ON THE ECONOMIC PERFORMANCE AND EFFICIENCY OF GILLNET VESSELS IN NHA TRANG, VIETNAM

NGUYEN NGOC DUY

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The Norwegian College of Fishery Science
University of Tromso, Norway
&
Nha Trang University, Vietnam

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ABSTRACT

Vietnam's policy was to shift the fishing pressure from onshore to offshore water since the coastal resource has been overexploited, and a program of investing offshore vessels has thus implemented since 1997. The question raised is whether the offshore fishing fleet is profitable and efficient or not? This study aims to evaluating economic performance and efficiency of the offshore fleet in Vietnam – the case of the Nha Trang gillnet fishery in open access condition, based on a costs and earning survey carried out on the 58 offshore vessels. The empirical results indicate that an average gillnet vessel earns a gross margin profit of 17.3% and a profit margin of 3.8%, but makes an economic loss, including the government fuel cost support. The average annual crew income is 74.5% more than the local average income per capita. Efficiency analysis of the vessels basing on an application of the Salter-diagram shows that the large number of vessels with high relative standardized effort (above one) is the most cost efficient vessels in both short- and long-run perspectives. The majority of them get intra-marginal rents. The government fuel subsidies help to increase 17.5% for gross cash flow and 36% for profit in an average vessel. The small-scale vessels receive the most benefits from these subsidies. The study also demonstrates that engine capacity, fishing gear and fishing day are the factors best reflecting fishing effort of the vessels.

Key words: gillnet fishery, economic performance, economic efficiency, cost efficiency, standardized fishing effort, relative standardized effort, fuel cost support, fishing subsidy.

Chapter 1

INTRODUCTION

1.1. GENERAL INFORMATION

"*Vietnam has a coastline of about 3,260 km and its exclusive economic zone (EEZ)*[1] *extends over more than one million square kilometers*" (FAO, 2005a, p.34). Its coast has many bays and estuaries as well as diversity of coastal and marine resources (FAO, 2005a, p.34) and the EEZ of Vietnam contain abundant multi-species of fishery (Pho Hoang Han, 2007). In Vietnam's marine waters there were about 3.1 million tones of the entire standing stock of marine fish with more than 2000 fish species and around 1.4 million tones of the sustainable potential yield (FAO,2004, p.33-34). These have created a good potential for development of marine capture fisheries as well as marine aquaculture in Vietnam. Therefore, in recent years, Vietnam's fisheries sector, including marine capture fisheries, has become an important sector in the national economy (FAO, 2004, 2005a), with its contribution for GDP (Gross Domestic Product) of 4% in 2006 (Pomeroy et al., 2009; FAO, 2009b; Lewis, 2005) and 5.44% in 2008 (ARGOINFO, 2009). According to FAO statistics, Vietnam's fisheries have achieved a high position in the world fisheries community, ranking 13th in capture production, 3th in animal aquaculture and 8th in export value in 2006 (FAO, 2008).

However, Vietnam's marine fishing fisheries are referred to as small scale, multi-species, multi-gear and open access (FAO, 2009a). Marine fisheries production has continuously increased over time (GSO, 2008) and the number of fishing vessels has increased significantly and gone far beyond the control (FAO, 2005a). Coastal fishing capacity has exceeded the sustainable limit (FAO, 2004 and 2005a). Coastal resources have thus been overexploited, and are in decreasing level. Therefore, Vietnamese government has run its offshore fishing program to reduce the fishing pressure on onshore waters (FAO, 2004 and 2005a).

Khanh Hoa is a coastal province in Southern Central Vietnam, and its sea area belongs to the Southern China Sea region. It is located along the coastal zone with total land area of more

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[1] United Nations defined EEZ showed in Articles 55-75, Part V: exclusive economic zone in the Law of the Sea Convention, p43-53 (See LOS Convention). Vietnamese Government stated that EEZ of the Socialist Republic of Vietnam is adjacent to the Vietnamese territorial seas and forms with it a 200 nautical-mile zone from the baseline used to measure the breadth of Vietnam's territorial sea (See [1]).

than 5200 square kilometers and the coastal line of 520 kilometers. This coastline is made up of territorial waters and more than 200 islands (Kim Anh et al., 2006; Kim Anh et al., 2007; Long et al, 2008). Khanh Hoa's marine resources are considered to be abundant and diversified. According to report of IEFP and RIMF (2005), Khanh Hoa sea area has about 600 fish species, of which there are 50 species with high economic value. The amount of pelagic fish species occupies a high rate, estimated amount of 115,800 tonnes. The habitat of these species was concentrative in coastal sea areas and the maximum sustainable yield (MSY) is estimated about 38,000 tonnes per year. In addition to all these advantages, there are also many other various marine resources in Khanh Hoa sea areas (IEFP and RIMF, 2005). For these preferential natural conditions, Khanh Hoa has had a long tradition of development for marine capture fisheries (Kim Anh et al., 2006; Kim Anh et al., 2007).

Nha Trang is the center city of Khanh Hoa province. It occupies an area of 251 km^2. This city is not only an attractive destination for tourism, but also a potential area for further development of fisheries (Kim Anh et al., 2006, Thanh Thuy et al., 2008). The fisheries sector is the driver of growth, responsible for 42% of the city's GDP (Gross Domestic Product) (Kim Anh et al., 2006). Khanh Hoa's capture fishery in general and Nha Trang's capture fishery in particular are, in general, largely small-scale fisheries. From statistics of DECAFIREP of Khanh Hoa (2009), the capture sector in Nha Trang city strongly represents for Khanh Hoa's capture sector, and most offshore fishing fleet is considered to concentrate in this city.

Marine capture production of Khanh Hoa has fluctuated over time (Khanh Hoa's DARD, 2009a). The number of vessels and engine capacity has increased in recent years, especially a dramatic increase in 2008 and 2009 with a program of the 2008 fuel cost support[2] of Vietnamese government. Catch per vessel and catch per unit of engine power have almost decreased over time (Khanh Hoa's DARD, 2009a, 2009b, 2009c; DECAFIREP of Khanh Hoa, 2009). Khanh Hoa's marine fisheries resources were considered to be declining remarkably over time (Long and Anrooy, 2004). Therefore, the necessity of sustainable fisheries development and the urgent need for the establishment of reasonable policies are of great important issues.

[2] See Decision 289/QD-TTg and Decision 965/QD-TTg, 2008

1.2. RESEARCH PROBLEM

As mentioned above, as coastal resources of Vietnam in general and Khanh Hoa in specific have been overexploited and are in decline, and a program of investing offshore vessels has thus implemented. However, the question raised here is whether this program has been efficient and the offshore fleet is profitable or not? The Vietnamese government, therefore, has emphasized the need to develop the offshore fleet, and to be done with great caution to avoid the development of an economically unsustainable fleet (FAO, 2005a). In 2005, Ministry of fisheries of Vietnam proposed two new major development goals of offshore fisheries management and development in Vietnam which are, (1) "*to ensure sustainable and efficient offshore fisheries, while maintaining both marine ecosystem functions and harmonious relationships with coastal fisheries and contributing to the protection of the sovereignty of the territorial waters and the national security of Viet Nam*"; (2) "*to enhance income, create new occupations and improve the living standards of fishing communities that depend on offshore fisheries*" (FAO, 2005a). In order to assess whether these two development goals are being achieved, monitoring and reporting the annual performance indicators were mentioned in Conference on the National strategy for marine fisheries management and development in Vietnam (FAO, 2005a). These indicators are referred as measures for making policies of marine resource management in Vietnam. In addition, Kim Anh et al. (2006) stated that "*Vietnam's marine fisheries are in need of knowledge-based management*". This implies that the Vietnamese policy-makers necessitate not only reliable assessments of offshore resources, but also an understanding of the economic realities of offshore fishing (FAO, 2005a; Long et al., 2008).

Based on above considerations, *a study on economic performance and efficiency of the offshore fishing vessels* is necessarily carried out, and following questions should be come up with, such as, "What are economic performance indicators of offshore fishing vessels?", "What is the income of crew members?", "Which vessels are more or less economic efficiency than others?", And "How does a government support like the fuel cost support affect annual earnings and costs of the fishing vessels?". At the industry level, fisheries managers may use the information to correct, design and implement policy instruments in order to obtain partly the above two important goals of offshore fisheries management in report of FAO (2005a). At the vessel level, fishermen may use this information to determine their real fishing effort for improving their economic efficiency in fishing.

In scope of Nha Trang city and Khanh Hoa, several researches on costs and earnings surveys for tuna-mackerel offshore gillnet fishery have been done in Kim Anh et al. (2006), researches on offshore longline fishery in Kim Anh et al. (2007) and Long et al. (2008). However, the studies on costs and earnings surveys are needed to be performed continuously since log-books of boat owners have not been implemented yet. Hence, this study will address economic performance indicators and economic efficiency of Nha Trang's gillnetting vessels in the season of 2008 through a costs and earnings survey. The offshore gillnet fleet is targeted to be chosen for this research. The reasons are that 1) gill net is one of the main Vietnamese gear types for offshore fisheries; 2) gill net is the type of gear that have high selectivity and less potential to do damage to the sea floor (King, 1995). The catching ability of this passive gear relies on the migration or movement of fish through the area where the nets are set; and it usually has a mesh size designed to catch fish of a specific size range, and does not gill very small and very large fish (King, 1995). As a possible result, the overexploited marine resources can be recovered quickly; 3) project suggestion for research cooperation between Nha Trang University and the Norwegian College of Fishery Science [2]. Finally, this study is done only for the offshore gillnet fleet in Nha Trang city of Khanh Hoa province in a limited time budget. Additionally, the majority of previous researches had answered the first two questions above in the case of Khanh Hoa. Therefore, the hope of this study is to venture into the last two questions above, on vessel efficiency and the fuel cost support effects.

1.3. RESEARCH OBJECTIVE

This thesis will address four main objectives. The first is to determine a set of economic performance indicators of the offshore gillnet vessels in Nha Trang, based on a costs and earnings survey for this fleet. The second is to find out which vessel group gets intra-marginal rents. The third is to find out which gillnet vessels are of economic efficiency. And the final objective is to determine how the government 2008 fuel cost support impacts on profitability of the offshore gillnet vessels in Nha Trang. In addition to the main objectives, this study's aim is also to contribute to the development of methods of measuring standardized fishing effort for the fishing vessels.

Chapter 2

OVERVIEW OF MARINE CAPTURE FISHERIES OF KHANH HOA AND VIETNAM

2.1. VIETNAM'S MARINE CAPTURE FISHERIES

Marine capture production

From 1995 to 2008, the total production from capture fisheries of Vietnam has increased approximately twice up to nearly 2.14 million tonnes in 2008 (Figure 2.1 and appendix B in details), accounted for about three-quarter of total fisheries production in 1995, and around a half of that in 2008 (GSO, 2008). Vietnam's marine capture fisheries production has tended to increase gradually during this period of time. The marine catch amounted from 0.99 million tones in 1995 to 1.95 million tones in 2008 (GSO, 2008). It is a fact that the proportion of the marine catch was always high and increasing in total capture production, and reached more than 91% of total quantity of capture in 2008, and of which marine fish ratio often occupied three-fourths of marine capture fisheries production.

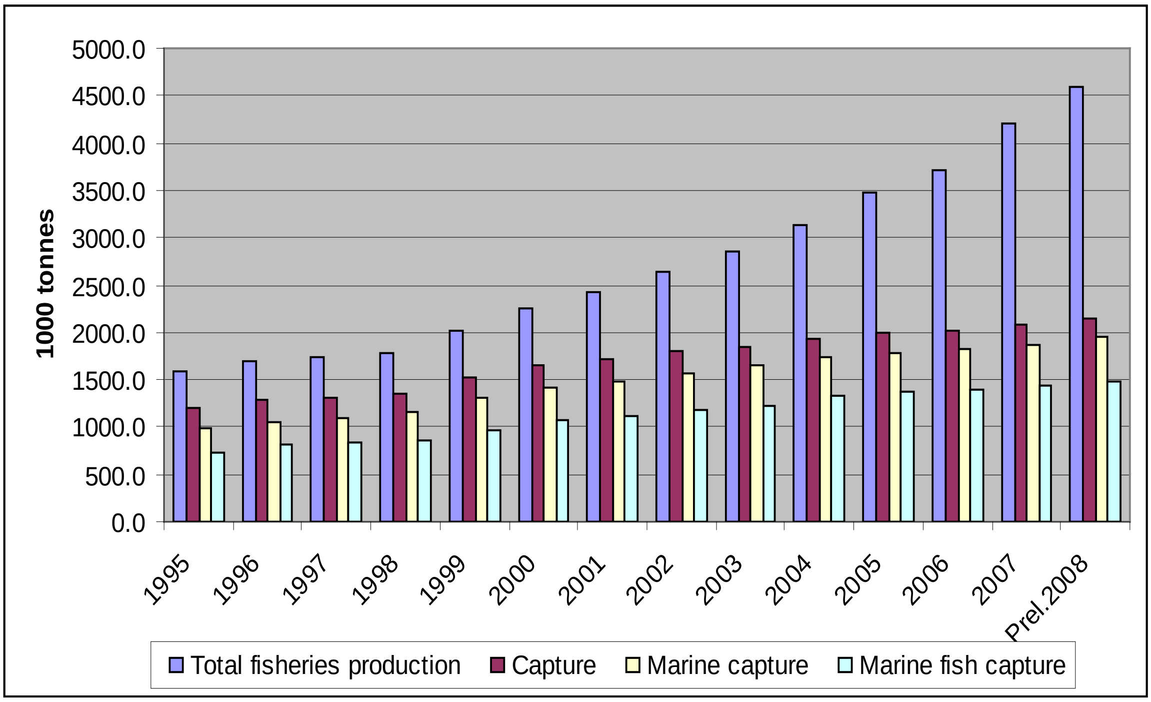

Figure 2.1: Fisheries production during 1995- 2008 in Vietnam. Source: General Statistic Office (GSO), 2008. *Note*: Fisheries quantity in 2008 is estimated preliminarily by GSO (See appendix B in detail).

Marine fishing fleet

The number of marine capture vessels and engine capacity increased rapidly over time in Vietnam (FAO, 2005a). In 1985, the total motorized fishing vessels were 29,000 with a total of 456,796 horsepower (HP) (FAO, 2004, p.5), while in 2006 these indicators were reported around 95,000 units with total horsepower of 5,735,000 (Pomeroy et al., 2009). According to a report of FAO (2005a, p.4), the total engine power of marine fishing fleet has increased about 12% per annum in the earliest years of this century. About 84% of marine fishing vessels have an engine size of less than 90 HP. The fishing grounds of these vessels focused mainly on coastal sea areas[3] (FAO 2005a, p.4; Pomeroy et al., 2009).

By the end of 2008, in 53,287 of the total marine fishing boats with engine of over 20 HP classified by group of capacity, there were more than 70% of vessels with engine of less than 90 HP (Table 2.1).

Table 2.1: The distribution of vessels with engine of over 20 HP in Vietnam, 2008

Engine capacity	Number of vessels	Rate (%)
20 – < 50 hp	25,130	47.16
50 - < 90 hp	12,569	23.59
90 – 800 hp	15,588	29.25
Total	53,287	100.00

Source: NADAREP [4] (2008) in Country Report: S.R. Vietnam (2009), West Pacific East Asia Oceanic Fisheries Management Project (See WPEAOFMP, 2009).

[3] Before November 2006, Coastal sea area was defined as inside areas of the waters of less than 30-m deep line from the shore onward for the Tonkin Gulf waters, East and Southwest waters and Thailand Bay, and by under 50-m deep line from the shore for Central coastal (See Circular no. 05/1998/TT-BTS on December 29, 1998 by the Ministry of Fisheries). On October 27, 2006, Decree no. 123/2006/ND-CP of Prime Minister of Vietnam defined that “Coastal sea areas, which are measured from the coast (the lowest tide line) to the line connecting points of 24 nautical miles from the coast”.

[4] Before 2008, NADAREP (National Directorate of Aquatic Resources Exploitation and Protection) under former MOFI (Ministry of Fisheries). Currently, DECAFIREP (Department of Capture Fisheries and Resources Protection) under MARD (Ministry of Agriculture and Rural Development). (See WPEAOFMP, 2009).

The Structure of offshore fishing fleet[5]:

In 2000, there were 5,896 vessels operating offshore (FAO, 2005a, p.35). This fleet has reached 6,675 units (a growth of 6% per year) with total engine power of about 1 million horsepower (HP) in 2002 (FAO, 2005a, p.37). According to statistic report of DECAFIREP (2009), until September, 2009, there were about 16,080 offshore fishing vessels. This figure was 2.7 times and 2.4 times higher than that in 2000 and 2002, respectively. The structure of the offshore fleet by fishing gear is presented in Table 2.2. The four most important fisheries consisted of trawl, purse seine, gillnet and long line fishery. At present, these fisheries are still fundamental components constituting the offshore fishing fleet in Vietnam (DECAFIREP, 2009)

Most offshore fishing vessels are constructed by wood and about 88.7% of this fleet is equipped with second-hand engine. The majority of them is equipped with oil and fresh water tanks that are too small for long trips; most of the fleet has only ice and salt storage compartments with no modern reefer systems (FAO, 2005a, p.37).

Table 2.2: The structure of offshore fleet by fishing gear in Vietnam

Fishing fishery	1997[a]	2000[b]	2002[c]
Trawl	34.2%	55%	37%
Purse seine	21.1%	20%	14.3%
Gillnet	20.4%	9%	20.2%
Long line	17.3%	9%	20.5%
Others	7%	7%	8%
Total	100%	100%	100%

Sources: [a] Lewis A.D. (2005); [b] FAO (2004, p.5); [c] FAO (2005a, p.37).

Marine resource status

Vietnam’s marine fishing is small scale (Son, 2004; Pomeroy et al, 2009; FAO, 2009a; Pho Hoang Han, 2007; Paul et al., 2002) as about 82% of total marine catch come from the coastal sea areas where there are almost 72% of fishing boats equipped with engines of less

[5] Offshore fishing fleet is generally taken to mean engines of a total capacity of 90 horsepower or more; offshore is defined as inverse of the definitions in quote 3 (See Circular no. 05/1998/TT-BTS on December 29, 1998 by the Ministry of Fisheries; and see Decree no. 123/2006/ND-CP of Prime Minister on October 27, 2006)

than 45 HP (Long, 2004) and more than 84% less than 90 HP vessels (FAO, 2005a; Pomeroy et al., 2009). During the last years, the fast increase in the number of vessels and engines has lead to a decrease in catch per unit of effort, from 1.11 tones /HP in 1985 to 0.61 tones /HP in 1993 and 0.36 tones/HP in 2004 (Long, 2002; FAO 2005a; Pomeroy et al, 2009) . This is a consequence of overexploitation of coastal resources in Vietnam, resulting in the unbalance between potential coastal stock abundance and fishing capacity in terms of amount of fishing vessels (FAO, 2005a). According to Long (2002), FAO (2005a) and Pomeroy et al. (2009), the maximum sustainable yield (MSY) of coastal fisheries resource was about 0.6 million tonnes. As mentioned above, 82% of total national marine catch was corresponding to the level of coastal marine catch from 0.812 to 1.596 million tonnes during the period 1995 to 2008. These figures were much higher than MSY, and the fishing effort levels have always been larger than the effort level of MSY. As a result, coastal resources in Vietnam have been overexploited (FAO, 2005a).

In order to reduce the pressure on coastal fisheries resource, Vietnam’s policy switch from onshore to offshore waters and a program of investing offshore vessels have thus implemented since 1997 (MOFI, 1997a; MOFI 1997b; FAO, 2004 and 2005a; FAO 2009b). Hence, the number of offshore fishing vessels has increased during the period 1997 to now. However, the offshore fishing program has not perfectly obtained its goals (FAO, 2005a). The reasons were that “*the lack of suitable fishing technologies and skilled skippers and crew, high input costs, insufficient information on offshore resources, fishing grounds and seasons, and inadequacy of onshore services*” (FAO, 2005a, p.37). A large number of offshore vessels had lower catch than expected rates and performed poorly in economic terms. Many of them were apparently facing economic difficulties and there have been trends removing from offshore fishing grounds into inshore waters (FAO, 2005a, p.37). According to some recent documents, it is indicated that there is a possibility for further development in the offshore fishery because the MSY estimation in Vietnamese EEZ area was 1.1 million tones while the offshore fishing production of Vietnam is forecasted to be 0.6 million tones in 2005 (excluding the catch of foreign illegal, unreported and unregulated fishing vessels) (FAO, 2005a). However, with a large increase of offshore fishing fleets like above, there will not be any guarantee to decrease the pressure on near shore exploitation and develop reasonably and suitably offshore fisheries in accordance with offshore resource capacity in the future.

Marine fishermen communities

For Vietnam's fishermen communities, there were about 640,000 laborers in 2004, of whom 60,000 take part in offshore fishing (Son, 2004), and there were an increasing number of 22,500 fishers involving in marine fisheries each year (Long, 2004). In 2007, the labor force working directly in marine capture increased at level of 700,000 people (WPEAOFMP, 2009). Most of them are considered poor (FAO, 2005a, 2009a; Long et al., 2008; Pomeroy et al, 2009). Their household income mainly depends on marine fishing (FAO, 2009a). The people here lack capital or access to formal credit. Hence, it was difficult for them to invest in big fishing vessel for offshore (Long, 2004). In addition, the majority of fishers has the low educational level[6]. Consequently, fishers cannot afford offshore fishing advanced technologies. As a result, a large percentage of fishers has focused on coastal fishing (FAO, 2005a; Pomeroy et al, 2009).

In summary, Vietnam's marine capture fisheries are small scales, multi-species and multi-gear (Son, 2004; Pomeroy et al, 2009; FAO, 2009a; Pho Hoang Han, 2007; Paul et al., 2002) and open access (Pomeroy et al, 2009; FAO, 2009a). Marine fisheries production has continuously increased over time and the number of fishing vessels has increased greatly and gone far beyond the control. Coastal fishing capacity has exceeded the sustainable limit. Coastal resources have thus been overexploited, and are exhausting. The majority of coastal fishermen communities is poor, lacks capital as well as lacks the knowledge for offshore fishing activities. Therefore, Vietnam's marine fishing fisheries are in need of good management.

2.2. KHANH HOA'S MARINE CAPTURE FISHERIES

Marine capture production and fleet

Figure 2.2 shows total marine capture production and the number of vessels as well as total engine capacity in Khanh Hoa during 2001 – 2009. The annual marine catch has fluctuated over time; it has slightly increased 1.3% in annual average. It often occupied from 73% to 88% in total fisheries production during the same period of time (Khanh Hoa's DARD, 2009a). In 2009, total marine capture production of Khanh Hoa was 72,301 tonnes (Khanh Hoa's DARD, 2009c).

[6] "*68% of fishers have not finished primary school; 20% have finished primary school and nearly 10% have finished secondary school; less than 1% of fishers have a certificate or diploma from a vocational school or university*" (see FAO, 2005a; Pomeroy et al., 2009).

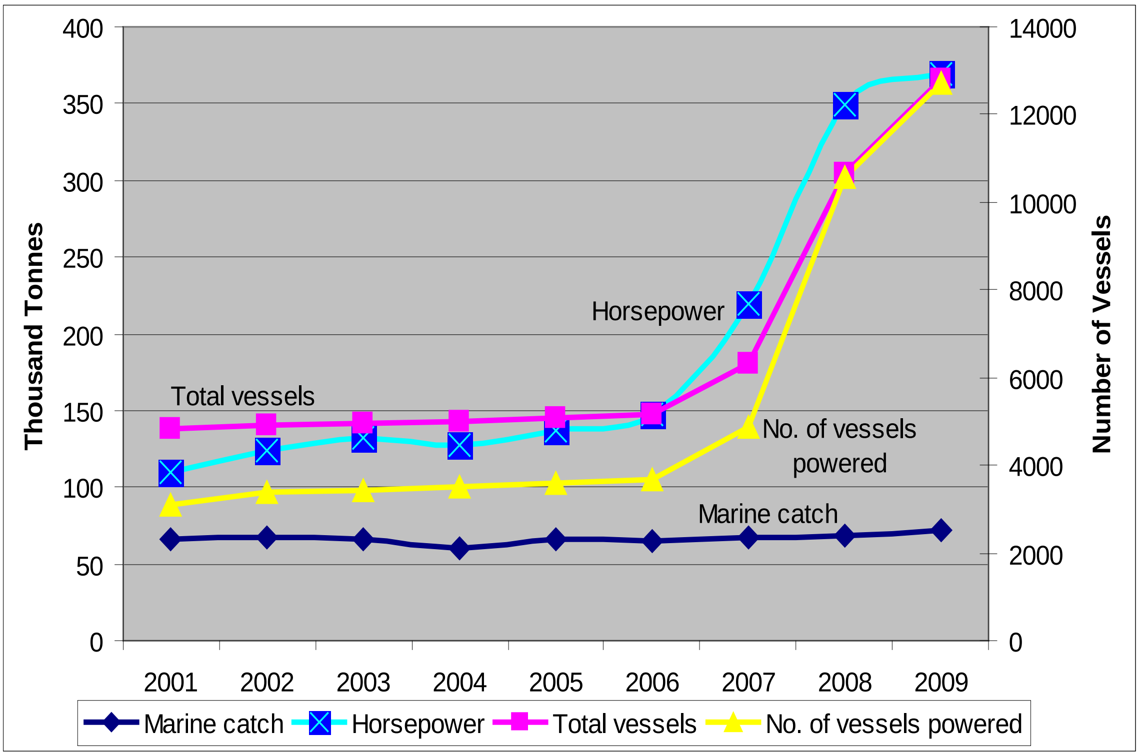

Figure 2.2: Marine catch, number of vessels, and total engine capacity during 2001-2009 in Khanh Hoa. *Note*: see Appendix C in detail. Sources: Khanh Hoa's DARD (2009a, 2009b, 2009c); DECAFIREP of Khanh Hoa (2009).

