54264	1.0000		
C	0.63498	0.48945	0.70109	1.0000	
D	0.24848	0.23829	0.21465	0.51607	1.0000
	L	E	N	C	D

Appendix 4. Test results of variables in the model for gross revenue (Model 1)

	Test statistic	P-value
F-test for the interactive terms	0.463	0.903
F-test for the second order terms	1.795	0.132
Tests for heterocedasticity		
Breusch-Pagan-Godfrey, Chi-Square with 5 DF	8.488	0.131
Koenker-Bassett, Chi-Square with 1 DF	0.847	0.357
Test for normality		
Jarque-Bera, Chi-Square with 2 DF	1.187	0.552
Test for error specification (Ramsey-Reset test)		
Reset (2), *F* with DF1= 1 and DF2= 51	0.391	0.534
Reset (3), *F* with DF1 = 2 and DF2 = 50	0.255	0.776
Reset (4), *F* with DF1 = 3 and DF2 = 49	0.689	0.563

Appendix 5. Test results of variables in the model for annual income (Model 2)

	Test statistic	P-value
F-test for the interactive terms	0.635	0.775
F-test for the second order terms	0.925	0.476
Tests for heterocedasticity		
Breusch-Pagan-Godfrey, Chi-Square with 5 DF	10.152	0.071
Koenker-Bassett, Chi-Square with 1 DF	0.847	0.357
Test for normality		
Jarque-Bera, Chi-Square with 2 DF	2.683	0.261
Test for error specification (Ramsey-Reset test)		
Reset (2), *F* with DF1= 1 and DF2= 51	0.375	0.543
Reset (3), *F* with DF1 = 2 and DF2 = 50	0.291	0.748
Reset (4), *F* with DF1 = 3 and DF2 = 49	0.197	0.898

Appendix 6. Test results of variables in the model for gross revenue of group less than 90hp vessels (Submodel 1)

	Test statistic	P-value
F-test for the interactive terms	0.86312542	0.59771
F-test for the second order terms	0.30143280	0.90526
Tests for heterocedasticity		
Breusch-Pagan-Godfrey, Chi-Square with 5 DF	21.469	0.00066
Koenker-Bassett, Chi-Square with 1 DF	0.354	0.55185
Test for normality		
Jarque-Bera, Chi-Square with 2 DF	2.1894	0.335
Test for error specification (Ramsey-Reset test)		
Reset (2), *F* with DF1= 1 and DF2= 21	0.41731	0.525
Reset (3), *F* with DF1 = 2 and DF2 = 20	0.67868	0.519
Reset (4), *F* with DF1 = 3 and DF2 = 19	0.43431	0.731

Appendix 7. Test results of variables in the model for annual income of group less than 90hp vessels (Submodel 2)

	Test statistic	P-value
Tests for heterocedasticity		
Breusch-Pagan-Godfrey, Chi-Square with 5 DF	13.079	0.02265
Koenker-Bassett, Chi-Square with 1 DF	0.334	0.56346
Test for normality		
Jarque-Bera, Chi-Square with 2 DF	5.3045	0.070
Test for error specification (Ramsey-Reset test)		
Reset (2), *F* with DF1= 1 and DF2= 21	0.53065	0.474
Reset (3), *F* with DF1 = 2 and DF2 = 20	0.25283	0.779
Reset (4), *F* with DF1 = 3 and DF2 = 19	0.25276	0.858

Appendix 8. Test results of variables in the model for gross revenue of group greater than 90hp vessels (Submodel 3)

	Test statistic	P-value
F-test for the interactive terms	0.75100756	0.67044
F-test for the second order terms	2.1991529	0.09713
Tests for heterocedasticity		
Breusch-Pagan-Godfrey, Chi-Square with 5 DF	12.580	0.02765
Koenker-Bassett, Chi-Square with 1 DF	2.107	0.14665
Test for normality		
Jarque-Bera, Chi-Square with 2 DF	4.2596	0.119
Test for error specification (Ramsey-Reset test)		
Reset (2), *F* with DF1= 1 and DF2= 23	2.4966	0.128
Reset (3), *F* with DF1 = 2 and DF2 = 22	1.4489	0.256
Reset (4), *F* with DF1 = 3 and DF2 = 21	0.92383	0.446

Appendix 9. Test results of variables in the model for annual income of group greater than 90hp vessels (Submodel 4)

	Test statistic	P-value
Tests for heterocedasticity		
Breusch-Pagan-Godfrey, Chi-Square with 5 DF	10.293	0.06734
Koenker-Bassett, Chi-Square with 1 DF	0.821	0.36502
Test for normality		
Jarque-Bera, Chi-Square with 2 DF	5.3305	0.070
Test for error specification (Ramsey-Reset test)		
Reset (2), *F* with DF1= 1 and DF2= 23	2.3942	0.135
Reset (3), *F* with DF1 = 2 and DF2 = 22	1.3561	0.278
Reset (4), *F* with DF1 = 3 and DF2 = 21	0.86403	0.475