The number of fishing vessels has increased significantly over time, from 4,812 vessels in 2001 to 12,802 vessels in 2009 – corresponding to an average annual increase of 15% (see Figure 2.2 and appendix C). The majority of fishing vessels is powered in last two years, with only 82 and 65 vessels without engine power in 2008 and 2009 respectively. With the increase in the number of vessels, the total engine capacity of the fleet has increased remarkably – an average annual increase of 18%. In 2007, the number of vessels increased about 33% in comparison with 2006, while total engine capacity rose almost at 50%. This implies that there was more investment in big vessels with large horsepower. Inversely, in 2008, the number of powered vessels increased more than twice in comparison with 2007 while an increase of 60% is for engine capacity. The reasons are that (1) Vietnamese government subsidized for fishing vessels in 2008; and (2) The Khanh Hoa's DECAFIREP discovered the large number of vessels without registration (2834 vessels in 2008), and these vessels are required to register in 2008 and 2009. (Khanh Hoa's DARD, 2009a; DECAFIREP of Khanh Hoa, 2009).

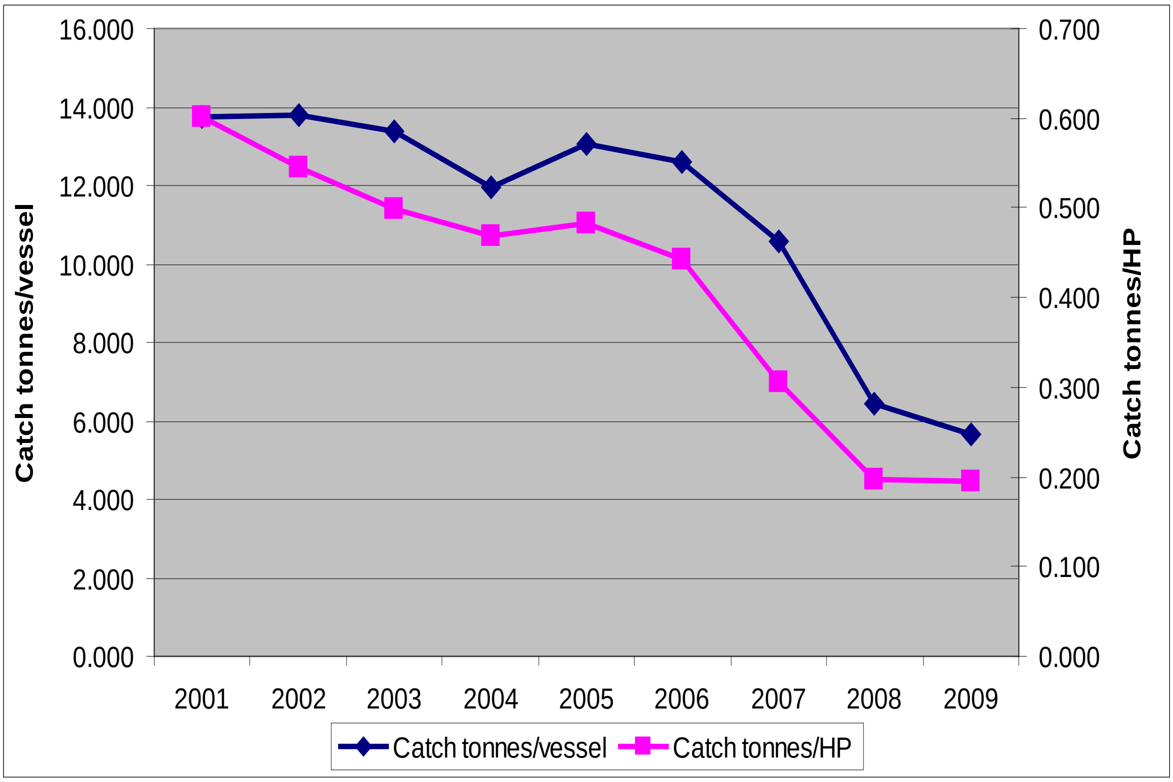

Figure 2.3: Marine catch per unit of vessel (in tones/vessel) and per unit of engine power (in tones/HP) during 2001-2009 in Khanh Hoa. *Note*: see Appendix C in detail. Sources: Khanh Hoa's DARD (2009a, 2009b, 2009c); DECAFIREP of Khanh Hoa (2009) and the author's calculations.

From the above figures, catch per unit of effort is calculated for Figure 2.3. Catch per vessel (in tones/vessel) and catch per unit of engine power (in tones/HP) have almost declined during period of time 2001 – 2009. The average annual decrease rate was 9.4% of catch per vessel and 12% of catch per HP during this period of time. In 2009, catch per vessel and catch per HP decreased to 5.65 tones and 0.195 tones, respectively. There was only a little increase in 2005.

Structure of fishing vessels

By the end of 2009, the number of purse seine using light was 3,322 vessels – accounted for the highest rate of 25.9% in total vessels in Khanh Hoa (see Table 2.3). The second position was the number of trawlers, accounted for 13.2% in total. Besides, Table 2.3 shows the majority of vessels had an engine size of less than 50 HP. Approximately 89% of the total mechanized vessels was less than 50 HP, and 95% was less than 90 HP. This is the same situation of Vietnamese capture fisheries. Khanh Hoa's capture fishery, as a master of fact, can be described as largely small scale.

Table 2.3: The distribution of vessels by fishing gear and engine power in Khanh Hoa, 2009.

Gear type	Range of engine power						Total	Rate
	0-<20	20-<50	50-<90	90-<250	250-<400	400-<4000		
Gill net	394	144	82	105	88	15	828	6.5%
Longline	860	277	55	86	19	2	1299	10.1%
Trawl	400	791	291	187	16	3	1688	13.2%
Purse seine	642	260	74	17	1	1	995	7.8%
Purse seine using light	1871	1194	169	83	5	0	3322	25.9%
Lift net	239	52	59	56	6	3	415	3.2%
Others	3619	581	37	16	1	1	4255	33.2%
Total	8025	3299	767	550	136	25	12802	100%
Rate	62.7%	25.8%	6.0%	4.3%	1.1%	0.2%	100%	

Source: DECAFIREP of Khanh Hoa (2009)

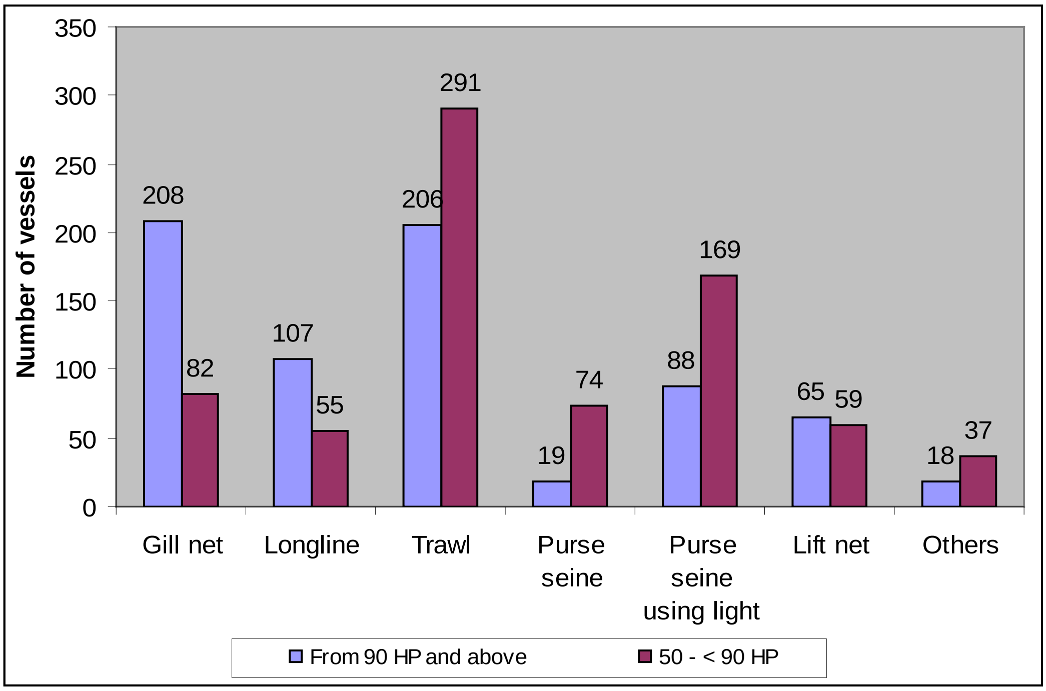

Figure 2.4: The distribution of vessels by fishing gear with engine of 50 HP and larger in Khanh Hoa, 2009. Source: DECAFIREP of Khanh Hoa (2009)

Among total number of fishing vessels, there were 711 vessels with engine of 90 HP and larger. This fleet is considered as offshore fishing vessels. The four most important fishing gears still consisted of gillnet, trawl fishery, purse seine (both with and without using light), and long line; of which gillnetters and trawlers accounted for the greatest number of vessels, 208 and 206 respectively (Figure 2.4). In fact, many of vessels with engine of 50-90 HP also joined into the offshore fishing fleet in Khanh Hoa (Long et al., 2008; Kim Anh et al., 2006). Trawling vessels occupied the largest amount in this range of horse power.

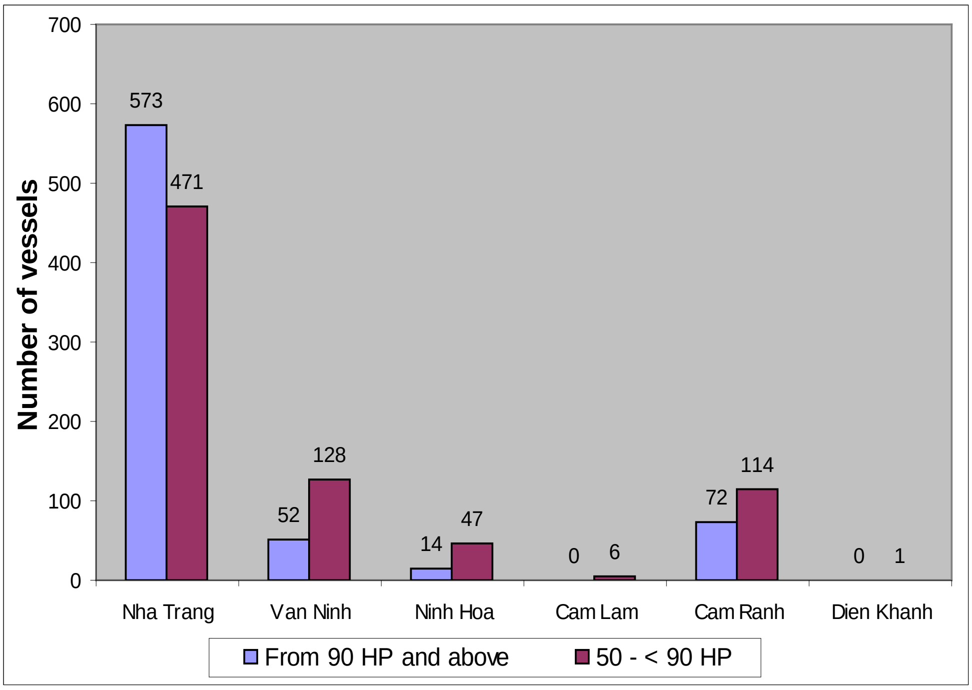

Figure 2.5: The distribution of vessels by location with engine of 50 HP and larger in Khanh Hoa, 2009. Source: DECAFIREP of Khanh Hoa (2009)

Nha Trang's fishing fleet

Nha Trang's fishing fleet has a high representation in Khanh Hoa province. This fleet helped account for the highest proportion in the total number of Khanh Hoa's fishing vessels in 2009, reaching nearly 34% (DECAFIREP of Khanh Hoa, 2009; see Table C3 in appendix C in detail). Most offshore capture vessels of the province is allocated in this city, with 80.6% of 90 HP and greater engine vessels (573 units) and 70.6% of 50 HP and larger engine vessels (1044 units) (see Figure 2.5).

Marine fishermen communities

According to report of Khanh Hoa's DARD (2009a), the number of labours in fishing sector was 31,500 people in 2007. The majority of fishers in Khanh Hoa has the low educational level with about 90% of fishers without finishing secondary school; most fishermen inherit fishing experience from previous generations. Based on the costs and earnings surveys for 2004 and 2005, the offshore and inshore fishing fleets of Khanh Hoa province were considered as highly profitable for both vessel owners and crews, whereas the small scale fisheries were negative profitable (Flaaten, 2008). The net profit in percent of gross revenue depended on the types of fishing gear in 2004 and 2005, generally fluctuating from 8.78% to 24.01% for anchovy purse seine, offshore gillnet and long line fisheries. However, fishermen might be considered as poor people if their family size was more than that in average level of the nation (Flaaten, 2008).

Khanh Hoa's offshore gillnet[7] fishery

At present, the total number of gillnet fleet is 828 units – corresponding to total engine power of 65,050.5 HP (DECAFIREP of Khanh Hoa, 2009), in which there are about 65% boats with engine of less than 50 HP and almost 75% boats with engine of less than 90 HP (Table 2.4). Most these groups are allocated in Cam Ranh district and Nha Trang city.

Table 2.4: The distribution of gillnet vessels by location and engine size in Khanh Hoa, 2009

Range of engine power	Districts in Khanh Hoa					Total	Rate
	Nha Trang	Cam Ranh	Ninh Hoa	Van Ninh	Cam Lam		
0-<20	62	303	22	0	7	394	47.6%
20-<50	59	51	23	10	1	144	17.4%
50-<90	55	14	7	6	0	82	9.9%
90-<250	79	16	1	9	0	105	12.7%
250-<400	86	1	1	0	0	88	10.6%
400-<4000	13	1	1	0	0	15	1.8%
Total	354	386	55	25	8	828	100%
Rate	42.8%	46.6%	6.6%	3.0%	1.0%	100%	

Source: DECAFIREP of Khanh Hoa (2009).

[7] Gill net and its characteristics are defined in books of King, 1995, p.65-78 and Jennings et al., 2001, p.90-111. In the case of the Khanh Hoa fishery, Kim Anh et al., 2006 defined that "*Gill net is composed of separate pieces of small nets that are combined together to form a big one. Each piece may contain up to 1,000 meshes in length and 180-200 meshes in depth. When casted, meshes will take the square shape with 5 cm for each side, corresponding to the measurements of 60m (in length) and 9-10m (in depth) for the whole piece*" (see Kim Anh et al., 2006, p.2).

Nha Trang city has 233 units in total of 290 gillnet vessels with engine of more than 50 HP (account for more than 80%), and 178 vessels in total number of 208 vessels with engine of more than 90 HP (account for nearly 86%). Most gillnet vessels with engine of more than 250 HP concentrate in this city (see Figure 2.6). Hence, it can be said that the offshore gillnet vessels of Khanh Hoa province are mostly located in Nha Trang's fishing community, of which they are mostly found in Vinh Phuoc (145 units) and Xuong Huan wards (75 units) (DECAFIREP of Khanh Hoa, 2009).

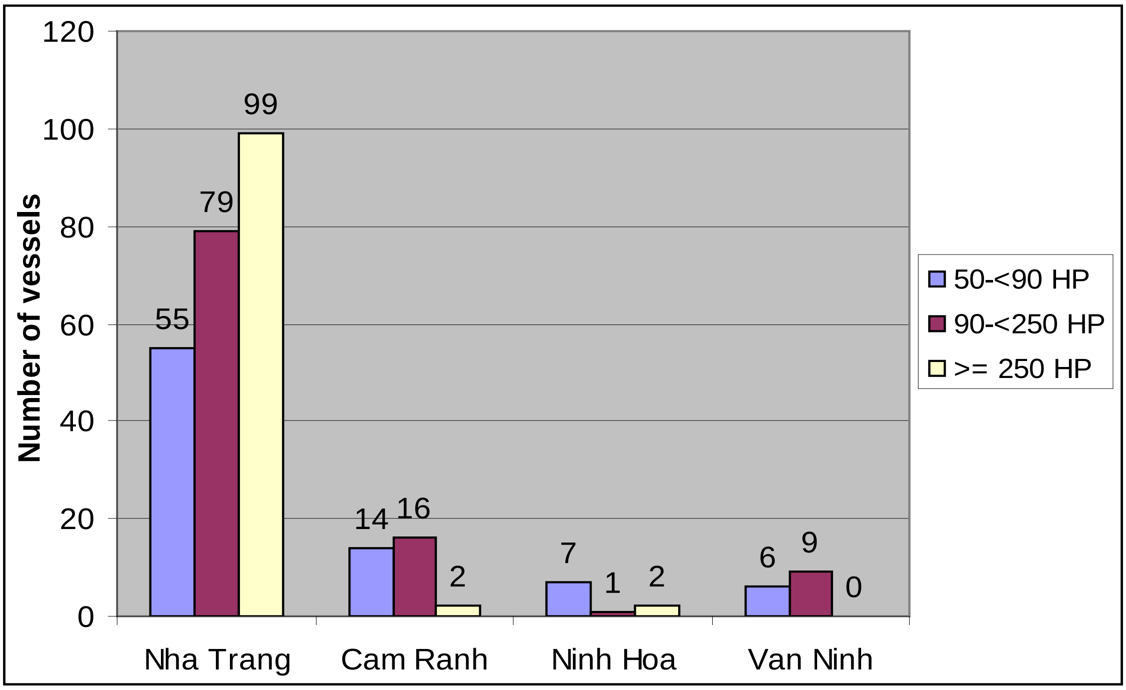

Figure 2.6: The distribution of gillnet vessels with engine of 50 HP and larger by location and engine capacity in Khanh Hoa, 2009. Source: DECAFIREP of Khanh Hoa (2009)

The Khanh Hoa's offshore gillnet operators often operate in the sea waters of 50 - 70 nautical miles onward from the coastline, along the territorial waters of Khanh Hoa province and move toward the East and Southwest waters (6^{o}00'-8^{o}00'N; 104^{o}30'-108^{o}00'E) and Southwest of Truong Sa Island (6^{o}00'-9^{o}00'N; 110^{o}30'-114^{o}00'E), and fishing grounds of high sea waters (6^{o}00'-7^{o}00'N; 109^{o}00'-110^{o}00'E). Fishing grounds depend on the movement direction of fish aggregation of migratory species (Kim Anh et al., 2006). The target species are mainly tuna[8] and mackerel[9] species. These offshore gillnetters operate from September

[8] Tuna species consist of "Bullet tuna (*Auxis rochei*), Frigate mackerel (*Auxis thazard*), Eastern little tuna (*Euthynnus affinis*), Longtail tuna (*Thunnus tonggol*), Striped tuna (*Sarda orientalis*), Skipjack tuna (*Katsuwonus pelamis*), Yellowfin tuna (*Thunnus albacares*) Bigeye tuna (*Thunnus obesus*)" (see Kim Anh et al., 2006)

[9] Mackerel species include "Indo-Pacific Spanish mackerel (*Scomberomorus guttatus*), Wahoo (*Acanthocybium solandri*), Narrow barred Spainish mackerel (*Scomberomorus commerson*)" (see Kim Anh et al., 2006)

(or October) to July (or August) of the following year. The major fishing season of tuna falls from February to July (called the south-west monsoon), which fish are found out in the offshore waters from Khanh Hoa to Ba Ria-Vung Tau province, while the fishing season that ranges from February to June is for mackerel species. The second season is normally called the north-west monsoon, ranging from October (or November) to January of the following year. Tuna is concentrated in the extreme South of Vietnam in this second season and only gillnet vessels with large engine power can go to further into this fishing ground. Almost all offshore gillnet vessels stay on shore for repairs and maintenance from August to September. The majority of them is the tuna gillnet vessels as it is difficult to find the mackerel gillnetters in Khanh Hoa province. The reasons are the mackerel stock depletion as the first reason and the requirements of fishing experience and capacity of prediction of fishing ground as the second cause (Kim Anh et al., 2006). Consequently, the mackerel gillnet owners have to transfer to fishing tuna or combine both operations.

According to Kim Anh et al. (2006), the offshore gillnet fleet is often invested with a large amount of capital. The crew size ranges from 8 to 12 people. Skippers and vessel-owners are above 40 years old and have more than 20 years of experience. Each trip takes 10 – 25 days with 1 or 2 trips per month depending on the fishing season and capacity of vessel. There is a break of 5 -7 days between trips, normally from 10th or 12th to 17th of every lunar month. In 2004 and 2005, average gillnetter earned more than 3,700 USD and 6,500 USD of net profit per year respectively – corresponding to 8.81% in 2004 and 12.15% in 2005 in term of profit margin. Average income per fishermen ranged from nearly 800 USD to 930 USD per year (Kim Anh et al., 2006; Flaaten, 2008).

In short, the Khanh Hoa fisheries are a largely small scale. 89% of the total mechanized vessels were less than 50 HP, and 95% was less than 90 HP. The pressure on already overexploited near-shore resources increasingly spreads out in the provincial sea areas. Hence, the strategy for offshore fisheries development is a need as declared in report of FAO (2005a) at the “Conference on the National strategy for marine fisheries management and development in Vietnam”. Gillnet vessels are one of main offshore fishing fleets in Vietnam as well as Khanh Hoa. In Khanh Hoa, most this fleet is allocated in Xuong Huan and Vinh Xuong wards of Nha Trang city. This offshore fishery is now an open access with the addition of tax systems abolishing in 2006 (Flaaten, 2008); the policy of fuel subsidy used in 2008. Other regulations have not been strong for Vietnamese offshore capture fisheries in general and Khanh Hoa’s offshore fishing fisheries in particular (Flaaten, 2008).

Chapter 3

FISHERIES ECONOMIC THEORY

3.1. LITERATURE REVIEW

Economic surveys of fisheries have been undertaken in many nations for many years as a means of assessing the economic performance of their fisheries. In 1987, a study of the profitability of the fishing fleets was performed in the Gulf of Thailand by Panayotou and Jentanavanich. The research was carried out through four surveys in 1969, 1974, 1977 and 1982. From these, some economic indicators were presented, such as revenues, costs, gross profits, net profits, pure profits, and rate of return on capital as well as catch per unit effort. The gross profits defined as the difference between revenue and operating cost, and net profit was gross profit after subtracting the fixed costs, and pure profits obtained as the distinctions of the net profits and the opportunity cost of capital assumed equals to 20% of capital. The study concluded that all indicators were positive for an average vessel by type of scale in different regions, whereas they were negative in terms of gross profits, net profits and economic rents in some types of fishing gear. Hence, the authors admitted that there might be misleading in average figures since variance was large because of the unreasonable definitions of vessel scales and small sample sizes. However, the study showed that the trawl fishery revealed the persistence of excess profits for most boat classes despite massive entry and marine resources overexploited in the Gulf of Thailand (Panayotou and Jentanavanich, 1987).

In Brazil, Almeida et al. (2001) presented the results of an economic analysis of the Santarem commercial fishing fleet in 1997 in lower Amazonian fisheries based on 50 interviews with boat operators that gill nets were their main gears. The boat fleet was homogeneous in technology in terms of gear and hull design, but different in boat size (weight). The study results showed that smaller boats had higher economic efficiency in terms of income in relation to expense, but had less in terms of catch per unit effort than larger boats. The authors explained that the greater economic efficiency of small boats was due to the combination of labor, fishing and marketing strategies, whereas the large boats faced small domestic market size. The crew payment was the biggest expenses of the fishing activity, which range from 30% for smallest boats to 63% for the largest (Almeida et al., 2001).

In the United States (U.S.), two researchers from the University of Hawaii's Joint Institute for Marine and Atmospheric Research (JIMAR), Marcia Hamilton and Steve Huffman carried out costs and earnings study of Hawaii's small boat pelagic fishery in 1995 and 1996. Data, which was surveyed through both direct and mail-back surveys from vessel owners and operators, consisted of information on vessel operations and characteristics, investment and fixed costs, trip costs, annual catch, gross revenue, and operator demographics. The surveys were stratified into four groups based on fishermen's motivations on fishing income, including the fulltime, part time, expense, and recreational fishermen[10]. The findings showed that, for those who sold fish, fishing intensity, catch rates, and gross revenues were highest for fulltime fishermen and lowest for expense fishermen. The average annual fixed costs accounted for large rate in total cost. Fixed costs were higher for pelagic vessels as compared to non-pelagic vessels across all motivations. Average trip costs showed no big differences between fisherman groups, with only slight variations by operator motivations, vessel targets, sizes, and islands, of which fuel consumption was the most significant cost which can vary according to size and gear type of the vessels. Fulltime fishermen reported receiving of 96% of their personal income from fishing profit; part-time fishermen got only 16% and expense fishermen dropped to 4%. It can be sees that the study was mostly done through the analysis of the structure of cost items by groups of fishermen, vessel target and vessel characteristics; yet it lacks labor share information. Therefore, the study was presented the result of net revenues of the vessels (Hamilton and Huffman, 1997).

Agar et al. (2005) also carried out a costs and earnings study of fish trap fishery in U.S. Caribbean in 2003. The main socio-economic characteristics of the trap fishery were described in the contexts of the Commonwealth of Puerto Rico and Territory of the U.S. Virgin Islands. The approach of economic and financial performance measures was adapted from Whitmarsh et al. (2000). However, the authors defined the costs of crew payments as the opportunity cost since they calculated economic profits in order to determine the economic performance. The study concluded that, on average, vessels could cover their cash cost from positive vessel income (financial profit). It also illustrated that the various economic surpluses generated were to give evidence to the heterogeneity of the trap fishery in U.S. Caribbean. Another thing is that higher gross revenue was always not likely to transform into higher net return. In addition, it is asserted that the results of negative economic profits

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[10] "*The fulltime fishermen were defined as those who reported receiving over 50% of their income from fishing profits; part time fishermen received 50% or less of their income from fishing, expense fishermen sold fish only to cover trip costs, and recreational fishermen did not sell any part of their catch over the previous 12 months*" (see Hamilton and Huffman, 1997).

were imputed as evidence of the overcapitalized trap fisheries, and that a higher economic return could be attained from a social perspective by retaining some of the scarce capital and human resource elsewhere in the industry (Agar et al., 2005).

In Australia, under the Fisheries Management Act 1991, the Australian Fisheries Management Authority (AFMA) pursued a number of objectives in managing Commonwealth fisheries and required annual assessment of the biological and economic status of Commonwealth managed fisheries (Hohnen et al., 2008).

Rose et al. (2000) presented a paper based on second data supplied by AFMA and the information collected was summarized in annual Australian Fisheries Surveys Report of Australia Bureau of Agriculture and Resource Economics (ABARE) from 1990 to 1998. The study adapted the calculating approach of economic performance indicators in Whitmarsh et al. (2000). However, the difference is that item of management cost was added in order to determine the net return (called as economic rent by the authors) to the fisheries resource. The purpose of the study was to analyze and provide performance indicators in public sector resource management of three Australian Commonwealth fisheries during period 1990 to 1998. The results showed that the net revenue was the largest and constantly increasing over time in the northern prawn fishery while it was decreasing in offshore trawl sector of the south east fishery. For net return, it was negative for the east coast tuna and billfish fishery during the same period of time. The study finally emphasized on the importance of integrating economic and biological indicators in assessing the performance of fisheries management, and recommended that consideration of the net returns could not be undertaken without an understanding of the ecological, market and institutional factors.

In 2008, ABARE also presented an annual report that assesses the economic state of the commercial fisheries managed by the Australian government in 2006-2007. The objective of the report was to present an assessment of the performance of the relevant fishery management authority against the objective of maximizing the net economic returns from the exploitation of Commonwealth fisheries for the Australian community. The report described characteristics and indicators of catch volume, value and composition, fisheries financial and economic performance, biological status of stock biomass, and management arrangements for each fishery. A range of economic indicators and tools are used for assessing economic performance. These indicators included net economic return (is calculated similar in the paper of Rose et al., 2000), productivity indexes, level of latent effort for small fisheries, and value of quota. For one quota-managed fishery, the authors compared actual catch to total allowable catch for each of the fishery's quota managed species. They indicated that latent effort in the fishery has been high and can be linked to the fishery's historically poor economic performance. The tools were profit decompositions, stochastic frontier analysis and bio-economic models. The results represented in details in Hohnen et al. (2008).

In Europe, there have been many studies and reports about costs and earnings survey for recent two decades on scale of country as well as the continent. For instance, Flaaten et al. (1995) carried out the analysis of the profitability for the Norwegian purse seine fishery, with costs and earning data of 1983 and 1984. The authors proposed the profitability model for determining economic performance indicators. A small different point in the model is that gross revenue to vessel was defined as the retained value after sharing to crew from fishing income. The study was to test empirically and to compare the profitability of vessels which had their free licenses, with the profitability of vessels which had to purchase the license, in order to determine the differences of rents between the two vessel groups. This results in the higher profit in the former vessels group than the later vessels group. However, the authors had applied the econometric models for analyzing of the factors affecting different sides of fishing vessels performance (Flaaten et al., 1995).

In United Kingdom (UK), costs and earnings surveys were carried out in the English Channel fisheries in 1994-1995 (Pascoe, Robinson and Coglan, 1996) and 1996-1997 (Coglan and Pascoe, 2001[11]). In report 44 of Centre for the Economics and Management of Aquatic Resources (CEMARE) carried out by Pascoe, Robinson and Coglan (1996), it was emphasized the purpose of explaining the methodology in undertaking the survey and presented key findings of the financial and economic performance of boats in the English Channel. The survey methodology began from determining the target population. In each target population, a stratified random sample of vessels was selected for interview on the basis of both boat numbers in each size class in each region category and the estimated value of landings. The sample statistical techniques were applied in accordance with a probability distribution which provided information on the probability that the estimates were true. The results of the study were presented into separated parts: boat characteristics and fishing behaviour, financial performance (revenue, running costs, crew costs, fixed costs and boat income) and economic performance (economic labor costs which included crew costs and skipper costs that were imputed as the opportunity cost, fixed economic costs which excluded interest payments due to no true resource cost in their study and which the depreciation cost

[11] Unfortunately, the document of Coglan and Pascoe (2001) is unavailable

was estimated rather than using an accountancy based measure, full equity profits and rate of return) by boat sizes and fishing activities, and overall value of the fishery. The opportunity cost of capital was referred to as the normal or expected rate of return (take a value of 10% in the study) which the rates of return to capital was compared with in the research. It is concluded that most vessels covered their cash cost during period 1994-1995 on average, resulting in positive vessel income. However, about 11% of vessel interviewed failed to cover their cash cost. When all costs was considered as economic costs (including non-cash costs and cash costs), about 29% of UK fleet had negative economic profits. The authors also mentioned in terms of resource rent and intra-marginal rent that derived from costs and earnings survey, and affirmed that "*the assessment of economic performance is a key element in further the understanding of the economic incentives that exist in the fishery*" (Pascoe, Robinson and Coglan, 1996).

On whole scale of European Union (EU) since 1998, economic performance of selected European fishing fleets was assessed within EU fisheries and it was suggested to have some annual reports on the topic. For example of 2004, an annual economic report on "Economic performance of selected European fishing fleets" had been prepared by the Concerted Action "Economic Assessment of European Fisheries" (Q5CA-2001-01502). The study carried out in marine fisheries of 20 countries, of which 86 specific segments of fishing fleets were included. Main characteristics, economic and technical indicators, economic performance of the fishing fleets in 2003 were discussed (not from the financial point of view). Most important economic indicators such as value of landing, gross value added, gross cash flow, net profit were presented for each selected segment of fishing gear for each country. The methodology of imputing capital cost followed the method in Davidse et al. (1993). For calculating and evaluating capital costs, the replacement value of the vessel was used to calculate depreciation. The replacement value was defined as the current building costs of similar new vessel. Each type of physical assets had different rate of annual depreciation, and majority of them was depreciated by the straight line method. An imputed interest was computed, reflecting the opportunity cost of the capital invested in the vessel as there was a widely difference in actual interest cost per vessel in different countries (Action 2004). Additionally, at the conference on energy efficiency in fisheries (Brussels, 11th-12th May 2006), a report of summery and conclusion related to the economic performance and the effects of fuel price changes on the costs and profits of selected EU fishing fleets during 1996-2004 was also presented [3].

On a global scale, FAO Fisheries Department began collecting empirical information on the economic of fishing operations in 1995 in close cooperation with fisheries research institutions and national fisheries administrations in selected nations in Europe, Asia, Africa, and Latin America (FAO, 1999a). According to reports in FAO Fisheries Technical Papers 377, 421 and 482, studies of costs and earnings carried out by FAO in 1995-1997, 1999-2000, and 2002-2003 (FAO 1999a; FAO 2001, FAO 2005b).

In 2005, FAO presented the findings of country level studies on the economic and financial performance of marine capture fisheries. During 2002 and 2003, 13 countries were studied with the 94 most important fishing fleets operating covered: South America (accounted for 62%), Caribbean (8%), Europe (42%), Africa (24%) and Asia (24%). The result of the studies showed that all 94 kinds of fishing vessels had a positive gross cash flow and fully recovered their operating costs, with no losses in 2002 and 2003. 88 of the 94 types of boats (corresponding to 94%) had a net profit after deducting the costs of depreciation and interest. The studies also found that there were significant improvements in financial and economic performance of fishing fleets in the Republic of Korea, Germany and Argentina comparing in both 2002 to 2003 with 1999 to 2000, partially due to reduction and limitation in fleet capacity. In other countries, the results, however, remained similar. The findings of the national studies also proved the variations in cost structure in different continents resulting from the differences in labor, maintenance and repair costs of fishing vessels (FAO, 2005b).

For the report of FAO (2005b), information on costs and earnings of the fishing fleets had been generated through empirical studies combining secondary data, and the methodology followed that used in the study “Costs and earnings of fishing fleets in four EC countries”, published by the Department of Fisheries of the Agricultural Economics Research Institute and funded by the European Union (FAO, 1999a). A same methodology was conducted in 1995-1997, 1999-2000 and 2002-2003. Two groups of indicators were used for assessing the economic and financial performance of fishing vessels. The economic performance was measured by the net cash flow (which is defined as net profit). The net cash flow was computed as the value of landing less all costs including the costs of depreciation and interest. Another indicator of economic performance used is the ratio of the net profit to total earnings. The financial performance was measured by rate of return on investment (net profit/capital invested ratio). The fishing fleets were divided by ranges of length. For each category of boats, the operating costs were divided into running, vessel and labor costs; and total costs included depreciation and interest, which were referred to as capital cost. “*Labour* *costs consist of wages and other labour charges such as insurance and employers' contributions to pension funds. Running costs include the costs of fuel, lubricants, selling fish via auction, preservation and storage of fish, packing materials, harbor dues, bait, salt, ice and food and supplies for the crew. Vessel costs are those of vessel insurance, vessel and gear repair, and maintenance expenses" (FAO, 2005b, p19).* For calculating and evaluating capital costs, the methodology was similar Action (2004) which mentioned above (FAO, 2005b).

With the available data from costs and earnings surveys and the annual reports which mentioned above, many papers were published to discussing such an issue related to the topic of the economic performance from different perspectives.

Coglan and Pascoe (1999) demonstrated that the use of average economic performance indicators would be misleading in the English Channel fishery with the multi-purpose fleets, and that failing to separate out the resource rents from intra-marginal rents might result in misrepresentation of the economic performance.

Whitmarsh et al. (2000) presented the profitability model in which the authors argued the need of separating the economic and financial performance indicators. According to the authors, the financial performance indicators were based on the concept of income that presented the rewards to the boats owner's labour and the return on his/her capital invested as well. Meanwhile, economic performance indicators were based on the concept of efficiency, of which the value of output was calculated based on the real cost of the needed to produce it. The study also focused on the role of costs and earnings surveys in assessing not only the current actual profitability of the fisheries, but the indicators of the profit-earning potential under alternative fisheries management regimes. Hence, the up-to-date picture of costs and earnings surveys and bio-economic modeling required different policy scenarios.

Boncoeur et al. (2000) proved that the irrelevance of rate of return on capital in measuring economic performance to small boats of the English Channel fishery, and proposed a better indicator on the rate of return on owner-operator labor for the small boats.

Surís-Regueiro et al. (2002) found out that the fishermen continued to invest in fishing despite the over-capitalization which existed at the same time since the authors studied on "profitability of the fishing fleet and structural aid in the European Union" during 1994-1999. The study also showed that the levels of profitability of some fleet segments were related to the levels of the public protection.

Additionally, Le Floc’h et al. (2008) concluded that the measure of economic and financial performance was depending on the different sources of information of the data, such as bookkeeping or field surveys. From two data sources, the authors focused on the comparative analysis of vessels’ economic performance (both in short and long run). They also demonstrated that the measures of economic performance, in the short term, required the indicators of the landing value, operating costs for assessing the gross surplus, and in the long term, required the capital cost.

Another research of Ceriola et al. (2008) proposed a system of 47 bio-economic indicators, including 22 biological indicators and 25 socio-economic indicators which were applied for the demersal trawl fishery in the southern Adriatic Sea in the central Mediterranean. Those economic indicators included the measures of economic performance, productivity, costs and prices. In fact, in previous time, FAO (1999b) “Indicators for sustainable development of marine capture fisheries” was also mentioned in FAO Technical Guidelines for Responsible Fisheries No. 8.

The majority of the above studies used the method of the proxy economic indicators or the market based economic valuation[12], excepting the study of Flaaten et al. (1995) whose methodology was the combination between indicators and the regression technique. There were a lot of researchers applying other methods, resulting in indicators of economic performance, such as the method of productivity and efficiency analysis (i.e. productivity indices, regression techniques, and frontier estimation). A typical example was presented in CEMARE Report 60 (2003) applying methods of stochastic production frontiers (SPF) and data envelopment analysis (DEA) for analyzing the efficiency of EU fisheries. However, these methods often required the significant amounts of data to estimate and more costly evaluation techniques (Vieira et al., 2009).

In Vietnam, there were only some studies on costs and earnings surveys such as Kim Anh et al. (2006), Kim Anh et al. (2007), Long et al. (2008), and Thanh Thuy et al. (2008). Most the studies used the definitions of costs and earnings in correspond to principle used in the profitability of fishing fleets in the studies of Action (2004) and FAO (2005b). The authors, however, had adjusted in accordance with the actual accounting and book-keeping systems in Vietnam, for example, the methodology of calculating depreciation and opportunity costs.

Kim Anh et al. (2006) carried out the study of costs and earnings of gillnett vessels in Nha

[12] Definitions of the methods of the proxy economic indicators and the market based economic valuation were showed in the study of Vieira et al. (2009, p.10-19).

Trang, Vietnam in 2004 and 2005, which assumed that the gillnet operators had achieved noteworthy economic efficiency. Average net profits of vessels with small size (measured by hull length of less than 15.5 m) were much higher than those of the large scale vessels (more than 17 m) while gross revenues were in inverse in both 2004 and 2005. Regarding the rate of return on equity, the small scale vessels still performed best while the group of the medium vessels (15.5-17m) produced the poorest return on equity. However, in general, all vessels had higher rate of return on equity than the average interest of Vietnamese commercial banks in 2005. In the study, the authors collected data from 50 gillnet vessels (accounting for 17.5% of the population) by the face to face interview on a questionnaire form designed. The study defined the items of depreciation and loan interest as the fixed costs since gross cash flow was an indicator that they did not take interest in their study. This similar method was also used in the study of Kim Anh et al. (2007) when the authors researched on costs and earnings from offshore tuna long-line fishery in Nha Trang of Khanh Hoa province of Vietnam (Kim Anh et al., 2007).

Two studies of Long et al. (2008) and Thanh Thuy et al. (2008) had the same characteristics of methodology since economic performance indicators were measured separately by gross revenue, gross value added, gross cash flow, net profit and profit margin. When calculating net profit, both these studies did not include opportunity cost of capital.

The results of Thanh Thuy et al. (2008) showed that in 2005, an average small-scale purse seiner in Khanh Hoa province was able to cover its all costs including depreciation and interest payment, and earned a profit margin of 24% and a return on investment of 30%. Crew income was higher than that in the local seafood processing companies. However, the authors concluded that this fishery was not an occupation of last resort since the purse seine fishing was an open access. For Long et al. (2008), the authors demonstrated longline vessels on average made a profit margin of 12.1%, and crew members earned high opportunity income. The authors assumed that the Vietnamese longline fishery might expand more in the future. With the regression analysis of annual performance, the results showed the long line operators would maximize their gross revenue and income since the vessels designed with hull length of 15.9m and 15.1m, respectively.

Another report of Flaaten (2008) compared the economic performance indicators of some major fishing vessel groups in Khanh Hoa of Vietnam in 2004 and 2005. It is proved that the two inshore vessel groups had a contrast in economic performance: a negative profit margin for small scale trawlers and a positive profit margin for anchovy purse seiners, whereas the offshore gillnetters and offshore longliners had positive net profits in percentage of gross revenue.

3.2. COSTS AND EARNINGS DEFINITIONS

A study on costs and earnings necessities defining explicitly what indicators is measured. Based on the discussion of the literature review above, economic performance indicators are derived in accordance with the objectives of this study and the actual accounting and book-keeping system in the study region. The definitions used in this study are adapted from Long et al. (2008) and Thanh Thuy et al. (2008) and partially the combination of the studies from Flaaten et al. (1995), Whitmarsh et al. (2000), Action (2004) and Le Floc'h et al. (2008). The generally calculation approach is presented as follows:

Gross Revenue

- *Variable costs* (except labour cost)

= *Income*

- *Fixed cost*

= *Gross value added*

- *Labour cost*

= *Gross cash flow*

- *Depreciation*
- *Interest payment on loans*

= *Profit*

- *Calculated interest on owner's capital*

= *Net profit*

Gross revenue is defined as landing value of the vessel in year of fishing operations. It is the result of the average vessel trip revenue times the number of trips in the year 2008.

In order to compare the effect of the 2008 fuel cost support of Vietnamese government to profitability of fishing vessels, gross revenue is calculated for two cases of including the fuel subsidies and excluding the fuel subsidies. The 2008 fuel cost support appears as quasi-lump-sum subsidies payable, and is given directly to fishers; and in fact fishermen have to accept the market fuel price in their fishing operation. Since a subsidy is referred to as quasi-lump-sum subsidy payable to fishers, the profitability of fishing vessels with this type of subsidy may be sum of the profitability without the subsidy and the quasi-lump-sum subsidy, regardless of adding this subsidy to revenue or subtracting it from cost. Additionally, although the 2008 fuel cost support seems like a fishing effort subsidy. In reality it was the income support of the government for fishermen, hence, this subsidy item should be added to gross revenue instead of subtracting from cost.

Variable costs are total expenses for all fishing trips in year, except labor costs. They include costs for fuel, lubricant, ice, provision, minor repair in one fishing year, exclusive of labor costs. They are the result of the average vessel variable cost per fishing trip times the number of fishing trips in the year 2008.

Income is the difference between gross revenue and variable costs, except labor cost.

Fixed cost is the total of annual repair and maintenance costs of hull, engine, gear, and other equipments on the vessel, and insurance for vessels and all crew members. Fixed cost does not change with the number of fishing trips taken in the fishing year 2008.

Gross value added is referred to as the difference between the values of landings (gross revenue) and cost paid to other supplying industries (except of labor costs). It is the result obtained from the annual gross revenue minus the total of annual variable costs and fixed cost, excluding labor costs.

Labor cost is expenditure for crew members in the income share system, as remuneration of crew members. Crew members are all fishermen who participate in fishing operations on the vessel, including vessel owner-operator’s labor, owner’s family-crew members.

Gross cash flow referred to as a reward for capital employed in fisheries. It is calculated as gross value added less labor cost or as gross revenue minus all expense, except depreciation and interests. It is the sum of costs of depreciation, interest payment on loans, opportunity cost of owner’s capital and the net profit.

Profit is the remaining value after deducting depreciation and interest payment on loans (except the calculated interest on owner’s capital) from gross cash flow. It is considered as a reward for the operating year exclusive of opportunity cost of owner’s capital.

Net profit is referred to as net economic profit to society of employing the owner’s capital in the current fishing activity after subtracting the opportunity cost of this capital from profit. It is calculated as the gross revenue less all expense, including the calculated interest on owner's capital. Thus, it is considered as an actual net reward after all factors of production have received their compensation.

The user cost of capital is considered as the cost for the use of the fixed capital assets for one period (OECD, 2001). This employed by the fishing operator has two components. The first is the economic consumption of the capital asset, which is called in terms of "economic depreciation" or "depreciation" in this study. The second is called in terms of interests. Since the fixed capital structure of fishing operation consists of the level of equity and debt, these interests include the paid interest on loans and interest on owner's capital.

Depreciation is calculated as the actual loss in the value of a capital asset through the use of the asset, which is not offset by maintenance and repairs over the period due to wear and tear (Pascoe, Robinson and Coglan, 1996; Boncoeur et al., 2000). In this study, the depreciation is computed basing on the fixed capital value which is to be valued at current prices. In this case, this means that assets acquired in earlier period (or called historic prices) have to be revalued in order to convert the prices of the current year (OECD, 2001). The price indices for the relevant types of asset should be used. However, constructing "constant quality" price indices for capital goods is a difficult task (OECD, 2001), and moreover, the information of the price indices for the relevant types of asset is unavailable in developing countries as Vietnam. Therefore, the annual average consumer price indices[13] are used. In this study, consumption of fixed capital is obtained by using straight-line depreciation basing on the owner's estimated lifespan of the fixed capital items.

Interest payment on loans is costs for payment of loan interest in year. The rate of interest on loans has differences among the vessel owners because of a non-perfect capital market as Vietnam. There are various loan sources for fishermen with the unfair price. These sources can come from their relatives, the national offshore fishery program, or Vietnam's commercial banks. Although interest payments are considered as a transfer within society rather than a real resource cost of the fishing activity, the interest paid on loans is a cash expense which the vessel owners often record to know how much money would spend for. Thus, the loan interest should be deducted before the profit.

The calculated interest on owner's capital is referred to as the opportunity cost of employing the owner's capital in the current fishing activity. Whitmarsh et al. (2000) assumed that "*the opportunity cost of capital is based on what the capital invested in the vessel would have earned in the next best alternative investment*". However, Pascoe, Robinson and Coglan

[13] Information of annual average consumer price indices of Vietnam is available IMF, 2009

(1996, p.25) demonstrated that "*the opportunity cost of capital is the normal or expected return forgone by holding the capital asset rather than some other comparable asset*". The researchers also assumed that it is necessary to have an objective benchmark for determining the opportunity cost of capital, and that the rate of return of firms in other industries with similar levels of risk can be chosen for reflecting the opportunity cost of capital.

Nha Trang's fishery includes a diversity of vessel kinds undertaking different fishing activities, and additionally, information about economic performance of the fishing fleets are limited, so it is difficult to identify an appropriate rate of return. For this study, the nominal rate of interest is chosen to reflect the opportunity cost of owner's capital.

The calculated interest (I) on owners' capital in the year of the profitability analysis (2008) is calculated in this study as follows:

$$I = [(TK - D) - L] * r$$

where TK is total fixed capital stocks revalued at the price of year 2008 (as mentioned above); D is the accumulated depreciation at year 2008; so TK – D is the net capital value of vessel at year 2008. L is the remaining debt at the current year 2008 or the remaining balance on the loan at year 2008; [(TK – D) – L] is the vessel owner's capital or the level of equity held by the owner at year 2008. r is the nominal rate of interest which is defined as the prime interest rate announced by the state bank of Vietnam. For 2008 the base interest rate in Vietnamese dong to be about 9% per annum[14], which was chosen to reflect the opportunity cost of owner's capital.

Gross profit margin is referred to as ratio of gross cash flow to gross revenue. This ratio expresses what is left as compensation to capital in relation to gross revenue as percentage of gross revenue.

Profit margin is defined as ratio of profit (before the opportunity cost of owner's capital but after depreciation and interest payment on loans) to gross revenue. This ratio expresses what is left as compensation to the vessel owner's capital in relation to gross revenue as percentage of gross revenue.

Return on capital value is defined as the profit in percent of net capital stock of the vessel (presented above) at year 2008 or rate of profit to net capital stock of the vessel. This ratio expresses the return on the net capital invested as percentage of net capital stock of the vessel.

[14] This information is available from website of the state bank of Vietnam

Return on owner's capital is defined as the profit in percent of owner's capital of the vessel at year 2008 or rate of profit to owner's capital of the vessel. This ratio reflects what is left to the vessel owner as compensation to the opportunity cost of owner's capital in relation to owner's capital of the vessel as percentage of owner's capital of the vessel.

In a fishery, gross revenue can be considered as an indicator of harvest since the price of fish catch is hardly affected by quantity fished in the competitive market where there are many sellers and buyers (Flaaten, 2009). Hence, the fixed price of fish for all vessels in short run is a reasonable assumption in this study. The study of Long et al. (2008) also was referred the annual gross revenue as a proxy of annual production with the assumption of fixed price of fish (Long et al., 2008).

In this study, indicators taken from interest are economic performance, not financial performance. This means particularly that almost capital costs are imputed which can depress the apparent net profit in some certain cases. Therefore, the main indicator added for this analysis is gross cash flow. Gross cash flow is referred to as a good short term indicator in fisheries (Action 2004). Positive gross cash flow means that the vessel owners are able to pay for all their operational costs and meeting at least part of their obligations to creditors. *A* reasonable hypothesis here is that the vessel owner has positive gross cash flow in the fishing operation year (Hypothesis 1).

Hypothesis 1

The vessel owner has a positive gross cash flow from his fishing in 2008, including the fuel cost quasi-lump-sum subsidy.

3.3. OPEN ACCESS BIOECONOMIC MODEL WITH HETEROGENEOUS EFFORT OF THE FISHERY

The traditional bioeconomic model of a fishery was derived from the population dynamic model, of which technical and economic variables were added in (Gordon, 1954). This traditional bioeconomic model was based on important assumptions[15]. Firstly, the vessel fleets in a perfectly competitive market are homogeneous with an identical cost structure and a given technology (Gordon, 1954). Hence, cost per unit of effort is constant, or, in order words, all vessels have the same of the average cost per unit of effort. All costs, including

[15] Other assumptions: A mobility of capital is guaranteed, a single stock of marine renewable resource is exploited, and information on prices and costs is perfect (see Gordon, 1954).

capital, labor, operating costs, opportunity cost of labor, are imputed to be directly proportional to effort[16]. Secondly, the motivation of fishers is assumed to be the profit maximization (Gordon, 1954). Thereby, individual vessel will operate at point where marginal cost equals to marginal revenue itself (Scott, 1955).

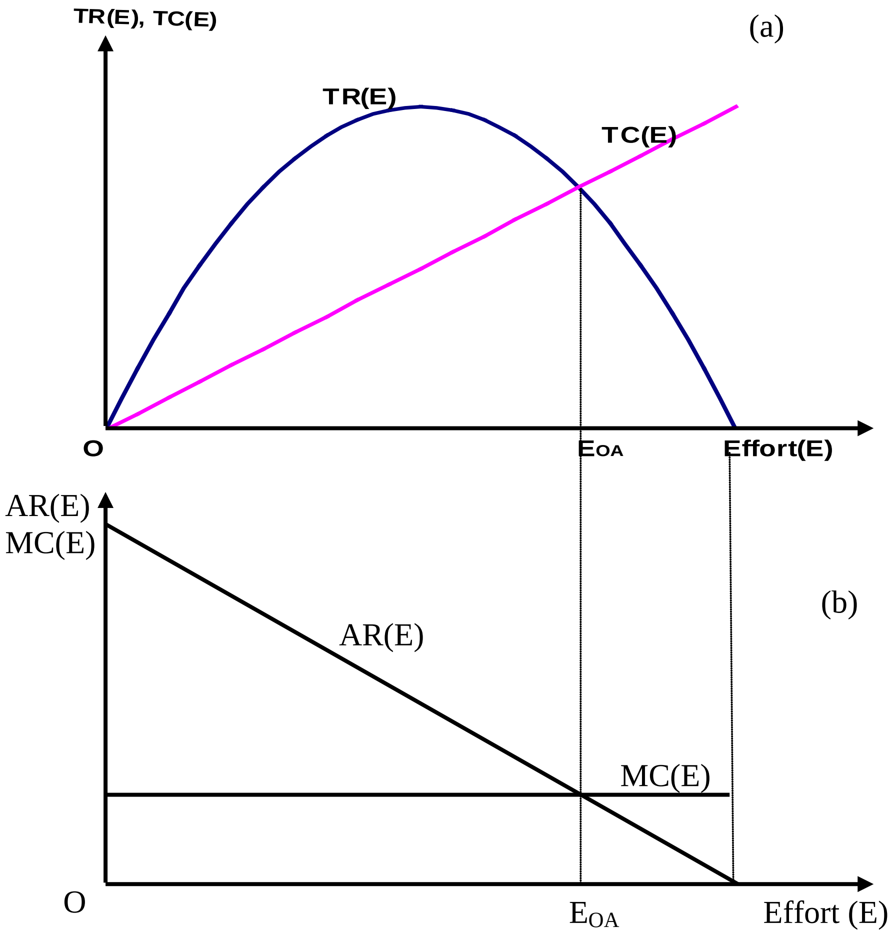

Figure 3.1: The traditional bioeconomic model. *Note:* the shape of total revenue curve is assumed the basis of biological equilibrium, and price of fish is constant over time. Source: Flaaten (2009, p. 21).

In a free and open access fishery where the common property of fisheries resource is not determined, individual vessels will enter the fishery since total revenue, TR(E), exceeds total cost, TC(E), and a economic equilibrium is at point where TR(E) =TC(E) (see Figure 3.1.a) (Gordon, 1954; Scott, 1955). In other words, when average revenue of effort, AR(E), equals marginal cost of effort, MC(E), there will be an open access equilibrium of effort (E_{OA}) (see Figure 3.1.b) where neither an incentive to leave nor an incentive to enter the fishery

[16] Griffin et al. (1976) proposed an empirical model that allowed costs to be proportional to both effort and catch and this was applied to the Gulf of Mexico shrimp fishery.

(Gordon, 1954; Scott, 1955; Anderson and Lee, 1986; Perman et al., 2003; Flaaten, 2009). Indeed, at lower levels of effort, individuals will be making economic profits[17] (resource rent). The existence of this positive profits (or called in term of super normal profits) will attract new entrants into the unregulated open access fishery, and lead to reducing the fisheries average revenue until individuals earning zero profits (called in terms of normal profits) (Coglan and Pascoe, 1999; Flaaten, 2009). As a result, the resource rent will be dissipated under open access condition (Gordon, 1954; Scott, 1955; Griffin et al., 1976; Anderson and Lee, 1986; Coglan and Pascoe, 1999; Flaaten, 2009). This is a consequence of the “Tragedy of the Commons” problem discussed in Hardin (1968).

The above discussions only aim the understanding of economic effects of fishing in the traditional bioeconomic model of Gordon (1954) under open-access condition, given some assumptions, which they are fundamental principles for the later theoretical parts.

As assumed, the fishing fleet of the fishery is homogeneous from a cost and efficiency point of view. This implies that average cost of unit effort is the same for all vessels. However, this assumption is not reasonable with heterogeneous vessels (Coglan and Pascoe, 1999; Bertrand and Le Floc’h, 2000; Flaaten, 2009) in the fishery case of this study as well as the fishing industry of many countries. A fishing fleet with heterogeneous vessels is characterized as differences in size, age, engine power, and cost, and other technical and economic characteristics (Coglan and Pascoe, 1999; Flaaten, 2009), or the difference in the skill of the skipper and crew (Coglan and Pascoe, 1999). Therefore, the fishing vessels are heterogeneous in cost structure and different in efficiency of effort, and resulting in the existence of heterogeneous effort in the fishery (Coglan and Pascoe, 1999; Flaaten, 2009).

Figure 3.2 illustrates relationship between the standardized effort and the cost efficiency of the effort of 10 heterogeneous vessels. For each of the 10 vessels, the standardized effort is along the horizontal axis and the average cost per unit standardized effort is with the vertical axis. Each standardized fishing effort is measured by the width of the bar whereas the height of the bar measures cost per unit effort. The vessels are arranged from the left to the right according to their cost efficiency, with vessel number 1 as the most cost efficient one and vessel number 10 as the least cost efficient. Since the cost bars in Figure 3.2 are substituted by a curve enveloping the bars, this curve is called the marginal cost of effort curve, MC(E), for a fishery (Flaaten, 2009).

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[17] Coglan and Pascoe (1999) defined the economic profits consisting of resource rent and intra-marginal rent. “*Resource rent is referred to as the return to the owner of the fisheries resource and represents the value of the input generated by the fish stock in the production process*”.

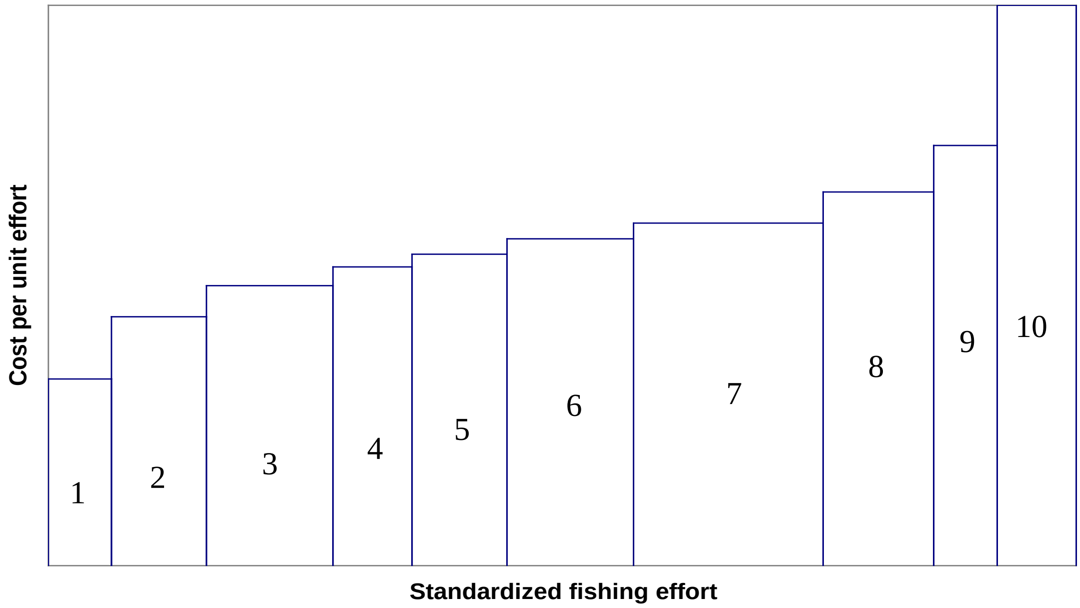


Figure 3.2: Relationship between the standardized fishing effort and the cost efficiency of the effort in heterogeneous vessels. Source: adapted from Flaaten (2009, p.95)

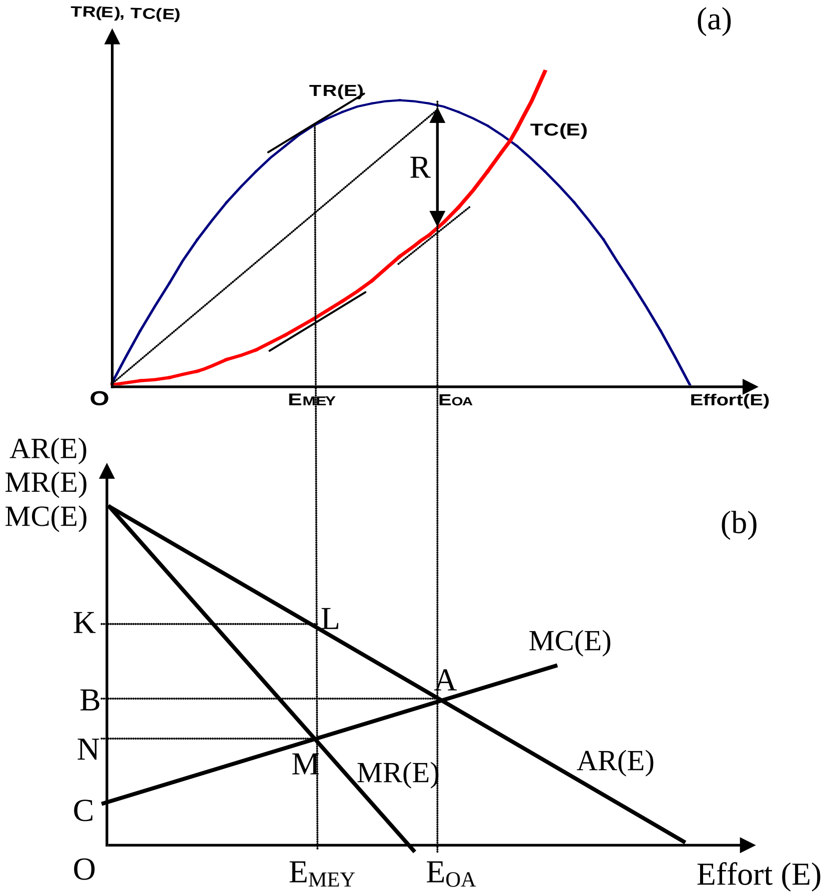


Figure 3.3: The traditional bioeconomic model with heterogeneous effort under open access and maximum economic yield management. Source: Flaaten (2009, p.96)

With heterogeneous vessels, the marginal cost of effort curve is increasing with respect to the increase of fishing effort of the fishery (Figure 3.3b). Based on the above fundamental principle of the traditional bioeconomic model, at low effort levels, the average revenue of effort, AR(E), is higher than the marginal cost of effort, MC(E), the new entrants will be attracted to the fishery under open access condition. And some vessels will exit the fishery since AR(E) < MC(E). So, an open access equilibrium is at effort level E_{OA} (Figure 3.3) where AR(E) = MC(E). In Figure 3.3, there is an existence of economic surplus which is called intra-marginal rent (see Coglan and Pascoe, 1999; Flaaten, 2009) at effort level of the fishery E_{OA}, showed in the area ABC (Figure 3.3.b) or the line segment R (Figure 3.3.a). The intra-marginal rent is generated from the existence of heterogeneous vessels, of which the most cost efficient vessels make above normal profits (Coglan and Pascoe, 1999; Flaaten, 2009). It is easily seen that there is a positive rent of the fishery at the open access equilibrium with the heterogeneous vessels. This is in contrast to the case of homogeneous vessels in which rent equals zero. Therefore, a survey indicating above-normal profits of an average vessel would indicate the existence of intra-marginal rent in the open access fishery with heterogeneous fleet.

In the case of maximum economic yield management, the level of rent maximizing effort, E_{MEY}, is determined at a point where MC(E) = MR(E). The total rent of the fishery generated consist of resource rent (area of KLMN) and intra-marginal rent (area of CMN) (Figure 3.3b). The intra-marginal rent is lower for the effort level E_{MEY} than that for E_{OA}, but the total rent of the fishery managed is greater than the intra-marginal rent of the open access fishery because some profits in total rent are obtained due to the effective use of fisheries resource (Flaaten, 2009). These profits are called resource rent. The existence of the resource rent is as a result of the fisheries management regimes (Anderson and Lee 1986; Bjørndal and Conard , 1987; Hartwick and Olewiler, 1998; Bertrand and Le Floc'h, 2000; Perman et al. 2003; Arnason, 2007; Flaaten, 2009).

The above analysis presents the bioeconomic model for heterogeneous vessels under open access regime, of which total rent produced is only intra-marginal rent[18]. However, this situation is determined at the fishery level of economics in long run rather than short run. In the next part, theory of fishing vessel economics will contribute a comprehensive picture to the understanding of free and open access situations in marine fishing sector.

[18] This rent is defined as generating by the factors of production owned by the fishers (Coglan and Pascoe, 1999).

3.4. ECONOMICS OF HETEROGENEOUS FISHING VESSELS IN AN UNREGULATED OPEN ACCESS FISHERY[19]

When an individual vessel's landing is considered as a small portion of the total landings of fish in a competitive market, it is firstly assumed that each vessel is not able to impact on market price of fish in the competitive market. This is reasonable to consider fishers as price-takers and assume that price of fish is the same in all vessels. It is secondly assumed that the activity of the vessel hardly impact on stock biomass, and fish stock is considered as constant from an individual vessel's point of view. Therefore, the vessel harvest function is a function of its effort, given period of time and the stock level, and assumes that this function is the Schaefer harvest function:

$$h(e,X) = qeX \qquad (3.1)$$

where e is effort of one individual fishing vessel, given the stock level of fish, X, and the catchability coefficiency, q.

The profit of the vessel is:

$$\pi(e;X) = p\,h(e,X) - tc(e)$$

$$\text{or} \qquad \pi(e;X) = p\,qeX - tc(e) \qquad (3.2)$$

where p is the market price of fish and tc(e) is total cost of effort. In short run, tc(e) is only total variable cost of effort, tvc(e), so this profit is the operating profit of the vessel. In long run, tc(e) consists of total variable cost of effort, tvc(e), and fixed cost, F. Total revenue of vessel is pqeX as a function of vessel effort, given p, q and X.

Assuming that the objective of the vessel is to maximize its profit given in equation (3.2), the first order maximum profit condition of the vessel is

$$\frac{d\Pi(e,X)}{de} = \frac{d(pqeX)}{de} - \frac{dtc(e)}{de} = 0 \qquad (3.3)$$

Solving (3.3) gives a criterion of choosing the optimal level of effort for maximizing profit of the vessel:

$$mc(e) = pqX \qquad (3.4)$$

This equation (3.4) shows that one vessel's profits are maximized at the level of effort where its marginal cost of effort equals its marginal revenue of effort. When the marginal revenue of

[19] This section is based primarily on "Lecture notes on Fisheries Economics and Management" by Flaaten (2009).

effort of each vessel is referred to as a function of vessel effort, and equals to product of price of fish, catchability coefficiency and level of stock, pqX, all vessels will have the same marginal revenue of effort, and equal to the fishery average revenue, given at point of time .

The second order maximum profit condition for the vessel is

$$\frac{d^2\Pi(e,X)}{de^2} = \frac{d^2(pqeX)}{de^2} - \frac{d^2tc(e)}{de^2} = -\frac{dmc(e)}{de} < 0 \qquad (3.5)$$

Rearranging (3.5) gives $\frac{dmc(e)}{de} > 0$. This implies that the profit maximizing supply level of effort can lie only on the upwards sloping part of the vessel's marginal cost of effort curve.

From equation (3.2), in the short run the vessel will operate at positive level of effort only if

$$pqX \geq \frac{tvc(e)}{e} = avc(e) \qquad (3.6)$$

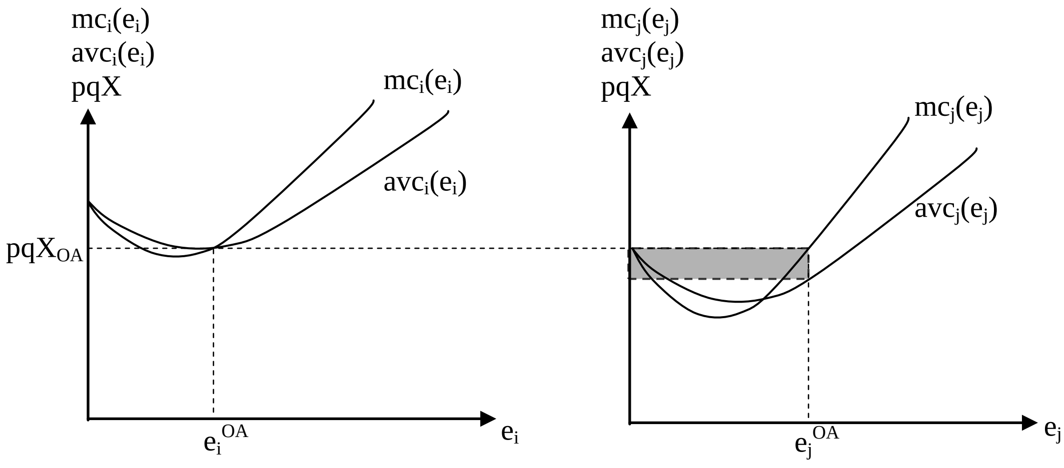
where avc(e) is average variable cost of vessel effort. This means that the marginal revenue of effort has to be more than minimum average variable cost of vessel effort.

In the long run, the condition for this is only if

$$pqX \geq \frac{tc(e)}{e} = \frac{tvc(e)+F}{e} = atc(e) \qquad (3.7)$$

where atc(e) is average total cost of vessel effort. This implies that the marginal revenue of effort has to be more than minimum average total cost of effort in order to cover the fixed capital cost in the long run.

Figure 3.4 shows graphically the differences between two heterogeneous vessels that will lead to the different cost structure of each vessel and different rents generated in the short run under unregulated open access condition. In the open access fishery, the marginal revenue of vessel effort is pqX_{OA}, with X_{OA} is at the stock level at open access equilibrium. Vessel ***i*** make zero profit at its optimal effort $\mathbf{e}_i^{\mathbf{OA}}$ in the short run since the marginal revenue of effort equal its minimum average variable cost of effort, $\mathbf{avc}_i(\mathbf{e}_i)$ (Figure 3.4 a). If condition of equation (3.6) is not satisfied or $\mathbf{pqX_{OA} < avc}_i(\mathbf{e}_i)$, the vessel will stop fishing. The vessel ***i*** is called as a marginal vessel. Figure 3.4 panel (b) shows that at level of effort $\mathbf{e_j^{OA}}$ vessel ***j*** will maximize its profits that are showed by the area shaded. When the vessel ***j*** has a lower cost structure, it will increase individual effort itself to reach the level of effort $\mathbf{e_j^{OA}}$. This profit is called intra-marginal rent and vessel ***j*** is called intra-marginal vessel since vessel ***j*** is more cost efficient than vessel ***i***.



(a) vessel ***i*** (b) vessel ***j***

Figure 3.4: Differences in cost structure, rent generated and short-run effort adaptation of two heterogeneous fishing vessels. Panel (a) for vessel namely **i**, panel (b) for vessel **j**. Source: Flaaten (2009, p. 82)

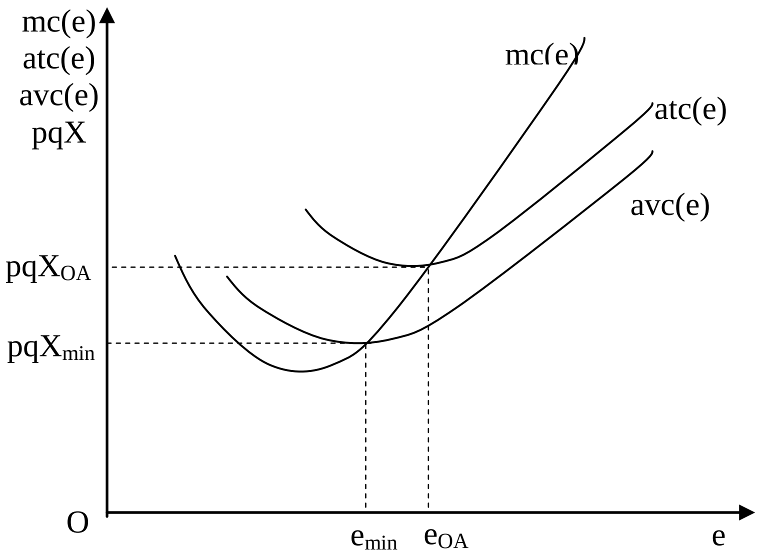


Figure 3.5: The vessel's behavior in short run and long run since two curves of its average total cost of effort and average variable cost of effort are drawn graphically in the same figure. Source: Flaaten (2009, p.84)

Figure 3.5 shows behavior of the individual fishing vessel for its adaptation in short run and long run in unregulated fishery. A noticeable point here is that the product of fish price, catchability and stock level may not be equal between short run and long run. In the long run, a vessel will operate at which its marginal revenue of effort is at or above its minimum average total cost of effort, atc(e), in order to be able to cover its fixed capital cost. Under open access regime if a vessel operates at which its marginal revenue of effort, pqX_{OA}, equals its minimum average cost of effort, corresponding optimal level of effort $\mathbf{e_{OA}}$ (in Figure 3.5) it is a marginal vessel with normal profit. If the vessel earns above normal profit since pqX_{OA} > min atc(e), it is a intra-marginal vessel with intra-marginal rent. In the short run, the vessel may operate at where its marginal revenue of effort at least is above minimum of its average variable cost, which is equal to pqX_{min}. For given constant values of p and q, this implies that the vessel is able to fish even though the stock level (X_{min}) is below X_{OA} in the short run.

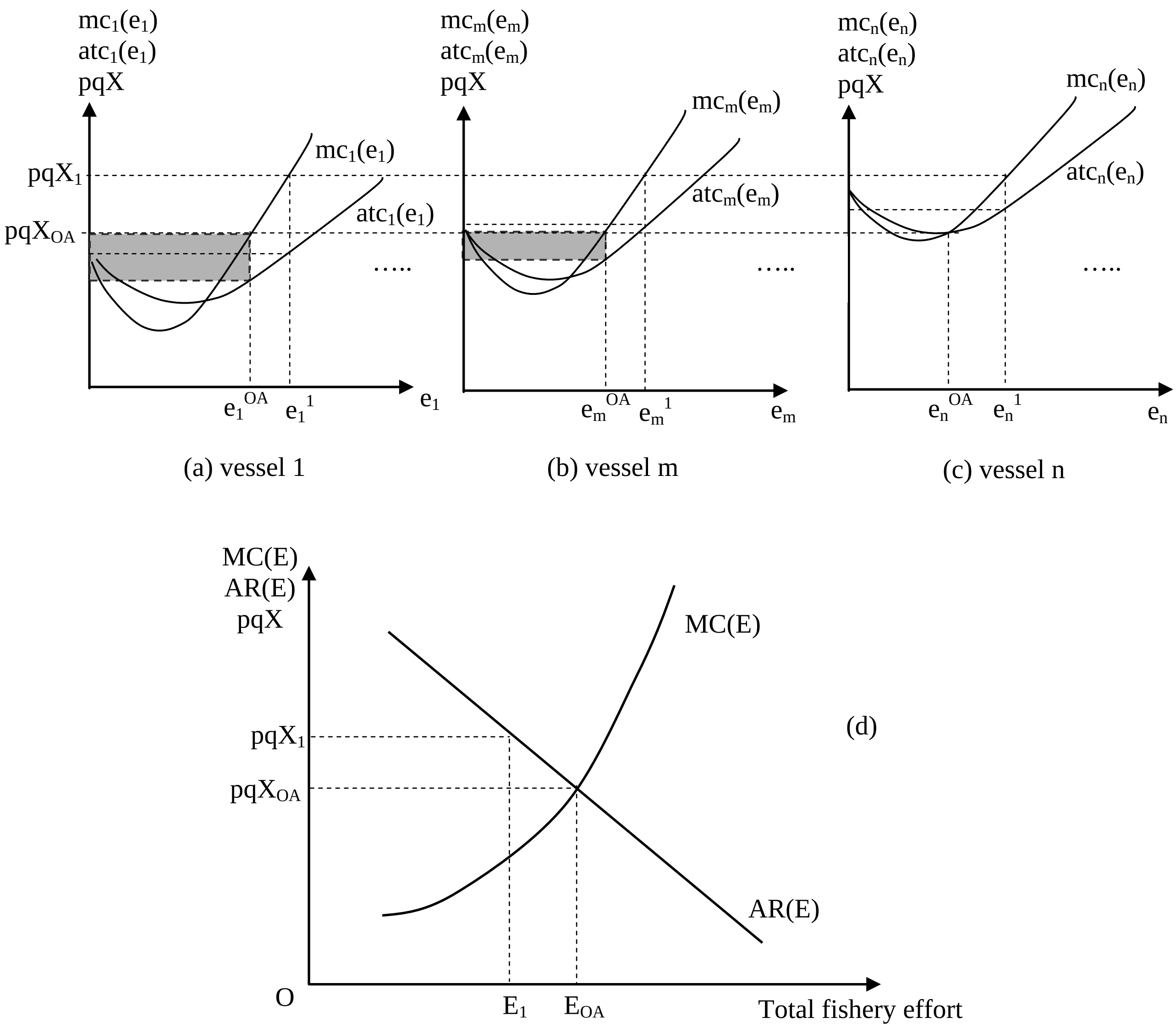


Figure 3.6: Heterogeneous vessels in an unregulated open access fishery and effects of fisheries management. *Notes*: Panel (a), (b) and (c) illustrate for vessel 1, m and n respectively; panel (d) for the fishery. Source: adapted from Coglan and Pascoe (1999).

Figure 3.6 illustrates a heterogeneous fleet in an unregulated open access fishery in long run and the effects of management on economic profits. Each vessel has different cost structure with different curves of marginal revenue of effort and average total cost of effort for individuals. The supply curve of the fishery, MC(E) (in Figure 3.6 panel d), with price of fish given, will be made up by the supply curves of the individual vessels. The establishment of a supply curve was presented by Scott (1955, p.120) for a fishery in theory of fisheries economics and by Varian (2006) for other industry in theory of microeconomics of firm.

Under open access management regime, the effort equilibrium of the fishery is at E_{OA}, corresponding to the fishery average revenue of pqX_{OA} (Figure 3.6 panel d). Vessel 1 and vessel m make intra-marginal rents (showed by the darker shaded areas) at levels of effort e_1^{OA} and e_m^{OA} respectively (Figure 3.6 panel a and b), in which the vessel 1 is earning a higher economic profit because vessel 1 has higher cost efficiency than the vessel m, whereas vessel n is earning a zero profit (normal profit) at its effort level e_n^{OA} (panel c). Hence, in the open access fishery with heterogeneous vessels, the intra-marginal rent is generated by those vessels that have the most cost efficiency making above-normal profit that is more than zero profit of the marginal vessel. However, Whitmarsh (1998) analyzed how new entrants with most modern and efficient vessels into the fleet over time will pressure on stock and resulting in reducing catch rate and increasing cost for all remaining vessels in the fleet, given price of fish remaining constant. As a result, the previously marginal vessels (for example vessel n) or even intra-marginal vessels will be pushed to become loss (called in terms of extra-marginal rent) and force exiting the fishery, so this is called fisheries treadmill in the case of unregulated open access fisheries (Whitmarsh, 1998).

If the existence of management is introduced into the fishery, total effort level of the fishery is assumed at E_1 as in Figure 3.6 panel (d), corresponding to a result of average revenue increasing from pqX_{OA} to pqX_1 (fisheries management is assumed that the removal of some vessels goes out the fishery. In Figure 3.6, it is also assumed that fisheries management has prevented new vessels entry to the fishery, and vessel n is assumed to exist in the fishery managed). In this situation, each vessel will increase its individual effort level until its marginal revenue pqX_1 equals its marginal cost of effort, corresponding e_1^1, e_m^1, e_n^1 for vessel 1, m and n respectively. The three vessels are earning positive economic profit. The vessel 1 and m make above normal profits that consist of resource rent and intra-marginal rent, whereas vessel n is earning only resource rent.

As discussed above, this section aims to presenting the theory of the economic adaptation of fishing vessels with the profit maximizing objective of fishing activities[20]. The activity level

[20] Anderson (2005) showed that fishermen could have a different behavior that was called the goal achievement behavior (GAB) which contrasts with the profit maximizing behavior (PMB). However, the goal achievement behavior do not mentioned in this study.

of a vessel is measured by its fishing effort which it can vary by varying its inputs needed for generating effort. Thus, a standardized efficiency measure of fishing effort (further discussion in the next section) is used to compare of economic performance of fishing vessels given the heterogeneity of vessels.

From equation (3.2), it is clearly seen that total revenue of vessel is the product of fish price, catchability, fishing effort and stock level, **pqeX**, as a function of vessel effort, given fixed price of fish, catchability, and constant stock. Hence, average revenue per unit of a vessel's standardized fishing effort as a function of its standardized effort will be **pqX** and a graphically horizontal line**.** Another explanation comes from the equation (3.1) that h = qeX is the Schaefer harvest function which gives catch per unit of effort (CPUE) = h/e = qX. A reasonable deduction is that CPUE of each vessel has the same amount of qX since the fishing effort of heterogeneous vessels is standardized, and fish stock level is assumed as constant in the short run. Since fish price is considered the same for all vessels, the average revenue of the vessel's standardized effort curve thus remains horizontal (hypothesis 2).

Hypothesis 2

The average revenue per unit of the vessel standardized effort as a function of standardized fishing effort is a horizontal line with slopping coefficient of zero.

Hence, it is concluded that all vessels will have the same average revenue of standardized effort, which equals the vessel's marginal revenue of standardized effort (from equation 3.4) and equals the average revenue of standardized effort of the fishery (hypothesis 3). If the average revenue per unit of the vessel standardized effort, ar(e), is known, this implies that the marginal revenue of vessel standardized effort, mr(e), and the average revenue of the fishery, AR(E), will be determined. Inversely, ar(e) and mc(e) will be specified since the average revenue of the fishery, AR(E), is known, at a given period of time.

Hypothesis 3

The average revenue per unit of the vessel standardized effort equals the average revenue of the fishery.

If the hypotheses 2 and 3 are not rejected, it proves a good choice of measuring standardized fishing effort, and the average revenue per unit of vessel standardized effort or the average revenue of standardized effort of the fishery will be applied in this empirical study. If these hypotheses are rejected, measurement of standardized effort may not be practical or marginal productivity of each increasing effort is diminishing in the vessels of this study.

3.5. FISHING EFFORT STANDARDIZATION

The fishing effort is a core concept in model of bioeconomic, public regulation, relative resource assessment, and productivity of marine capture fishery (Squires, 1987). FAO (2003, p.39) determined that fishing effort is an abstract concept that is defined as the combined effect of the inputs used in fishing, including fixed components of vessel and variable components. The use of the variable inputs and the fixed capital components makes up the overall input base as an aggregate input that is underlying the measure of total fishing effort in order to generate catch (FAO, 2003, p.28). Early contributions, such as Pollak and Wales (1987) and Sathiendrakumar and Tisdell (1987), viewed fishing effort as an intermediate output which transfers from the factors of production to harvesting quantity. FAO (2003) also determined the fixed input stocks which make up the capacity base (capital base) while the variable inputs such as days fished or days at sea, which represents the combination of inputs applied to the capacity base to generate catch.

An earlier collection of papers in this topic, Cunningham and Whitmarsh (1980) showed that there are two terms of fishing effort: the first is nominal fishing effort (i.e. total time spent fishing) as the volume of resource devoted to fishing, quantified in monetary or physical units, whereas effective fishing effort (in terms of fishing power of the vessel) defines as the biomass of fish extracted by fishing expressed as a proportion of the mean population size or in other words, effective fishing effort can be considered as fishing mortality. Similarly, Pascoe and Robinson (1996) showed that the true level of effort comprises a multitude of factors which is divided into two groups: the nominal (or observable) effort and the effective effort.

In short term, the vessel's major characteristics such as weight, length, engine power, hold size are fixed, while effort measured in days and hour of fishing (nominal fishing effort) is flexible. However, this nominal effort may depend on the vessel's technical characteristics that are built before, which all they generate total fishing effort (Flaaten, 2009). The performance analysis of different vessels arise the problem if some forms of standardization are not performed (Padilla and Trinidad, 1995).

According to Taylor and Prochaska (1985, p.89), "*standardization of fishing effort is based on an index formed utilizing an aggregate fishing power function that reflects changes in the average input composition of vessels operating in the fishery*". Hence, fishing effort standardization is related to fishing power. The concept of the relative fishing power was mentioned in the studies of Beverton and Holt (1957) who discussed about actual measurement of effective effort. Fishing power is regarded as measurement the potential ability of a vessel to catch fish (potential ability in terms of average vessel characteristics) (Beverton and Holt, 1957). Due to the within-year variations in catch rates of vessels with different characteristics will lead to the variations in fishing power between the vessels, which are usually attributed to variations in the characteristics of the vessels (Pascoe and Robinson, 1996). This may be significant with heterogeneity in vessels of this study with data of one year because the result of the analysis or estimation of fishing power is used as a way of standardizing fishing effort between different vessels within a given fishery (Pascoe and Robinson, 1996; FAO 2003, p.40).

Measurable items such as vessel size, engine power and fishing gear are considered as factors affecting fishing power in previous studies. Betervon and Holt (1957) found that fishing power was closely correlated with gross tonnage. Byrne (1982) estimated fishing power as a function of vessel length and engine power, and then this estimation result was used to predict increases in total effort in the face of limited entry to the South Australian prawn fishery. Taylor and Prochaska (1985) found fishing powers of vessel in the Gulf of Mexico reef fish fishery were best explained by the number of crew and the size of the boat. Padilla and Trinidad (1995) showed that the factors affecting effective effort production was tonnage which varied considerably by boat type in the case of the small-pelagic fishery in central Philippines. Smit (1996) found that an aggregate effort measurement for Dutch cutter fleet was derived from the fishing capacity based on engine power of vessel and the number of days at sea, in which the engine power of vessels of different sizes was weighted according to their economic productivity.

Additionally, Griffin et al. (1997) found that shrimp fishing power depended on vessel length and footrope length in the Gulf of Mexico shrimp fishery. The study of Alemany and Álvares (2003) explained that fishing effort on hake catch was considered as number of days multiplied by GRT (Gross Register Tonnage) of correspondent vessel in Mallorca island (western Mediterranean) during the period 1983-1991. In the case of Long et al. (2008), although the fishing effort was not directly estimated via the fishing power for longlining vessels in Vietnam, the authors found that productivity was best explained via hull length which indicates fishing power. Cunningham and Whitmarsh (1980) assumed that among the vessels of a given type, length, engine horsepower, tonnage and crew number, each can be shown to be associated with fishing power. However, measures of fishing power based on more inclusive features are more accurate than standardized effort unit base on a single feature when comparing vessels within a fishery (FAO 2003, p.40).

In reality, there were some methods for measures of standardized effort. A review of the literature of FAO (2003, p.39) shows that standardized effort measures are often constructed by normalizing effort by multiplying the ratio of the catch per unit effort of an existing vessel to the catch per unit effort of a reference vessel. An alternative version of a standardized unit of effort can be derived by multiplying a particular feature parameter of the vessel such as engine power by days fished to produce a hybrid measure (i.e. kW days fished) (FAO, 2003, p39-40).

In another way, Taylor and Prochaska (1985) and Griffin et al. (1997) had applied the same methodology of estimation of standardized effort in the heterogeneous Gulf of Mexico vessel fleets, of which the standardization of nominal effort was accomplished by utilizing the estimated fishing power function. An index of the estimated relative fishing power of each vessel was firstly derived, which is based on the estimated fishing power function. Then, a standardized measure of fishing effort was calculated by multiplying the nominal days fished of each vessel by this index.

Andersen (1999) may have presented a comprehensive review that describes the concept and measure of fishing effort using biological and economic approaches. The report interpreted fishing effort from both biological and economic perspective, of which each section included a theoretical part and an empirical analysis of measuring fishing effort.

In this study, the standardized fishing effort indicators for vessels will be estimated by fishing effort function through the production function approach. Hannesson (1983) and Campbell (1991) applied the production function to estimating fishing effort in the Lofoten winter cod fishery and in the Tasmanian rock lobster fishery, respectively. Padilla and Trinidad (1995) also applied the production theory to fishing effort standardization in the small-pelagic fishery in central Philippines, of which the catch was referred to as a measure of fishing effort.

The economic production function of each vessel adopted by Schaefer in equation (3.1) is a special form of the Cobb-Douglas function that can rewrite:

$$h = qe^{\beta_1}X^{\beta_2}, \quad \beta_1 = \beta_2 = 1 \qquad (3.8)$$

where h is the produced catch, e is fishing effort of each vessel, X is the stock level of fish, and q is a constant.

The general form of the economic production function is

$$h = f(e, X) \qquad (3.9)$$

where e = g(**x**) and **x** is a vector of inputs consisting of capital (K), labour (L) and other variable inputs (V). With cross-sectional data of one year is considered for the short run, an assumption of constant the variable of resource stock is reasonable. This assumption implies that the production function is separable. Hence, the production function can be of form:

$$h = f(g(\mathbf{x}), X) \qquad (3.10)$$

The separability generating the form of equation (3.10) is presented in the studies of Squires (1987), Campbell (1991), and Padilla and Trinidad (1995). This separability allows aggregation of individual inputs into the aggregate variable fishing effort. And the effort function of each vessel, g(**x**), can be presented by the form of Cobb-Douglas function

$$EFFORT = g(x_1, x_2, ..., x_k) = Ax_1^{\alpha_1} x_2^{\alpha_2} ... x_k^{\alpha_k} \qquad (3.11)$$

where $x_1, x_2, ..., x_k$ are a set of inputs of the vessel, and A is a constant.

The Cobb-Douglas - effort function was used validly in many studies of the fisheries fishing sector, such as the studies of Comitini and Huang (1967), Hannesson (1983), Taylor and Prochaska (1985), Campbell (1991), Padilla and Trinidad (1995). A literature review of application of Cobb-Douglas function for estimating of fishing effort, which it was quite fully, could be found in Campbell (1991).

The Cobb-Douglas production function has some economic quantities of interest (Coelli et al., 2005). Firstly it has property of non-negative marginal product (MP) of an input, keeping other inputs constant. And there is the existence of diminishing marginal productivity, in other words, all marginal products are non-increasing with respect to an increase of the inputs. Secondly, the marginal rate of substitution (MRTS) between factors of production determines how much amount of an input is required to produce a fixed output when we use specific amounts of other inputs. Thirdly, the Cobb-Douglas function can exhibit decreasing returns to scale or constant returns to scale or increasing returns to scale. The analysis of scale economies is essentially a long run phenomenon since the assumption that all factors are variable (see appendix D in details). However, for the objectives of this study, the estimation of a Cobb-Douglas production function demonstrates sufficient in terms of the standardized fishing effort between fishing vessels.

According to Padilla and Trinidad (1995) the fishing effort that is estimated from equation (3.11) is considered as standardized fishing effort. Since output of fish, which is measured either in weight or value of fish caught per unit of time, is chosen as a proxy of fishing power, this fishing power is called in terms of the effective fishing effort (Cunningham and Whitmarsh, 1980).

Proxy for vessel fishing effort

In order to estimate the standardized fishing effort by the effort function via the production function method, amount of fish caught per unit of time is often used as a measure of fishing effort. However, since it is assumed that fixed prices of fish are the same for all vessels and months within one year, the annual gross revenue is considered as a proxy for annual quantity of fish. In this study, the 2008 gross revenue, therefore, is chosen as a proxy of vessel fishing effort due to lack of catch volume data for each vessel.

In addition, Cunningham and Whitmarsh (1980) assumed that a proxy of effective fishing effort can be measured either in weight or value of fish caught per unit of time. These two authors demonstrated that it depends on what the production function is to be used for. It might be better to consider weight if a fisher is concerned about the biological effect of fishing. If one is seeking economic optimum, then value of fish caught may be more relevant, and the authors also had stated that “*catch is measured in monetary terms it often gives a better fit to the data*” even though for biological objectives (Cunningham and Whitmarsh, 1980). The authors explained that skippers, in fact, are more concerned about revenue than biomass and therefore, value of catch correlates better with inputs than weight of caught. Moreover, if fish caught with heterogeneous species will be better when dependent variable is measured in value terms (Cunningham and Whitmarsh, 1980). As a result, it is asserted that annual gross revenue of each vessel as a proxy for vessel fishing effort is reasonably considered in this study.

Relative fishing power (RFP) and relative standardized fishing effort (e)

Beverton and Holt (1957, pp. 172-173) defined relative fishing power (RFP) as “*the ratio of the catch per unit fishing time of a vessel to that of another taken as standard and fishing on the same density of fish on the same type ground*." Adapting this definition, the relative standardized fishing effort and the RFP index of vessel ***i*** can be determined for this study by

$$e_i = \frac{EFFORT_i}{\overline{\overline{EFFORT}}} = RFP_i \qquad (3.12)$$

where e_i is the relative standardized fishing effort of vessel *i*; $EFFORT_i$ is the standardized fishing effort of vessel ***i***, which is estimated from equation 3.11; $\overline{EFFORT}$ is called in terms of unit of standardized effort which it is an average standardized fishing effort of the vessels in the sample.

RFP_i is the relative fishing power of vessel ***i***, which is also determined by the formula (3.12) above. The fishing power of vessel ***i*** is compared in relation to average fishing power of the vessels in the sample. This method is slightly different with the definition above of the Beverton and Holt (1957), which the catch per unit of fishing time of a standard vessel is chosen for denominator in calculating RFP index.

In this study, the relative standardized effort of vessel *i*, e_i, is used for analyzing economic efficiency of fishing vessels. By nature, using the results of "standardized effort" estimated from equation (3.11) or "relative standardized effort" calculated from formula (3.12) will give the same conclusions. For the purpose of this study, the notion of the "relative standardized effort" is applied. The reason is that costs and earnings of each vessel can be compared not only among vessels, but also from their real costs and earnings. Additionally, calculating "relative standardized effort" of the vessel gives new indices of relative fishing power (RFP). These indices can express as relative fishing power efficiency of the vessels.

3.6. SOME ECONOMIC CONCEPTS FOR EMPIRICAL STUDY

The annual revenue per unit of relative standardized effort of vessel ***i***, with the 2008 fuel cost subsidy, is

$$ar_w e_i = \frac{Total\_revenue\_of\_vessel\_i,\_with\_subsidy}{e_i} \qquad (3.13)$$

The annual revenue per unit of relative standardized effort of vessel ***i***, without the 2008 fuel cost subsidy, is

$$ar\_e_i = \frac{Total\_revenue\_of\_vessel\_i,\_without\_subsidy}{e_i} \qquad (3.14)$$

The average revenue per unit of relative standardized effort of the fishery assumed with all surveyed vessels for the case of the 2008 fuel subsidy is

$$AR_{ws}(E) = \frac{\sum_{i=1}^{58} Total\_revenue\_of\_vessel\_i,\_with\_subsidy}{\sum_{i=1}^{58} e_i} \quad (3.15)$$

The average revenue per unit of relative standardized effort the fishery assumed including all surveyed vessels, without the 2008 fuel cost subsidy, is

$$AR_{os}(E) = \frac{\sum_{i=1}^{58} Total\_revenue\_of\_vessel\_i,\_without\_subsidy}{\sum_{i=1}^{58} e_i} \quad (3.16)$$

The average total variable, fixed and labor costs per unit of relative standardized fishing effort of vessel ***i*** in 2008 is

$$avc_i = \frac{Total\_\text{var}iable,\_fixed,\_labour\_\cos ts\_of\_vessel\_i}{e_i} \quad (3.17)$$

The average total costs (excluding the calculated interest on owner's capital) per unit of relative standardized fishing effort of vessel ***i*** in 2008 is

$$atc_i = \frac{Total\_\cos ts\_of\_vessel\_i,\_excluding\_the\_calculated\_\text{int}erest}{e_i} \quad (3.18)$$

In (3.18), total costs of vessel ***i*** consist of variable cost, fixed, labor costs, depreciation and interest payment on loans, except the calculated interest on vessel owner's capital.

The average total costs (including the calculated interest on owner's capital) of relative standardized effort of vessel ***i*** in 2008 is

$$ac_i = \frac{Total\_\cos ts\_of\_vessel\_i,\_including\_the\_calculated\_\text{int}erest}{e_i} \quad (3.19)$$

In the formula (3.19), total costs consist of all costs (both cash expenses and non-cash expenses), including variable, fixed, labor costs, depreciation, interest payment on loans and the calculated interest on owner's capital.

When values of $\mathbf{ac}_i$ are sorted from the lowest to the highest value along the horizontal axis from the left to the right, the marginal cost of relative standardized effort of the fishery curve, **MC(E)**, is established.

The average total costs (including the calculated interest on owner's capital) of relative standardized effort of the fishery assumed including all surveyed vessels is

$$AC(E) = \frac{\sum_{i=1}^{58} Total\_\cos ts\_of\_vessel\_i,\_including\_the\_calculated\_\text{int}\,erest}{\sum_{i=1}^{58} e_i} \qquad (3.20)$$

In this study, economic efficiency of the vessel is considered as cost efficiency of the vessel since the average revenue per unit of the vessel relative standardized effort is regarded identical. The ratio of costs to relative standardized effort reflects the cost efficiency of the vessel. Relationship between the cost efficiency and the relative standardized effort of each vessel will be graphed in the same manner as Figure 3.2 by Salter-diagram software. It will be presented in three perspectives. The short run perspective includes variable, fixed and labor costs. There will be two perspectives in the long run. The first long run perspective comprises of all costs excluding the opportunity cost of owner's capital. The second long run perspective is analyzed with all cost items, including the opportunity cost of owner's capital.

Chapter 4

DATA AND DESCRIPTIVE STATISTICS

4.1. DATA COLLECTION

Data for this study was obtained by a survey of costs and earnings of gillnet fishing vessels in Nha Trang city of Khanh Hoa province, Vietnam with technical and operational characteristics as well as some other information. The information collected was based on a questionnaire used in previous studies on economic performance of the Nha Trang, Khanh Hoa fisheries (see Kim Anh et al., 2006; Long et al., 2008; Thanh Thuy, et al., 2008; and Khanh Ngoc, 2009). However, the questionnaire was adjusted for gillnet fishery and the objectives of this study (see appendix A).

The data was collected through direct interviews with fishing households, which was represented by vessel owner and/or his wife in a face-to-face manner. All 2008 data was collected in July and August 2009 by the author. Annual fishing operation of the gillnet vessels often stretches from September (or October) to July (or August) of the following year. So, the costs and earnings survey from September of 2008 to August of 2009 is stipulated for 2008. The previous studies had done this in Nha Trang's fisheries, such as Kim Anh et al. (2006), Long et al. (2008), Thanh Thuy et al. (2008), and Khanh Ngoc et al. (2009).

The data consists of detailed information on various aspects of gillnet fishery such as vessel technical characteristics, number of trips and number of total operating months in year, number of fishing days per trip, crew size, fixed costs and variable costs per trip, and revenue per fishing trip, and other information. The 2008 vessel revenue and variable costs had to be calculated because of the data on revenue and variable costs as the average per trip.

4.2. REPRESENTATIVE CHARACTERISTICS OF SAMPLE

From a population of 225 registered offshore gillnet vessels in Nha Trang at the time of survey (on July 7th 2009), a sample of 58 gillnet vessels was selected for investigation (for a discussion of representativeness – see below). The Vinh Phuoc and Xuong Huan wards were chosen since the number of gillnet vessels of both two wards accounted for 95.6% of the population (see Table 4.1). Table 4.1 shows that the number of gillnet vessels investigated occupied about 25.8% of the population. During surveying process, the apportionment of range of horsepower in samples was also employed in order to obtain the sample representativeness.

Table 4.1: The distribution of the gillnet vessels in sample by location

Ward	Population [b]		Number of vessels in sample [c]	Rate of sample to population[c]
	Number of vessels	Rate (%)		
Vinh Phuoc	143	63.6%	36	25.2%
Xuong Huan	72	32.0%	22	30.5%
Others [a]	10	4.4%	0	0%
Total	225	100%	58	25.8%

Notes: [a] other wards include Vinh Tho (3 vessels), Vinh Truong (3), Vinh Hai (1), Van Thang (1), Phuoc Dong (1) and Ngoc Hiep (1); [b] source from DECAFIREP of Khanh Hoa (2009); [c] source from own data and calculations.

The sample representativeness was tested. Engine horsepower and hull length were selected to test because they were available in the database of DECAFIREP of Khanh Hoa and the data of 58 gillnet vessels. In order to test whether this sample is a representative sample of the population or not, t-Test statistics are applied for hypothesis tests about the population mean, as well as a confidence interval of the population mean is estimated. A null hypothesis is here that the population mean, μ, is μ = c, against the alternative hypothesis is μ # c.

The steps of this hypothesis test are as follows[21]:

1. The null hypothesis is Ho: μ = c. The alternative hypothesis is μ # c.
2. The test statistic $t = \dfrac{\overline{X} - c}{\hat{\sigma} / \sqrt{N}}$ ~ $t_{(N-1)}$ if the null hypothesis is true.

   where $\overline{X}$ is the sample mean, c is value of the population mean that is chosen for test, $\hat{\sigma}$ is the standard deviation of the sample, N is the number of observations in the sample.
3. Let us select the level of significance α = 0.05. The critical values for this two-tail test

[21] Theoretical contents in this section are based primarily on "Principles of Econometrics" by Hill et al., 3rd Edition. John Wiley & Sons, 2008, p. 501-525.

are the 2.5-percentile $t_{(0.025, 57)}$ = - 2.0025 and the 97.5-percentile $t_{(0.975, 57)}$ = 2.0025 for t-distribution with N – 1 = 57 degree of freedom.

4. We will reject the null hypothesis if the calculated value of $t \leq -2.0025$ or $t \geq 2.0025$. If $-2.0025 \leq t \leq 2.0025$ we will not reject the null hypothesis, and conclude that the sample information we have is compatible with the hypothesis that the population mean μ = c.

When the null hypothesis Ho is true, the value c will fall within a 95% confidence interval estimate of the population mean, that means

$$P\left[-2.0025 \leq t = \frac{\overline{X} - c}{\hat{\sigma}/\sqrt{N}} \leq 2.0025\right] = 95\%$$

Rearranging gives $$P\left[\overline{X} - 2.0025 * \frac{\hat{\sigma}}{\sqrt{N}} \leq c \leq \overline{X} + 2.0025 * \frac{\hat{\sigma}}{\sqrt{N}}\right] = 95\%$$

Thus, a 95% confidence interval estimate of the population mean is

$$[\ \overline{X} - 2.0025 * \frac{\hat{\sigma}}{\sqrt{N}}; \overline{X} + 2.0025 * \frac{\hat{\sigma}}{\sqrt{N}}\ ].$$

The hypothesis testing procedures and the confidence interval above are based on the assumption that the population is normally distributed in order for t-statistic having a t-distribution with N – 1 degrees of freedom. However, invoking the central limit theory says that the sample mean is approximately normally distributed since the sample is sufficiently large (N ≥ 30) (see Hill et al., 2008, p.508). This is compatible with this study since the sample size is 58.

With the population means known, from Tables 4.2, 4.3 and 4.4, test results show that we do not reject the null hypothesis at the level of significance 5% for both cases of testing with engine power and hull length. The results also indicate that the population means known of engine power and hull length belong the 95% confidence intervals of their population mean. Thus, there is no evidence against the null hypotheses. The sample information of 58 gillnet vessels is compatible with the population of 225 gillnet vessels in NhaTrang. It would be surprised if this sample of 58 gillnet vessels is not considered as a representative sample of Nha Trang offshore gillnet population.

Table 4.2: A brief descriptive statistics for the sample and the population

Variable	Sample [a]			Mean of the population [b]
	N	Mean	S.D.	
Horsepower	58	249.57	149.30	211.50
Hull length	58	16.43	1.55	16.14

Sources: [a] own data and calculations, [b] DECAFIREP of Khanh Hoa (2009)

Table 4.3: Test about the population mean for horsepower

	Test Value = 211.5					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Horsepower	1.942	57	.057	38.0689	-1.1883	77.3263

Sources: own data and calculations

Table 4.4: Test about the population mean for hull length

	Test Value = 16.14					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Hull length	1.413	57	.163	.2867	-.1196	.6930

Sources: own data and calculations

However, there would be some uncertainty about the reliability of the results with any survey (Pascoe, Robinson and Coglan, 1996, p.38). In this study, the investigating process was performed to try and capture a representative sample. Horsepower and hull length were two physical characteristics used to test the sample representativeness due to the available information of data. It was found that the population data of horsepower might not confident because there were some differences among horsepower registered at the Khanh Hoa's DECAFIREP (Department of Capture Fisheries and Resources Protection) and actual horsepower surveyed. The Khanh Hoa's DECAFIREP only allowed registering maximum 450 HP of engine power in the past time, whereas the real engine power of some vessels was more than 450 HP, which were collected confidently through interviewing fishers trusted well. Thus, the confidence of the population data for HP is questionable. As a result, the investigated sample has low representative for this population in terms of horsepower. Regardless of horsepower, a comparison of the hull length of the sample and those of the offshore gillnet fleet in Nha Trang as a whole suggest that the sample was fairly representative of the fleet. It can only be assumed that this extended to economic performance. Nevertheless, economic analyses of this study are considered for the sample data rather than for population.

4.3. TECHNICAL AND OPERATIONAL CHARACTERISTICS

Table 4.5 presents a summary of technical and operational data for 58 surveyed offshore gillnet vessels. All parameters are per vessel. “Engine” and “Length” are engine power and hull length (measured in metric system), respectively. “Age” shows age of vessel. “Gear” indicates the average number of pieces of gill net used in the fishing operation year 2008. “Months”, “Trips” and “Days fished” are total operating months, number of fishing trips and number of days fished in the year 2008, respectively. “Fuel” is the level of fuel consumption in the year (in 1000 liters). “Crew” is crew size including captain (in persons).

Table 4.5: Descriptive statistics of some technical and operational characteristics of the 58 gillnet vessels.

Criteria	N	Minimum	Maximum	Mean	Std. Deviation
Engine (HP)	58	50.00	630.00	249.57	149.30
Length (m)	58	13.50	20.05	16.43	1.55
Age (years)	58	2.00	21.00	8.69	5.24
Gear	58	150.00	350.00	267.74	63.56
Months	58	7.00	12.00	10.31	1.05
Trips	58	7.00	33.00	13.52	5.36
Days fished	58	140.00	288.00	231.24	28.64
Fuel (1000 liters)	58	11.00	55.00	31.92	11.84
Crew (persons)	58	8.00	12.00	10.47	1.38

Source: own data and calculations.

The results in Table 4.5 show that the sample vessels are heterogeneous in terms of technical and operational characteristics. Engine powers for the sample gillnet vessels ranged from 50 to 630 HP, with a mean of about 249.57 HP. Hull length varied from 13.5 to 20.05 m, with an average length of 16.43 m. The average age of the vessels was about 8.7 years, of which the youngest age is 2 years, whereas the oldest one is 21 years of age. The vessel age is estimated from year of construction to year 2008. It is not the case of estimating from year of purchasing of a second hand vessel. The average number of pieces of gillnet used for fishing of the vessels were nearly 268 pieces, with a range from 150 to 350 pieces. The average total operating months and the average number of fishing trips of the vessels were 10.31 months and 13.52 trips, with a range from 7 to 12 months and a range from 7 to 33 trips in the year 2008, respectively. Total fishing days of the vessels in the year also varied from 140 to 288 days, with an average of about 231 days. The average crew size was 10.47 persons, with a range from 8 to 12 persons. A final characteristic is the level of fuel consumption for the fishing operations in 2008. The average total number of fuel used of the vessels was 31.92 thousand liters, with a range of fuel consumed from 11 to 55 thousand liters.

Table 4.6: Descriptive statistics of some technical and operational characteristics among vessel groups of the 58 gillnet vessels.

Criteria	Ranges of horsepower							
	50 <= HP < 90 (N=12)		90 <= HP < 250 (N=16)		250 <= HP < 400 (N=19)		HP >= 400 (N=11)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Engine (HP)	64.58	*11.96*	148.44	*54.73*	333.95	*33.27*	452.73	*63.73*
Length (m)	14.72	*.66*	15.53	*.94*	17.22	*1.00*	18.23	*.67*
Age (years)	14.17	*3.38*	10.00	*4.58*	6.95	*4.17*	3.82	*3.25*
Gear	184.25	*29.02*	240.31	*46.56*	307.47	*31.38*	330.09	*15.30*
Months	9.83	*1.19*	10.00	*1.15*	10.63	*.96*	10.73	*.47*
Trips	21.00	*5.72*	12.63	*4.47*	11.16	*2.34*	10.73	*.47*
Days fished	212.67	*32.43*	219.63	*20.47*	240.53	*27.46*	252.36	*15.74*
Fuel (1000 l.)	17.29	*4.48*	26.93	*7.93*	37.75	*7.10*	45.05	*6.46*
Crew	8.58	*.67*	9.94	*.77*	11.26	*.81*	11.91	*.30*

Source: own data and calculations

Table 4.6 presents a comparison of technical and operational characteristics between four groups of the offshore gillnet vessels, which are categorized according to engine sizes. Almost figures in Table 4.6 show the large mean values in the groups with great engine size, except the age characteristic and the number of fishing trips in the year. Characteristics such as hull length, number of pieces of gill net, total number of fishing days and fuel consumption had remarkable differences among the first two groups with smaller engines and the last two groups with higher engines. For example, the average number of pieces of gill net was 307.47 and 330.09 for the 250-400 HP vessel group and group with engine of 400HP and larger, respectively; whereas the 50-90HP and 90-250HP vessel groups, on average, only had 184.24 and 240.21 pieces, respectively. For vessel age, the average age of the vessels with engine of 400 HP and larger is 3.82 years while those of 50-90 HP engine vessels is 14.17 years. The average number of fishing trips was 21 trips for the 50-90HP group, but vessel groups with engine of more than 250 HP were only round 11 trips per year.

In summary, Tables 4.5 and 4.6 shows the 58 offshore gillnet vessels were quite heterogeneous because there were quite great differences in some technical and operational characteristics.

4.4. DESCRIPTIVE STATISTICS OF STRUCTURE OF FIXED CAPITAL

Fixed capital stock or investment capital

Table 4.7 presents the investment capital re-valued at prices of year 2008 for the vessels. The average amount of investment capital re-valued (or capital invested or fixed capital stock or the value of the vessel) of a vessel is computed at 1,481.3 million VND with a wide range from 559.1 to 2,513.0 million VND (see appendix E in detail). These figures just reflect the total investment capital or total value of the vessel already in operation. The vessel fixed assets are valued basing on original investments and annual consumer price indices in order to convert the value of year 2008. Of the total investment, fishing gear consumed an average amount of 771.8 million VND, accounted for about 52.1% in total. It took the greatest share in the components of the total fixed capital stocks. Hull and engine on average are valued at 422.2 and 199.2 million VND, ranking in the second and third position with 28.5% for hull and 13.4% for engine in total capital invested, respectively.

Contrary to fishing gear, hull and engine, other items such as mechanical equipments, electronic equipments and storage facilities accounted for a modest proportion of the total fixed capital stocks (Table 4.7). Mechanical equipments included winch, dynamo, lighting system, battery. Most vessels are equipped electronic equipments such as compass, sonar and short-distance communication equipment. Long-distance communication equipment is more widely used on large engine vessels. There were a few vessels using radar.

Table 4.7: Investment components of the 58 gillnet vessels

	Minimum	Maximum	Mean	S.D.
Hull	131.8	875.0	422.2	196.8
Engine	29.3	480.0	199.2	98.9
Mechanical equipments	22.5	57.0	38.5	8.7
Electronic equipments	8.8	80.6	27.7	11.1
Fishing gear	288.0	1155.0	771.8	249.3
Storage equipments	1.8	30.0	11.1	7.1
Others	4.7	17.0	10.7	2.7
Total fixed capital stocks	559.1	2513.0	1481.3	521.1

Unit: million VND per vessel. Source: own data and calculations

Table 4.8: Investment components among vessel groups of the 58 gillnet vessels

	Range of engine power							
	50<=HP<90 (N=12)		90<=HP<250 (N=16)		250<=HP<400 (N=19)		HP >= 400 (N=11)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Hull	195.8	*50.8*	323.0	*83.7*	515.6	*144.7*	652.2	*133.3*
Engine	93.4	*41.2*	180.0	*66.0*	215.3	*70.3*	314.9	*96.3*
Mechanical equip.	29.6	*3.1*	33.8	*1.0*	40.4	*5.6*	52.1	*5.1*
Electronic equip.	20.9	*8.3*	27.5	*8.1*	26.5	*6.6*	37.4	*17.0*
Fishing gear	452.2	*132.2*	656.6	*175.0*	919.1	*108.9*	1033.7	*85.8*
Storage equip.	3.9	*1.2*	6.6	*2.9*	14.6	*4.3*	19.7	*6.5*
Others	7.9	*1.3*	9.9	*2.1*	11.3	*2.1*	13.7	*2.0*
Total fixed capital stocks	803.7	*181.5*	1237.4	*282.0*	1742.9	*245.2*	2123.6	*232.1*

Unit: million VND per vessel. Source: own data and calculations

Table 4.8 describes capital invested among four vessel groups by engine size category. The average fixed capital stock increased with vessel engine sizes. Two vessel groups with higher engine power had investment capitals far greater than those of smaller engine groups. Fishing gear also occupied a high ratio with around 50% of investment capital in vessel groups.

Net capital value

Net capital value is the remaining fixed capital stock at the year 2008 after subtracting the accumulated depreciation from fixed capital stock or investment capital. The average net capital value at 2008 is estimated about 862.8 million VND (Table 4.9). Fishing gear and hull, on average, also held the biggest amounts of net capital value: 42% for fishing gear and 35.6% for hull.

Table 4.9: Components of the net capital value of the 58 gillnet vessels at 2008

	Minimum	Maximum	Mean	S.D.
Hull	8.7	805.0	307.1	209.5
Engine	.0	432.0	145.3	93.0
Mechanical equipments	9.7	41.1	22.9	7.7
Electronic equipments	2.0	58.3	14.4	9.3
Fishing gear	89.1	701.3	363.4	165.2
Storage equipments	.5	20.0	5.7	4.5
Others	1.2	11.3	4.1	2.8
Total net capital value	171.5	1954.0	862.8	454.7

Unit: million VND per vessel. Source: own data and calculations

It can be calculated that net capital value of an average vessel at 2008 occupied about 58.2% of its fixed capital stocks (calculated from Tables 4.7 and 4.9). This means that, until year 2008, the loss in the value of an average vessel (or accumulated depreciation) was about 41.8% of capital invested. Similarly, 47% and 73% were percentages of net capital value to capital invested of fishing gear and hull, respectively. This implies that the accumulated depreciation accounted for 53% for fishing gear and 27% for hull, respectively. It can be explained that depreciation rate of fishing gear is more than that of hull (the average lifespan is estimated about 8.5 years for fishing gear and 24 years for hull) while capital invested for fishing gear was higher than that of hull.

Table 4.10: Components of the net capital value among vessel groups at 2008

	Range of engine power							
	50<=HP<90 (N=12)		90<=HP<250 (N=16)		250<=HP<400 (N=19)		HP >= 400 (N=11)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Hull	92.8	*45.1*	199.1	*87.7*	388.6	*178.8*	557.3	*153.3*
Engine	46.6	*36.7*	119.7	*41.8*	160.8	*62.6*	263.4	*97.7*
Mechanical equip.	17.2	*3.8*	18.7	*3.8*	23.9	*6.1*	33.6	*5.8*
Electronic equip.	6.4	*3.1*	11.4	*6.0*	15.7	*4.9*	25.5	*12.4*
Fishing gear	178.6	*55.7*	278.9	*95.3*	423.8	*94.3*	583.5	*99.4*
Storage equip.	1.2	*.7*	2.8	*1.5*	7.1	*1.7*	12.2	*4.1*
Others	1.7	*.7*	2.5	*1.4*	4.7	*2.0*	7.6	*3.0*
Total net capital value	344.5	*108.1*	633.0	*185.7*	1024.6	*274.1*	1483.1	*314.2*

Unit: million VND per vessel. Source: own data and calculations

Table 4.10 shows components of the net capital value among vessel groups at year 2008. The average net capital value also increased with engine sizes. Two vessel groups with higher engines had the net capital value far higher than those of two groups with smaller engines. The average net capital value of vessels with engine of 400HP and larger was estimated about 1483.1 million VND, accounting for nearly 70% of their capital invested, while those of 50-90 HP vessels was 344.5 million VND, accounting for 43% of their capital invested, respectively. The reason is that an average age was about 3.82 and 14.17 years for the former and the latter vessels, respectively (see Table 4.6). Of vessels with engine of 400HP and larger, there were 10 vessels with their age from 2 to 5 years.

Structure of net capital value

Structure of net capital value comprises of the remaining debt (called in terms of loan as in Table 4.11 and 4.12) and owner's capital of the vessels at the time of 2008. An average vessel owner's capital is estimated about 766.1 million VND, accounting for 88.8% in net capital value, whereas average remaining debt of the vessel was 96.7 million VND – corresponding ratio of 11.2%, (Table 4.11). This implies that fishers tend to be highly self-financed. As shown in Table 4.12, at year 2008, the remaining debt and owner’s capital of the vessels increased with engine sizes. Two higher engine groups had the greatest amount of owner’s capital.

Table 4.11: Structure of the net capital value of the 58 gillnet vessels at 2008

	Minimum	Maximum	Mean	S.D.
Loan	.0	500.0	96.7	142.1
Owner’s capital	171.5	1771.5	766.1	435.3
Total net capital value	171.5	1954.0	862.8	454.7

Unit: million VND per vessel. Source: own data and calculations

Table 4.12: Structure of the net capital value among vessel groups at year 2008

	Range of engine power							
	50<=HP<90 (N=12)		90<=HP<250 (N=16)		250<=HP<400 (N=19)		HP >= 400 (N=11)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Loan	36.1	*40.7*	95.4	*159.6*	86.8	*126.8*	181.8	*183.4*
Owner’s capital	308.5	*81.6*	537.5	*209.1*	937.7	*326.5*	1301.3	*330.4*
Total net capital value	344.5	*108.1*	633.0	*185.7*	1024.6	*274.1*	1483.1	*314.2*

Unit: million VND per vessel. Source: own data and calculations

By investigation, 12 out of the 58 vessel owners responded that they had not borrowed and paid any loan. 21 vessel owners had paid all their debts and loan interest before 2008, of which there were loans from the offshore fishery program initiated by the Vietnamese government. Meanwhile, there were 27 vessel owners to provide information about their remaining debts at year 2008 and their interest payment on loans in 2008 (see appendix E in detail). The fishers borrowed from various sources such as relatives, neighbors, banks, middle-buyers, with diversified interests of loans. Three vessels had debts from some loan sources. Three vessels still had to pay debts from the national offshore fishery program with an interest rate from 0.5 to 0.6% per month. There were 15 vessels to borrow from their relatives, of which 5 vessels paid loan interest of 0%. 23 vessel owners admitted they had obtained loans from banks. Most loans from banks are performed from year 2005 to 2008 with a range of interest rate from 0.7 to 1.75% per month.

The majority of fishers noted that it was difficult to access loans from banks because the banks always insist on secured loans to minimize risks while fishing operations are greatly exposed to risks. For example, the banks only lend at a limited level since a new vessel is constructed completely or an old vessel is re-valued sensibly. In addition, fishing gear often consumed a large amount of investment capital, but it may not be put up as security for a loan. Thus, a joint investment was often established on the basic of kinship for vessels.

4.5. DESCRIPTIVE STATISTICS OF STRUCTURE OF COSTS

Variable costs

The annual average vessel variable costs was of about 604.4 million VND with a wide range from 280 to 880 million VND, of which expenses for fuel and lubricant were highest with 371.4 million VND (corresponding to accounting for 61.4% of annual variable costs), also with a large range from 150 to 600 million VND (Table 4.13). Provisions for crew and ice for preserving fish held the second and third important components in annual variable costs, respectively.

As presented in Table 4.5, the technical and operational characteristics such as engine power, the number of fishing months, trips and days fished, the number of fuel consumed, as well as crew size of the vessels varied greatly in 2008. Thus, the annual vessel variable costs and its components also fluctuated with wide ranges showed in Table 4.13.

Table 4.13: Structure of the variable costs of the 58 gillnet vessels, 2008.

	Minimum	Maximum	Mean	S.D.
Fuel & Lubricant	150.0	600.0	371.4	128.1
Ice	20.0	130.0	70.8	27.4
Provisions	45.0	155.0	100.4	26.4
Minor repairs	15.0	90.0	54.3	20.9
Others	2.0	20.0	7.5	3.3
Total variable costs	280.0	880.0	604.4	174.5

Unit: million VND per vessel per year. Source: own data and calculations

Table 4.14: Structure of the variable costs among vessel groups, 2008

	Range of engine power							
	50<=HP<90 (N=12)		90<=HP<250 (N=16)		250<=HP<400 (N=19)		HP >= 400 (N=11)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Fuel & Lubricant	199.3	*40.1*	317.8	*84.3*	448.7	*61.5*	503.5	*59.9*
Ice	41.9	*10.3*	54.6	*13.6*	84.0	*20.1*	102.9	*16.6*
Provisions	74.3	*19.0*	90.3	*17.4*	113.9	*22.9*	120.0	*20.6*
Minor repairs	45.8	*21.0*	61.6	*23.6*	59.6	*16.8*	44.1	*18.1*
Others	5.1	*2.0*	6.9	*2.1*	8.4	*3.1*	9.5	*4.7*
Total variable costs	366.3	*50.5*	531.3	*101.8*	714.7	*97.7*	780.0	*67.0*

Unit: million VND per vessel per year. Source: own data and calculations

The annual average variable costs and its components almost increased with engine sizes (Table 4.14). The 400 HP or larger vessels consumed higher amounts of fuel, provisions and ice. However, expenses for minor repairs (mainly fishing gear), of this vessel group was lowest. One of the reasons is that these vessels almost operated in fishing grounds of high sea waters and the extreme South of Vietnam, and resulting in a few damages and losses with their fishing gear. Additionally, most these vessels were from 2 to 5 years of old. This may result in lowest minor repair costs of equipments.

Fixed cost

Fixed costs included annual major repair costs and fees and insurance for crews and the vessel in year 2008. The major repair costs were for hull, engine, mechanical and storage equipments, and fishing gear. In this study, the major repairs just covered those preparing for the next year or season. The repair costs for fishing gear comprised of costs of fixing gear as well as money paid for labors to mend nets, including family-member labors. Yearly, the vessel is required to have a paper of register certificate so the vessel owners have to pay at least fee for this.

Table 4.15 shows that the average vessel fixed cost substantially varied from 30 to 150.9 million VND, with a mean of 89.4 million VND in 2008. The annual average repair costs of hull, engine and equipments accounted for a greatest amount of 44.4 million VND. However, respondents noted that repair costs of fishing gear were larger than that of each of hull, engine and equipments. Through direct interviews, none of the vessel owners paid the annual fee of register and insurance for crew and vessel. Thus, this item of fixed cost greatly varied from 0.3 to 12.6 million VND.

Table 4.15: Structure of the fixed cost of the 58 gillnet vessels, 2008

	Minimum	Maximum	Mean	S.D.
Hull, engine, equipments	13.0	85.0	44.4	14.3
Fishing gear	10.0	80.0	39.9	18.9
Fees and insurance	.3	12.6	5.1	3.0
Total fixed costs	30.0	150.9	89.4	30.1

Unit: million VND per vessel per year. Source: own data and calculations

Table 4.16: Structure of the fixed cost among vessel groups, 2008

	Range of engine power							
	50<=HP<90 (N=12)		90<=HP<250 (N=16)		250<=HP<400 (N=19)		HP >= 400 (N=11)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Hull, engine, equipments	32.8	*8.5*	41.3	*10.5*	53.9	*12.0*	45.4	*17.4*
Fishing gear	22.2	*6.8*	26.1	*13.5*	50.6	*12.0*	60.6	*8.6*
Fees & insurance	3.2	*2.4*	4.6	*3.1*	6.0	*2.6*	6.4	*3.4*
Total fixed costs	58.1	*10.3*	71.9	*23.6*	110.6	*20.9*	112.4	*17.9*

Unit: million VND per vessel per year. Source: own data and calculations

Table 4.16 presents the structure of the fixed cost among vessel groups by engine sizes. It can be seen that the fixed cost increased with engine sizes. Among vessel groups, the 400 HP and greater vessel group had the highest repair cost of 60.6 million VND for fishing gear, whereas this group had lower repair costs for hull, engine and equipments than the 250-400 HP group.

Depreciation

Table 4.17 shows that the average vessel depreciation was 136.4 million VND with a wide range from 60.5 to 215.4 million VND. The composition of component items in depreciation is considered to be compatible with that in capital invested. Depreciation of fishing gear was at the highest level of 91.8 million VND. Because the lifespan of gill net is fairly short, often replacing within the range 7 – 10 years, this kind of gear is often required rapid depreciation compared with other gear, even when the usage period of time can be extended. Since gill nets are used for fishing in many years, the sea blue of gill nets would be faded by many times of fishing, resulting in keeping off from fishing gear by target species. Moreover, fish could easily escape from mesh since gill nets are so old. Hence, productivity of fishing would decrease over time.

As can be obtained from investigation, the majority of owners who had vessels with engine of more than 250 HP often replaced their fishing gear after 7 or 8 years. This is one of the reasons why these vessels had great depreciation for fishing gear showed in Table 4.18.

Contrary to fishing gear, hull and engine can be operated for a long time, with 15 – 25 years and 7 – 20 years, respectively, in this study. Thus, the annual hull and engine depreciation are generally lower than depreciation of fishing gear.

Table 4.17: Structure of depreciation of the 58 gillnet vessels, 2008.

	Minimum	Maximum	Mean	S.D.
Hull	7.0	35.0	17.6	7.3
Engine	4.2	24.0	11.6	4.2
Mechanical equipment	5.4	10.9	8.1	1.5
Electronic equipment	1.5	5.7	3.1	.7
Fishing gear	36.0	144.4	91.8	32.9
Storage equipmet	.5	5.0	2.4	1.3
Others	.8	2.8	1.8	.4
Total depreciation	60.5	215.4	136.4	45.8

Unit: million VND per vessel per year. Source: own data and calculations

Table 4.18: Structure of depreciation among vessel groups, 2008.

	Range of engine power							
	50<=HP<90 (N=12)		90<=HP<250 (N=16)		250<=HP<400 (N=19)		HP >= 400 (N=11)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Hull	9.4	*1.7*	13.4	*2.9*	21.3	*4.9*	26.1	*5.3*
Engine	6.3	*1.7*	10.4	*2.4*	12.9	*2.1*	16.9	*3.4*
Mechanical equip.	6.1	*.6*	7.5	*.6*	8.6	*.9*	10.1	*.5*
Electronic equip.	2.5	*.7*	3.0	*.4*	3.1	*.6*	3.8	*.9*
Fishing gear	49.2	*10.7*	74.3	*18.2*	111.8	*15.8*	129.2	*10.7*
Storage equip.	1.0	*.3*	1.6	*.6*	3.2	*.7*	3.9	*.9*
Others	1.3	*.2*	1.7	*.3*	1.9	*.3*	2.3	*.3*
Total depreciation	75.7	*12.0*	111.8	*22.0*	162.9	*19.6*	192.3	*14.8*

Unit: million VND per vessel per year. Source: own data and calculations

Interest payment on loans and the calculated interest on owner's capital

The average interest payment on loans of the vessels was 8.9 million VND, with a range from 0 to 42 million VND (Table 4.19). There were 31 vessel owners not to pay any loan in 2008; in contrast, 27 vessel owners had to pay interest on their loans (see appendix E in detail) with different rate of interest, which is mentioned in section 4.4.

Interest payment on loans increased with engine sizes (see Table 4.20). As presented, the large engine vessels had a great value of net capital of hull and engine. Thus, these vessels would have a larger security for loans; lenders would loan a greater level for these vessels compared with other small engine vessels. This may be compatible with results in Table 4.20 that the vessel group with engine of 400 HP and larger had the highest interest payment on loans in average (19.8 million VND), 2.3 times higher than that of the 250-400HP group, 3.7 times greater than that of the 90-250 HP group, and 4.5 times larger than that of the 50-90 HP group.

Also shown in Table 4.19 and 4.20 are the calculated interest on owner's capital of the vessel. The average of this item substantially varied from 15.4 to 159.4 million VND, with a mean of 68.9 million VND (Table 4.19). This interest also increased with vessel engine sizes (Table 4.20 and appendix E in detail).

Table 4.19: Interest payment on loans and the calculated interest on owner' capital of the 58 gillnet vessels, 2008.

	Minimum	Maximum	Mean	S.D.
Interest payment on loans	.0	42.0	8.9	13.9
Calculated interest on owner's capital	15.4	159.4	68.9	39.2

Unit: million VND per vessel per year. Source: own data and calculations

Table 4.20: Interest payment on loans and the calculated interest on owner' capital among vessel groups, 2008

	Range of engine power							
	50<=HP<90 (N=12)		90<=HP<250 (N=16)		250<=HP<400 (N=19)		HP >= 400 (N=11)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Interest payment on loans	4.4	5.4	5.3	10.2	8.6	13.7	19.8	19.8
Calculated interest on owner's capital	27.8	7.3	48.4	18.8	84.4	29.4	117.1	29.7

Unit: million VND per vessel per year. Source: own data and calculations

As discussed partially in chapter 3 (section 3.2), the calculated interest on owner's capital is considered as the opportunity cost of owner's capital. The 2008 base interest rate in Vietnamese dong to be about 9% per annum is chosen as a benchmark for determining the opportunity cost of capital in this study. There may be some reasonable explanations for this. First, the fixed assets on the vessel may not be easily altered to participate in other sectors of the economy, other than into another fishery (Agar and Sutinen, 2004). Moreover, it is difficult to assess the degree of financial risk involved in the activity of other industries since information is imperfect in some developing countries as Vietnam. Second, it is difficult to identify an appropriate rate of return in Nha Trang fishery with the diversity of vessel kinds of different fishing activities. Third, the habit of fishers is often to either deposit their savings in bank or lend others as a loan since they have a saving amount of money.

4.6. DATA ANALYSIS TOOLS

Data analysis procedures were conducted by using Microsoft Excel 2003; the Salter-diagram software; the statistical package SPSS version 15.0; and by the econometric and statistical package SHAZAM version 10.

Chapter 5

ECONOMETRIC MODEL AND ANALYSIS OF RESULTS

5.1. ECONOMETRIC MODEL

This study uses engine capacity (measured in horsepower) and fishing gear (measured by the average number of pieces of gill net) as proxies for capital inputs, and the number of fishing days in a year as the proxy for variable inputs. All are identified as factors affecting fishing effort of the vessel. Initially, other inputs such as hull length and crew size were also considered part of the input bundle generating fishing effort. However, they were excluded in the final model because neither individual nor joint tests produced any evidence to support their significant effects on the fishing effort of the vessel. Consequently, the equation used in the application of the model of this study is

$$EFFORT_i = A * HP_i^{\alpha_1} GEAR_i^{\alpha_2} DAY_i^{\alpha_3} \qquad (5.1)$$

where $EFFORT_i$ is the standardized fishing effort of vessel ***i***, HP_i is horsepower of vessel ***i***, $GEAR_i$ is the average number of pieces of gill nets of vessel ***i***, DAY_i is the number of fishing days in a year of vessel ***i***, A is a constant.

Model in specification:

From equation 5.1, the log-linear effort model for vessel ***i*** can be written as follows:

$$\ln EFFORT_i = \alpha_0 + \alpha_1 \ln HP_i + \alpha_2 \ln GEAR_i + \alpha_3 \ln DAY_i + u_r \qquad (5.2)$$

where α_0, α_1, α_2, α_3 are coefficients estimated, in which A = exp(α_0), and u_r is a random error term.

HP is engine capacity of the vessel, which is measured in horsepower. It is expected that engine power has positive effects on the fishing power of the vessel.

GEAR is the average number of pieces of gill net used to fish in the fishing season of the year 2008. When one fisher uses more pieces of gill net for fishing than others do, he might expect that his catch will be higher. Thus, it may be predicted that this independent variable have the strongest positive impact on the fishing power.

DAY shows the total number of fishing days in the year 2008. The data available from the survey only have the total average number of fishing days per trip and the total number of fishing trips in the year (whereby the total number of fishing days in the year is the product of these two quantities). If a fisher fishes one day more, his total catch in year will increase accordingly. Therefore, it is expected that this independent variable has positive relationship with fishing effort.

5.2. ECONOMETRIC RESULTS

In this section, the regression analysis results of standardized fishing effort for Nha Trang's 58 gillnet vessels in 2008 are presented. The parameters estimated, test of goodness of fit (R^2), and test of overall significance of the regression model (F-test) for model 5.2 are reported in Table 5.1 by using ordinary least square (OLS) estimation. The results show the effect of the independent variables in explaining variations in fishing effort is significant for the sample vessels with R^2 of 98.7%. The F – test specifically shows the null hypothesis that all coefficients of the explanatory variables are zero is rejected, and provides that the estimated relationship is significant.

Table 5.1: Parameter estimate and test statistics of standardized effort function

VARIABLE NAME	ESTIMATED COEFFICIENT	t-value	P-VALUE	WHITE t-value	WHITE P-VALUE
lnHP	0.251	16.229	0.000*	20.120	0.000*
lnGEAR	0.542	12.451	0.000*	12.200	0.000*
lnDAY	0.478	9.704	0.000*	11.060	0.000*
CONSTANT	-0.045	-0.153	0.879	-0.161	0.873

Dependent Variable: lnEFFORT;
R-square = 0.987; F - statistic = 1394.375; DW-statistic = 2.027
** Statistically significant at the level of 1%*

Source: own data and calculations

However, a good regression model should not violate the least square assumptions. The hypotheses testing outcome procedures have shown that autocorrelation are not the problem in this model. The calculated value for Durbin-Watson statistic is d = 2.027, whereas upper and lower critical value bounds for the Durbin-Watson test are $d_{Uc} = 1.51$ and $d_{Lc} = 1.30$, respectively, with 58 observations and 3 explanatory variables at 1% of significant level. Since value of d nears 2 or satisfies $d_{Uc} < d < 4 - d_{Uc}$ we can conclude that there is no evidence to suggest that autocorrelation exists (Hill et al., 2008, p. 261-264). This conclusion is reasonable with cross-section observations (Hill et al., 2008, p. 227).

When using cross-sectional data, heteroskedasticity is often encountered (Hill et al., 2008, p. 200). The OLS procedure outcome has shown the random error values are normally distributed about their mean of zero (3.15E-14 is considered to close with 0) with standard deviation of 0.973, approximately 1. Standardized residuals are plotted along standardized predicted values have shown that there may be no patterns of any sorts in the residuals (see appendix F). However, the potential problem of heteroskedasticity can be warned for a formal treatment (Flaaten et al., 1995). Thus, White's procedure for correcting for heteroskedasticity is applied and White's heteroskedasticity consistent t-values are also reported in Table 5.1.

The second potential problem of this model is multicollinearity since the sample correlation coefficients between the explanatory variables are considered high (see appendix F). However, this may not be an important problem for four reasons: first, the coefficients estimated are statistically significant, and have the expected signs and magnitudes. Second, these coefficients are not sensitive since few observations are deleted from samples of 58 gillnet vessels for test of collinearity. Third, estimating the auxiliary regressions by choosing each of one of explanatory variables as an artificial dependent variable while keeping the remaining explanatory variables; the results show that all R^2 of these artificial models are less than R^2 of 0.987 in the main model of this study and level of 0.80 discussed in Hill et al. (2008, p.156). Finally, a nonexact multicollinearity is not a violation of the least square assumptions. Therefore, there is no reason to try mitigating multicollinearity.

The RESET test (Regression Specification Error Test) is also reported to detect omitted variables and incorrect functional form (Hill et al., 2008, p. 151-152). The outcome of this test indicates that the model is adequate and well specified (see appendix F).

Table 5.1 demonstrates that all coefficients estimated of the explanatory variables are significantly different from zero at 1% level or better based on the OLS estimation with White's procedure for correcting for heteroskedasticity. These parameters, estimated with positive signs, are expected in this model to register values of 0.251, 0.542 and 0.478 corresponding lnHP, lnGEAR and lnDAY, respectively. Keeping other variables constant, a 10% increase in horsepower (HP) is estimated to produce about a 2.51% in the fishing effort of the vessel. Similarly, the elasticity corresponding to the average number of pieces of gill nets (GEAR) estimates that a 10% increase in this factor will increase average fishing effort of the vessel by 5.42%, given other inputs constant. Regarding the effect of the nominal fishing effort, the effective fishing effort will increase 4.78% since days fished increases 10%, given other inputs constant.

5.3. ESTIMATES OF STANDARDIZED FISHING EFFORT

The estimated fishing effort equation is used to derive standardized measures of fishing effort for each vessel as follows:

$$EFFORT_i = \exp(-0.045) * HP_i^{0.251} GEAR_i^{0.542} DAY_i^{0.478} \quad (5.3)$$

In this study, the estimated equation (5.3), the actual engine power, the average number of pieces of gill net and the number of fishing days for each vessel are used to estimate the standardized fishing effort. Estimated results for 2008 for each of the sample vessels are presented in Figure 5.1 and appendix G in detail.

Table 5.2: Descriptive Statistics of the standardized effort and the relative standardized effort of the 58 gillnet vessels

	N	Min	Max	Mean	S.D.
Standardized effort	58	478.53	1514.77	1043.18	336.64
Relative standardized effort	58	.46	1.45	1.00	.32

Source: own data and calculations

The average standardized fishing effort is 1043.18 (unit of effort). The vessel number 35 has the minimum standardized effort of 478.53 (units of effort), whereas the maximum standardized effort of 1514.77 is amount of fishing efforts of the vessel number 30 (see Figure 5.1 and Table 5.2).

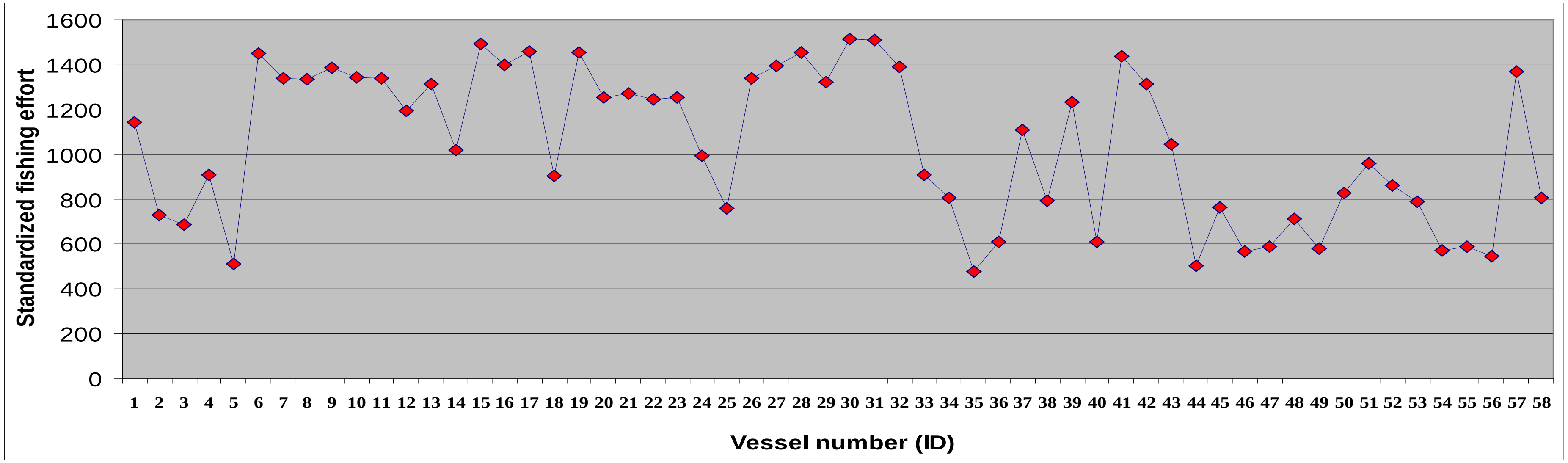


Figure 5.1: Standardized fishing effort of the 58 gillnet vessels. Source: own data and calculations

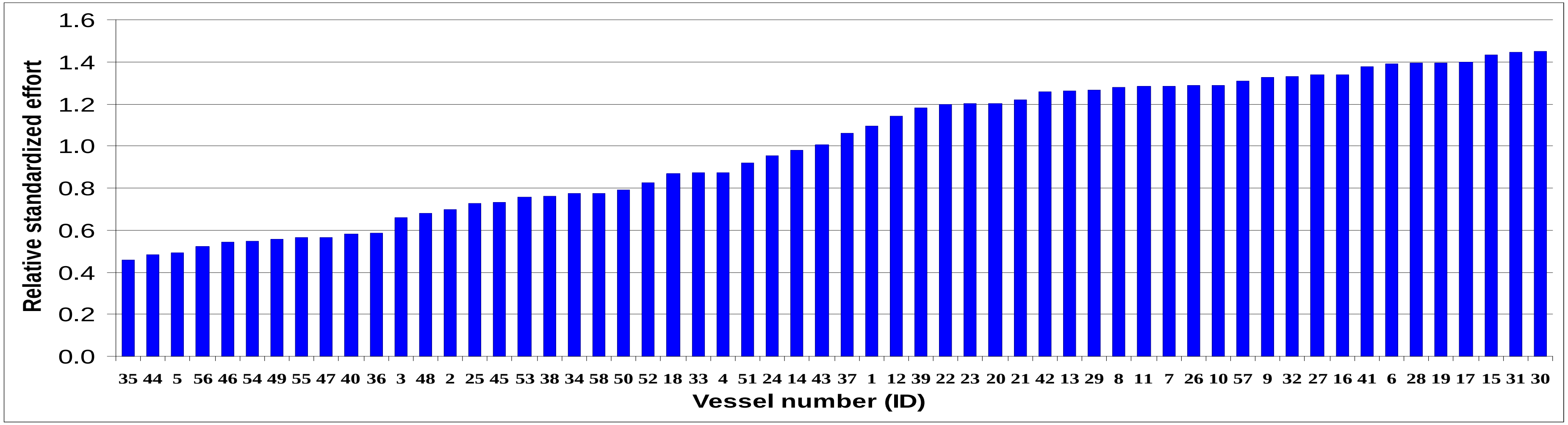


Figure 5.2: Relative standardized fishing effort of the 58 the gillnet vessels. *Note:* sorted from the lowest to the highest effort level. Source: own data and calculations

5.4. RELATIVE STANDARDIZED EFFORT AND RELATIVE FISHING POWER INDEX

Applying the formula 3.12, the relative standardized fishing effort is computed for each of the sample vessels. The average value of relative standard effort is equal to one. The minimum and maximum of the relative standardized effort are 0.46 and 1.45, corresponding to the vessel number 35 and 30, respectively (see Figure 5.2, Table 5.2 and appendix G in detail).

The relative standardized effort indices are also considered as the relative fishing power (RFP) indices in the same manner of measure. Figure 5.2 shows that RFP indices range from 0.46 to 1.45 for the 58 surveyed vessels (see appendix G in detail). There were 28 vessels with a relative fishing power less than one, whereas 30 vessels had the relative fishing power greater than one, which is an average RFP index of all vessels in the sample and also as the RFP index of an artificial standard vessel. The vessel number 43 with the RFP of 1.0035, most closely with 1, is considered to nearly equal the average RFP index. The majority of vessels with RFP indices above the average RFP index had engine power of more than 250 HP and 300 pieces of gill net and over.

5.5. ECONOMIC PERFORMANCE INDICATOR RESULTS

Economic performance indicators, including the 2008 fuel subsidies

The key economic performance indicators for an average gillnet vessel are given in Table 5.3 and summarized partially in Figure 5.3, including the 2008 fuel subsidies of Vietnamese government. There were three vessel classes of the subsidies in 2008. Vessels with an engine of 90 HP or larger received the total subsidies of 30 million VND per year. Vessels with engine of from 40 HP to less than 90HP were subsidized total values of 26 million VND. Others received 20 million VND in 2008 (Decision 965/QD-TTg, 2008). All 58 surveyed gillnet vessels received enough the subsidies. The relative performance indicators include gross profit margin, profit margin, return on capital value, and return on owner’s capital. Gross profit margin is estimated by dividing gross cash flow by gross revenue with the subsidies. Profit margin, return on capital value and return on owner’s capital estimated by dividing profit by gross revenue with the subsidies, net capital value and net owner’s capital, respectively.

Table 5.3: Economic performance indicators, including the 2008 fuel cost support

Criteria	Minimum	Maximum	Mean	Std. Deviation
Gross revenue from fishing	**480.0**	**1550.0**	**1044.6**	**341.2**
Subsidy	26.0	30.0	29.2	1.6
Gross revenue, including subsidies	**506.0**	**1580.0**	**1073.7**	**342.3**
Variable costs	280.0	880.0	604.4	174.5
Income	**140.0**	**810.0**	**469.3**	**193.8**
Fixed costs	30.0	150.9	89.4	30.1
Gross value added	**84.2**	**702.2**	**379.9**	**172.3**
Labour costs	57.8	396.0	184.1	78.4
Gross cash flow	**-35.8**	**440.2**	**195.8**	**121.2**
Depreciation	60.5	215.4	136.4	45.8
Interest payment on loans	.0	42.0	8.9	13.9
Profit	**-152.5**	**249.3**	**50.5**	**93.1**
Calculated interest on owner's capital	15.4	159.4	68.9	39.2
Net profit	**-211.0**	**157.1**	**-18.4**	**84.4**
Net capital value	171.5	1954.0	862.8	454.7
Net owner's capital	171.5	1771.5	766.1	435.3
Gross profit margin	-.045	.315	**.173**	.083
Profit margin	-.166	.186	**.038**	.085
Return on capital value	-.285	.329	**.053**	.127
Return on owner's capital	-.298	.329	**.061**	.139
Average income per fisherman	**7.2**	**33.0**	**17.1**	**5.8**

Notes: all economic values are in million VND; the averages of gross profit margin, profit margin, return on capital value and return on owner’s capital are estimated with relative to standard error, and measured in decimal number. All they are per vessel and year. Source: own data and calculations.

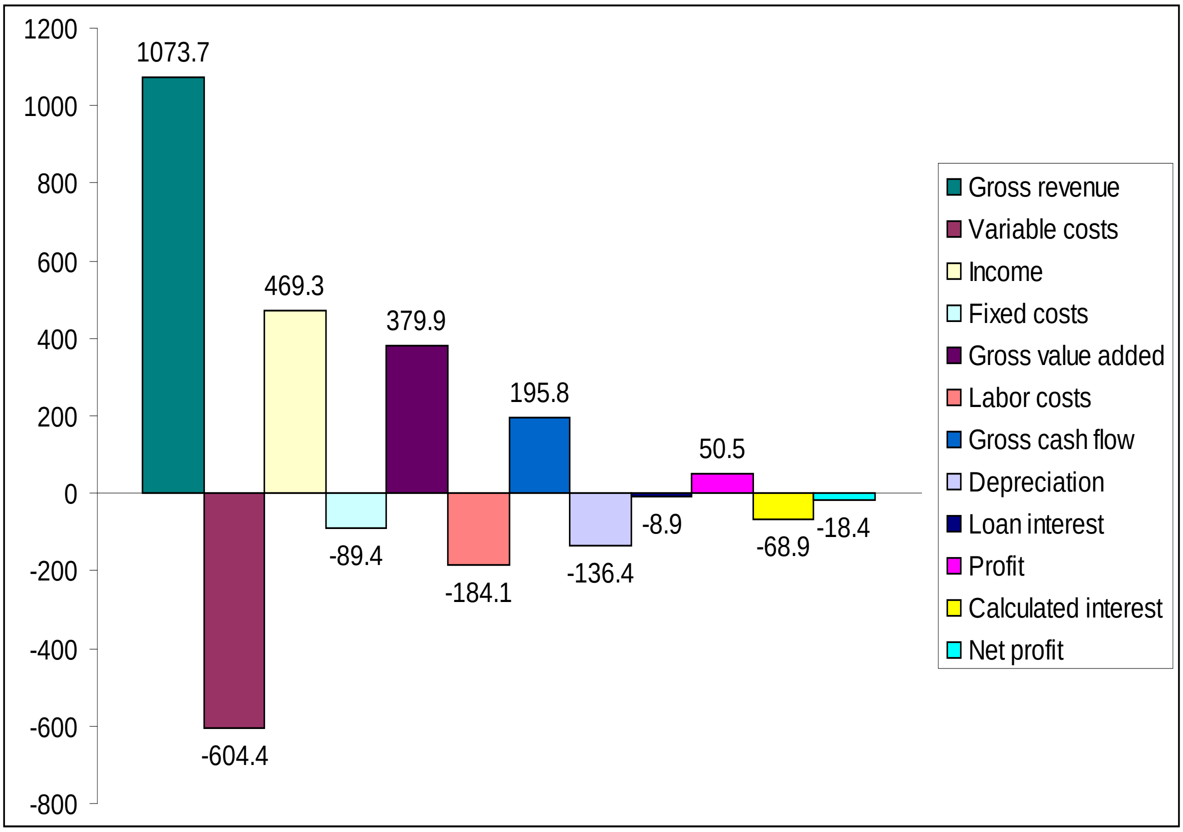


Figure 5.3: Economic performance indicators of an average gillnet vessel, including the 2008 fuel cost support. *Notes*: items of costs are assigned the negative sign; unit: million VND per vessel per year. Source: own data and calculations.

The results show indicators which include income, gross value added, gross cash flow and profit are positive for an average vessel, whereas net profit is negative in 2008.

However, the first performance measure computed was the annual gross revenue from fishing operation. This indicator varied from 480 to 1550 million VND, with an average of 1044.6 million VND. Because all 58 surveyed gillnet vessels were received the 2008 fuel cost support from Vietnamese government, the average gross revenue including this subsidy of the gillnet vessels increased at level of 1073.7 million VND.

The second performance measure estimated was the difference between annual gross revenue with the subsidies and variable costs. The average annual income of the vessels was estimated at 469.3 million VND, with a wide range from 140 to 810 million VND.

The next is an indicator of gross value added, which is considered as the remaining value after less costs paid to other industries from gross revenue with the subsidies. The annual gross value added of the vessels, on average, was largely varied from 84.2 to 702.2 million VND, with a mean of 379.9 million VND.

Test hypothesis 1

The average gross cash flow of the gillnet vessels was 195.8 million VND with a large range from –35.8 to 440.2 million VND. As obtained from investigating, there were two vessels (vessel number 25 and 40) where gross revenue including the subsidies did not offset their variable, fixed and labor costs. Thus, the null hypothesis that the vessel owner has a positive gross cash flow from his fishing in 2008, including the fuel cost lump-sum subsidy, is rejected in the case of these two vessels (see hypothesis 1 in chapter 3, p.31). However, this hypothesis is not clearly rejected since the average gross cash flow of the 58 vessels was positive with large difference from zero. Thus, the null hypothesis rejection would not be statistically significant for whole 58 vessels.

In addition to the results, the average annual vessel profit was estimated at 50.5 million VND, including the 2008 fuel subsidies. Profit also fluctuated greatly from – 152.5 to 249.3 million VND.

An indicator that measures the vessel owner efficiency from society's point of view is net profit or net economic profit. Table 5.3 shows that the average annual net profit of the vessels was negative sign of 18.4 million VND in 2008. This indicator varied greatly from – 211 to 157.1 million VND. Thus, there was a negative economic return of the vessel, on annual average, to society of employing owner's capital in the current fishing activity.

Also shown in Table 5.3, each of the five indicators, including income, gross value added, gross cash flow, profit and net profit, accounted for each of their items of costs. For example, net profit accounted for all expenses, including the calculated interest on owner's capital. Variable costs, fixed costs, labor costs, depreciation and interest payment on loans, as well as calculated interest on owner's capital as the annual average per a vessel were 604.4, 89.4, 184.1, 136.4, 8.9 and 68.9 in unit of million VND, respectively. These cost items also varied greatly (see Table 5.3). The labor costs are here what were included in the survey of crew members, skipper, owner-operator's labor and also crew members of the boat owner's family in the income share system, resulting the labor costs as a resource cost incurred if the vessel operates in the fishery.

Also shown in Table 5.3 are the average relative performance indicators in the case of including the 2008 fuel cost support. Rates are estimated for each gillnet vessel. Results are represented including the standard deviation to determine differences in the 58 gillnet vessels. The average vessel gross profit margin and profit margin were 17.3% and 3.8%, respectively, with wide ranges from – 4.5% to 31.5% for gross profit margin and from – 16.6% to 18.6% for profit margin. The average vessel return on capital value and return on owner's capital were 5.3% and 6.1% respectively, also with large ranges for both two indicators. The large variance of the return on capital value and return on owner's capital was caused by not only greatly differences in profit, but also wide ranges from 171.5 to 1954 million VND in net capital value and from 171.5 to 1771.5 in net owner's capital of the vessels.

For income of fishermen, 17.1 million VND was the income level of the average annual crew share. The average income per fisherman also varied greatly from 7.2 to 33 million VND. As a result, the average monthly crew share during the fishing season is 1.65 million VND, being that the average annual total operating months of a gillnet vessel are 10.31 months. As mentioned above, crew remuneration also was to include for crews, skipper and owner-operator's labor in the income share system.

Economic performance indicators among the vessel groups

A breakdown of the sample by engine size of the vessels is given in Table 5.4 and summarized partially in Figure 5.4. The results show most annual performance indicators increased on average with engine size classes of the vessels. These indicators comprised of gross revenue with/without the subsidy, income, gross value added, gross cash flow and profit. Crew remuneration on average also increased with vessel engine sizes. Costs followed the same trend as gross revenue and vessel engine sizes. An average gillnet vessel of each group covered the cash cost as well as depreciation (non-cash costs) (Table 5.4).

However, while 400 HP vessels and larger barely covered all expenses including the opportunity cost of owner's capital and got only a very small surplus with a net profit of 0.3 million VND on average for 2008, other vessels got negative net profits. The reason is that the smaller than 400 HP groups of vessels, on average, earned the return on owner's capital less than the opportunity cost of owner's capital, the nominal interest rate of 9% in this study (see Figure 5.5).

In general, as shown in Table 5.4, Figure 5.4 and 5.5, two vessels groups with higher engine power had economic performance indicators far better than those of two vessels groups with smaller engines in 2008. The 400 HP and greater vessel group had the best average economic performance indicators with gross cash flow of 329.5, profit of 117.4 million VND and positive net profit, including subsidies.

Table 5.4: Economic performance indicators among vessel groups, including the 2008 fuel cost support.

Criteria	Range of engine power							
	50<=HP<90 (N=12)		90<=HP<250 (N=16)		250<=HP<400 (N=19)		HP >= 400 (N=11)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Gross revenue from fishing	**594.2**	*75.6*	**848.1**	*168.3*	**1249.7**	*125.1*	**1467.3**	*70.9*
Subsidy	26.0	*.0*	30.0	*.0*	30.0	*.0*	30.0	*.0*
Gross revenue with subsidies	**620.2**	*75.6*	**878.1**	*168.3*	**1279.7**	*125.1*	**1497.3**	*70.9*
Variable costs	366.3	*50.5*	531.3	*101.8*	714.7	*97.7*	780.0	*67.0*
Income	**253.8**	*50.8*	**346.8**	*137.0*	**565.1**	*81.6*	**717.3**	*79.9*
Fixed costs	58.1	*10.3*	71.9	*23.6*	110.6	*20.9*	112.4	*17.9*
Gross value added	**195.7**	*49.7*	**274.9**	*125.6*	**454.5**	*78.8*	**604.9**	*83.7*
Labour costs	105.7	*41.9*	141.4	*40.2*	216.7	*57.2*	275.4	*57.6*
Gross cash flow	**90.0**	*59.7*	**133.5**	*110.1*	**237.7**	*88.0*	**329.5**	*71.2*
Depreciation	75.7	*12.0*	111.8	*22.0*	162.9	*19.6*	192.3	*14.8*
Interest payment on loans	4.4	*5.4*	5.3	*10.2*	8.6	*13.7*	19.8	*19.8*
Profit	**9.9**	*62.6*	**16.4**	*100.9*	**66.2**	*92.8*	**117.4**	*71.2*
Calculated interest on owner's capital	27.8	*7.3*	48.4	*18.8*	84.4	*29.4*	117.1	*29.7*
Net profit	**-17.9**	*65.1*	**-32.0**	*97.6*	**-18.2**	*94.8*	**.3**	*69.3*
Net capital value	344.5	*108.1*	633.0	*185.7*	1024.6	*274.1*	1483.1	*314.2*
Net owner's capital	308.5	*81.6*	537.5	*209.1*	937.7	*326.5*	1301.3	*330.4*
Gross profit margin	**.145**	*.088*	**.145**	*.101*	**.187**	*.069*	**.219**	*.043*
Profit margin	**.015**	*.095*	**.011**	*.103*	**.053**	*.072*	**.078**	*.046*
Return on capital value	**.046**	*.178*	**.021**	*.152*	**.068**	*.096*	**.081**	*.052*
Return on owner's capital	**.046**	*.185*	**.031**	*.169*	**.077**	*.113*	**.093**	*.063*
Average income per fisherman	**12.2**	*4.2*	**14.2**	*3.7*	**19.2**	*4.8*	**23.1**	*4.6*

Notes: all economic values are in million VND per vessel per year; the averages of gross profit margin, profit margin, return on capital value and return on owner’s capital are estimated with relative to standard error, and measured in decimal number. Source: own data and calculations.

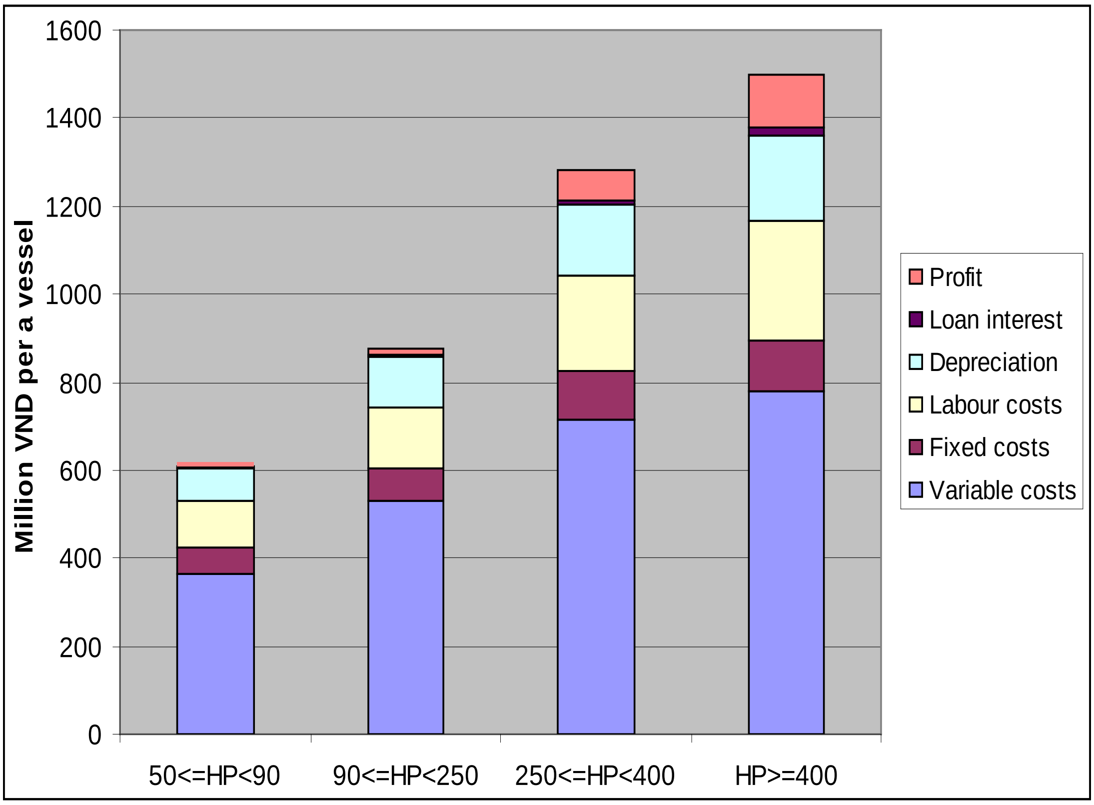


Figure 5.4: Costs and profit in gross revenue by engine sizes, including the 2008 fuel cost support. Source: own data and calculations.

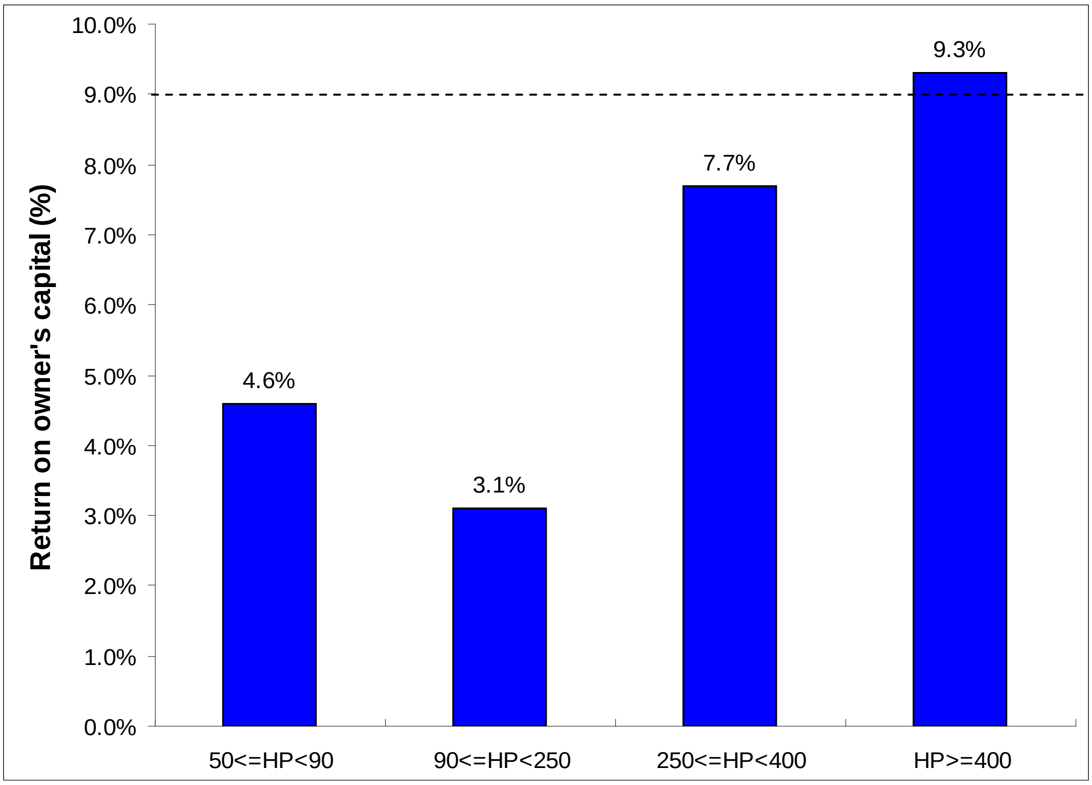


Figure 5.5: Return on owner’s capital by engine sizes, including the 2008 fuel cost support. Source: own data and calculations.

Economic performance indicators, excluding the 2008 fuel subsidies

Table 5.5 and 5.6 represent economic performance indicators assuming no 2008 fuel cost support of Vietnamese government to determine the effect level of said subsidies on economic performance of the gillnet vessels.

As seen in Table 5.5, since vessel economic performance is estimated from vessel actual fishing operation, annual economic performance indicators (income, gross value added, gross cash flow, profit and net profit) on average were less than those of the case with the subsidy by 29.2 million VND: an average quasi-lump-sum subsidy of the surveyed gillnet vessels. These indicators also varied from their minima of the subsidy case deducting 26 million VND to their maxima of the subsidy case subtracting 30 million VND.

Noticeably, there would have been 3 vessels with the negative gross cash flow (increased one vessel in comparison with the subsidy case), 23 vessels (accounted for 40% in the total) with negative profit (increased 7 vessels) and 42 vessels (accounted for more than 72% in the total) uncovered their opportunity cost of owner's capital (increased 9 vessels). Consequently, the surveyed gillnet vessels were earning, on average, negative economic profits (–47.6 million VND) from their actual fishing. Similarly, the actual relative performance indicators without the subsidies in Table 5.5 are lower rates than those of the case with the subsidies in Table 5.3.

Table 5.6 presents economic performance indicators among the gillnet vessel groups in the exclusive case of the 2008 fuel cost support. The results show that vessels with less than 90 HP had 26 million VND less economic performance (including income, gross value added, gross cash flow, profit and net profit) than those that had been subsidies. In a similar explanation, the economic performances of 90 HP or higher engine vessels were 30 million VND less than those subsidized.

It can be seen that an average vessel in each group was covering its variable, fixed and labor costs by its gross revenue of fishing operations during fishing season, excluding the subsidies. However, on average, vessels less than 250 HP were not able to cover depreciation and interest payment on loans from their gross revenue of fishing operation, whereas the two groups of vessels with higher horsepower averaged positive profits annually. Additionally, the annual average of each individual vessel group could not have earned positive economic profits for society of employing owner's capital to the fishing activities.

Table 5.5: Economic performance indicators, excluding the 2008 fuel cost support

Criteria	Minimum	Maximum	Mean	Std. Deviation
Gross revenue from fishing	**480.0**	**1550.0**	**1044.6**	**341.2**
Variable costs	280.0	880.0	604.4	174.5
Income	**110.0**	**780.0**	**440.2**	**192.9**
Fixed costs	30.0	150.9	89.4	30.1
Gross value added	**54.2**	**672.2**	**350.7**	**171.4**
Labor costs	57.8	396.0	184.1	78.4
Gross cash flow	**-65.8**	**410.2**	**166.6**	**120.5**
Depreciation	60.5	215.4	136.4	45.8
Interest payment on loans	.0	42.0	8.9	13.9
Profit	**-182.5**	**219.3**	**21.4**	**92.7**
Calcuated interest on owner's capital	15.4	159.4	68.9	39.2
Net profit	**-241.0**	**127.1**	**-47.6**	**84.4**
Net capital calue	171.5	1954.0	862.8	454.7
Net owner's capital	171.5	1771.5	766.1	435.3
Gross profit margin	-.085	.299	**.147**	.089
Profit margin	-.211	.166	**.008**	.092
Return on capital value	-.359	.250	**.007**	.128
Return on owner's capital	-.359	.250	**.007**	.142
Average income per fisherman	**7.2**	**33.0**	**17.1**	**5.8**

Notes: all economic values are in million VND per vessel per year; the averages of gross profit margin (estimated by dividing gross cash flow by gross revenue without the subsidies), profit margin, return on capital value and return on owner's capital are estimated with relative to standard error, and measured in decimal number. Source: own data and calculations.

Table 5.6: Economic performance indicators among vessel groups, excluding the 2008 fuel cost support.

Criteria	Range of engine power							
	50<=HP<90 (N=12)		90<=HP<250 (N=16)		250<=HP<400 (N=19)		HP >= 400 (N=11)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Gross revenue from fishing	**594.2**	*75.6*	**848.1**	*168.3*	**1249.7**	*125.1*	**1467.3**	*70.9*
Variable costs	366.3	*50.5*	531.3	*101.8*	714.7	*97.7*	780.0	*67.0*
Income	**227.8**	*50.8*	**316.8**	*137.0*	**535.1**	*81.6*	**687.3**	*79.9*
Fixed costs	58.1	*10.3*	71.9	*23.6*	110.6	*20.9*	112.4	*17.9*
Gross value added	**169.7**	*49.7*	**244.9**	*125.6*	**424.5**	*78.8*	**574.9**	*83.7*
Labor costs	105.7	*41.9*	141.4	*40.2*	216.7	*57.2*	275.4	*57.6*
Gross cash flow	**64.0**	*59.7*	**103.5**	*110.1*	**207.7**	*88.0*	**299.5**	*71.2*
Depreciation	75.7	*12.0*	111.8	*22.0*	162.9	*19.6*	192.3	*14.8*
Interest payment on loans	4.4	*5.4*	5.3	*10.2*	8.6	*13.7*	19.8	*19.8*
Profit	-16.1	*62.6*	-13.6	*100.9*	36.2	*92.8*	87.4	*71.2*
Calcuated interest on owner's capital	27.8	*7.3*	48.4	*18.8*	84.4	*29.4*	117.1	*29.7*
Net profit	**-43.9**	*65.1*	**-62.0**	*97.6*	**-48.2**	*94.8*	**-29.7**	*69.3*
Net capital value	344.5	*108.1*	633.0	*185.7*	1024.6	*274.1*	1483.1	*314.2*
Net owner's capital	308.5	*81.6*	537.5	*209.1*	937.7	*326.5*	1301.3	*330.4*
Gross profit margin	**.107**	*.092*	**.114**	*.107*	**.167**	*.070*	**.203**	*.044*
Profit margin	**-.029**	*.099*	**-.025**	*.109*	**.030**	*.073*	**.059**	*.047*
Return on capital value	**-.036**	*.170*	**-.033**	*.150*	**.037**	*.095*	**.060**	*.050*
Return on owner's capital	**-.044**	*.179*	**-.036**	*.165*	**.040**	*.111*	**.068**	*.062*
Average income per fisherman	**12.2**	*4.2*	**14.2**	*3.7*	**19.2**	*4.8*	**23.1**	*4.6*

Notes: all economic values are in million VND per vessel per year; the averages of gross profit margin (estimated by dividing gross cash flow by gross revenue without the subsidies), profit margin, return on capital value and return on owner's capital are estimated with relative to standard error, and measured in decimal number. Source: own data and calculations.

In summary, with the 2008 government fuel subsidies, an average gillnet vessel from each group was able to compensate its variable, fixed, labor costs as well as economic depreciation and interest payment on loans. However, these vessels were not able to cover its opportunity cost of owner's capital, save of vessel group with engines of 400 HP and larger. Regarding economic performance, from the vessels calculated from gross revenue of fishing operation (except the 2008 fuel subsidies), the vessels with less than 250 HP, on annual average, were not able to cover their depreciation and interest payment on loans. The relative performance indicators without the subsidies were lower than those of the case with the subsidies, even though negative with the vessels less than 250 HP. The costs also were quite different among the gillnet vessels. A vessel's economic costs, on average, increased with engine size as well as the increasing trend of gross revenue. In order to compare the vessel's actual economic performance, an analysis of relative economic efficiency in production of the vessels is presented next.

5.6. ECONOMIC EFFICIENCY OF THE VESSEL

Economic efficiency of the vessel in short run

This section presents individual efficiency of the 58 gill net vessels in the short run. Figure 5.6 shows the relative cost efficiency between vessels, of which the relative standardized effort of each vessel i is measured by the width of the bar, the height of the bar measures the average total variable, fixed and labor costs per unit of relative standardized effort, $\boldsymbol{avc_i}$, of each vessel i. In this figure, all $\boldsymbol{avc_i}$ is sorted in order from the most to least efficient vessel and from the left to the right. The figures within the bars are to show the vessel numbers.

In Figure 5.6, it can be seen that avc_{22} of vessel number 22 was lowest (avc_{22} = 733 million VND) with its relative standardized effort, e_{22}, of 1.20, whereas avc_{25} of vessel number 25 was highest (avc_{25} = 1147.4 million VND) with its relative standardized effort, e_{25}, of 0.73 (see Figure 5.2 and appendix G). Thus, vessel number 22 and 25 are considered as the most and the least cost efficient vessels in the short run, respectively.

If we choose vessel number 43 with its avc_{43} = 837.7 million VND, corresponding to its e_{43} of 1.0035, closely to 1, as a standard vessel in order to compare with others, there were 14 vessels with their relative standardized effort of more than e_{43} = 1.0035, but their avc_i were less than avc_{43}. These 14 vessels included vessel number 22, 19, 37, 57, 31, 26, 20, 9, 27, 15, 1, 41, 30, and 42. Additionally, the majority of vessels with their relative standardized effort of less than e_{43} = 1.0035 had their avc_i more than avc_{43}. There were only 4 vessels with relative standardized efforts of less than e_{43} = 1.0035, including vessel numbers 4, 47, 48 and 50, to have more cost efficiency than vessel number 43 in the short run perspective.

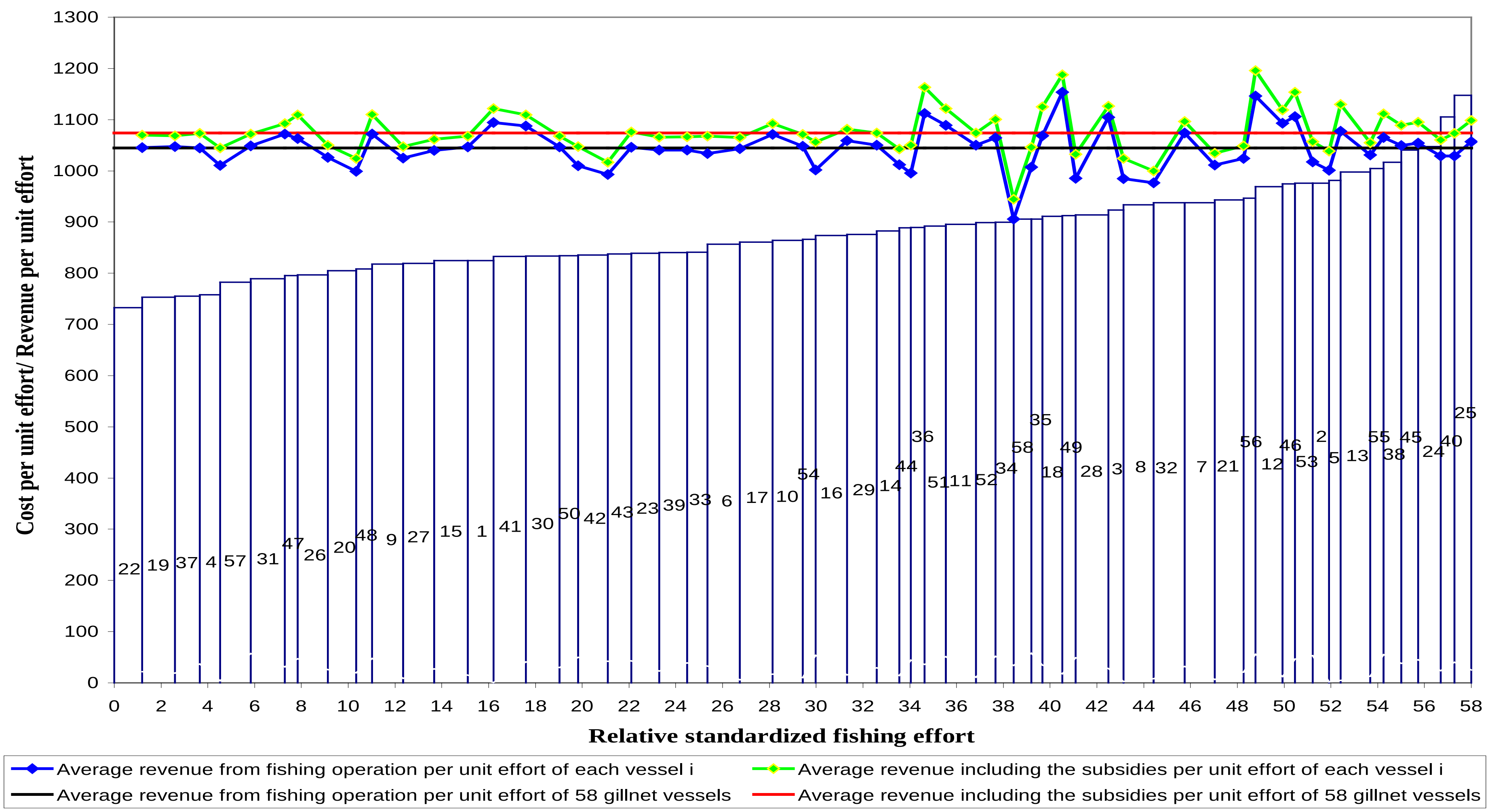


Figure 5.6: The cost efficiency of relative standardized effort in the short run and average revenue per unit of relative standardized effort among the 58 gillnet vessels. Unit: million VND per vessel per year. Source: own data and calculations.

The average all avc_i of the 58 surveyed gillnet vessels was about 889.8 million VND. The vessel number 36 had relative standardized effort of 0.58, but avc_{36} was 889.4 million VND, approximately 889.8 million VND (the average level of all avc_i). 23 vessels out of 30 vessels with relative standardized effort of more than one had their avc_i less than that of vessel number 36, whereas 19 vessels of 28 with relative standardized effort of less than one had their avc_i more than that of vessel 36 as well as more than the average of all avc_i.

In general, Figure 5.6 illustrates that the majority of the most cost efficient vessels in the short run were those with large relative standardized fishing efforts (above one) (indicated by the large width of the bars), while there were many vessels with smaller relative standardized fishing efforts (below one) belonging with the group of the lower cost efficient vessels. However, some vessels such as numbers 4, 47, 48 and 50 with small relative standardized effort were operated with high cost efficiency, whereas some vessels like numbers 11, 28, 8, 32, 7, 21, 12 and 13 with high relative standardized efforts belonged to the group of low cost efficient vessels.

Figure 5.6 also represents the average revenue per unit of relative standardized effort of each of the individual 58 vessels including the 2008 fuel subsidies, $\boldsymbol{ar_w e_i}$, versus $\boldsymbol{ar\_e_i}$ which excludes the subsidies. The gross revenue variance analysis of the 58 surveyed gillnet vessels is already presented in the previous part 5.5. However, as can be seen in Figure 5.6, average revenue per unit of relative standardized effort of each vessel might fluctuate horizontally around a horizontal line, of which vessels 34, 18 and 56 had remarkable differences in their $\boldsymbol{ar\_e_i}$ in comparison with others.

Test hypothesis 2

In order to test the hypothesis that the average revenue per unit of the vessel relative standardized effort as a function of relative standardized fishing effort is a horizontal line with slopping coefficient of zero (see hypothesis 2 in chapter 3, p.41), a simple linear regression model is estimated of which the dependent variable is the average revenue per unit of relative standardized effort of each vessel, $\boldsymbol{ar\_e_i}$, and the corresponding independent variable is the relative standardized effort of each vessel $\boldsymbol{e_i}$. Revenue is gross revenue from fishing operation of each vessel, not including the 2008 fuel subsidies.

Table 5.7: Results of testing hypothesis 2

VARIABLE NAME	ESTIMATED COEFFICIENT	t-value	P-VALUE	WHITE t-value	WHITE P-VALUE
e	1.040	0.060	0.952	0.060	0.952
CONSTANT	1043.400	57.538	0.000*	51.060	0.000*

Dependent Variable: ar_e;

R-square = 0.0001; F - statistic = 0.0040; DW-statistic = 2.0023

** Statistically significant at the level of 1%*

Source: own data and calculations.

In this test method, in order to make the econometric model complete, assumptions of the simple linear regression model should firstly be held. Outcomes of OLS estimation show that autocorrelation is not a problem (see appendix H). However, heteroskedasticity can still be a potential problem in cross-section data. Since the existence of heteroskedasticity, the OLS estimator is still a linear and unbiased estimator, but it is not efficient (no longer best). This leads to standard errors usually calculated for the least squares estimator are incorrect. Thus, confident intervals and hypothesis tests that use these standard errors may be misleading (Hill et al., 2008, p. 201). The result of testing this hypothesis can be also concluded incorrectly. White's procedure for correcting for heteroskedasticity is therefore applied and results of White's heteroskedasticity consistent t-values are also reported in Table 5.7.

Table 5.7's results show the dependent variable's proportion of variation is unexplained by variation in the explanatory variable due to the coefficient of determination R^2 of 0.0001. Both F – test and t – test show that we do not reject the null hypothesis that the explanatory variable coefficient is zero. Therefore, the estimated relationship is insignificant. In other words, the sample data for dependent variable and independent variable are uncorrelated showing no linear association, resulting in the least squares fitted line being "horizontal". This is compatible with the constant coefficient having statistically significance of 1%.

For this simple linear regression model, the RESET-test is also reported to detect omitted variables and whether the simple linear functional form is correct. RESET-test results show that the simple linear model is adequate and well specified (see appendix H).

From the test results above, it can be concluded that there is no statistically significant relationship between $\boldsymbol{ar\_e_i}$, and $\boldsymbol{e_i}$. This is compatible with the hypothesis that the average revenue per unit of vessel relative standardized effort as a function of relative standardized fishing effort is a horizontal line with slopping coefficient of zero.

Test hypothesis 3

The next is to test the hypothesis that the average revenue per unit of the vessel relative standardized effort equals the average revenue of the fishery (see hypothesis 3 in chapter 3, p.41). The average revenue per unit of relative standardized effort of all 58 gillnet vessels, $AR_{os}(E)$, is considered as the average revenue of the fishery in this study. $AR_{os}(E)$, without the 2008 fuel subsidies, is estimated 1044.6 million VND from the formula (3.16).

The test results in Table 5.8 show that we can not reject the null hypothesis that $AR_{os}(E)$ of 1044.6 million VND equals the mean of the average revenue per unit of relative standardized effort of the vessels (see section 4.2 in chapter 4 for the same testing way). In other words, the average revenue per unit of relative standardized effort of each vessel (ar_e_i) varied around and closely with the horizontal line of 1044.6 (unit of million VND).

Table 5.8: Results of testing hypothesis 3

	Test Value = 1044.6					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
ar_e	-.026	57	.979	-.1445	-11.1361	10.8471

Source: own data and calculations.

As expected, both hypothesis 2's and 3's test results leave us unable to reject the null. This means that parameters of each gillnet vessel (including engine power, the number of pieces of gill net and the number of days fished in the year) may be a good choice of measuring vessel's standardized fishing effort. These results also show that analyses of vessels' economic efficiency of the vessels in this section are significant.

Figure 5.6 shows the lower horizontal line is the average revenue per unit of relative standardized effort of all 58 gillnet vessels for the case of excluding the 2008 subsidies ($AR_{os}(E)$ = 1044.6 million VND). The horizontal line at 1044.6 can be considered as the theoretical average revenue per unit of relative standardized effort of individual vessels, and also as the average revenue per unit of relative standardized effort of a fishery assumed with the 58 gillnet vessels. It can be easily seen that the most cost efficient vessels earned the highest gross cash flows since the costs only comprised of the variable, fixed and labor costs. There would have been three vessels (vessel numbers 24, 40 and 25) operating at a loss. Since $AR_{os}(E)$ of 1044.6 million VND is more than the mean of all avc_i of all 58 surveyed gillnet vessels (889.8 million VND), the annual gross cash flow of the vessels was positive on average.

The higher horizontal line in Figure 5.6 is the average revenue per unit of relative standardized effort of all 58 gillnet vessels, including the 2008 fuel subsidies ($AR_{ws}(E)$ = 1073.7 million VND, including the subsidies with a mean of 29.2 for 58 gillnet vessels). This means that the annual gross cash flow of each vessel increased 29.2 million VND. Futhermore, there were only two losing vessels: number 40 and 25.

Economic efficiency of the vessel in long run

Economic efficiency of the vessel in long run for the case of excluding the opportunity cost of owner's capital

Figure 5.7 presents each vessel's individual efficiency in the long-run in the case of excluding the opportunity cost of the owner's capital. The height of the bars on Figure 5.7 measures the average total cost (except the calculated interest on owner's capital) per unit of relative standardized effort of each vessel *i*, $\boldsymbol{atc_i}$. All $\boldsymbol{atc_i}$ are also sorted in order from the most (left) to least (right) efficient vessel.

There were a few differences in the cost efficiency of the gillnet vessels between the short and long run (except the calculated interest on owner's capital). The vessel numbers 22 and 25 were still the most and the least cost efficient vessels, respectively (atc_{22} = 871.6 million VND and atc_{25} = 1280.2 million VND).

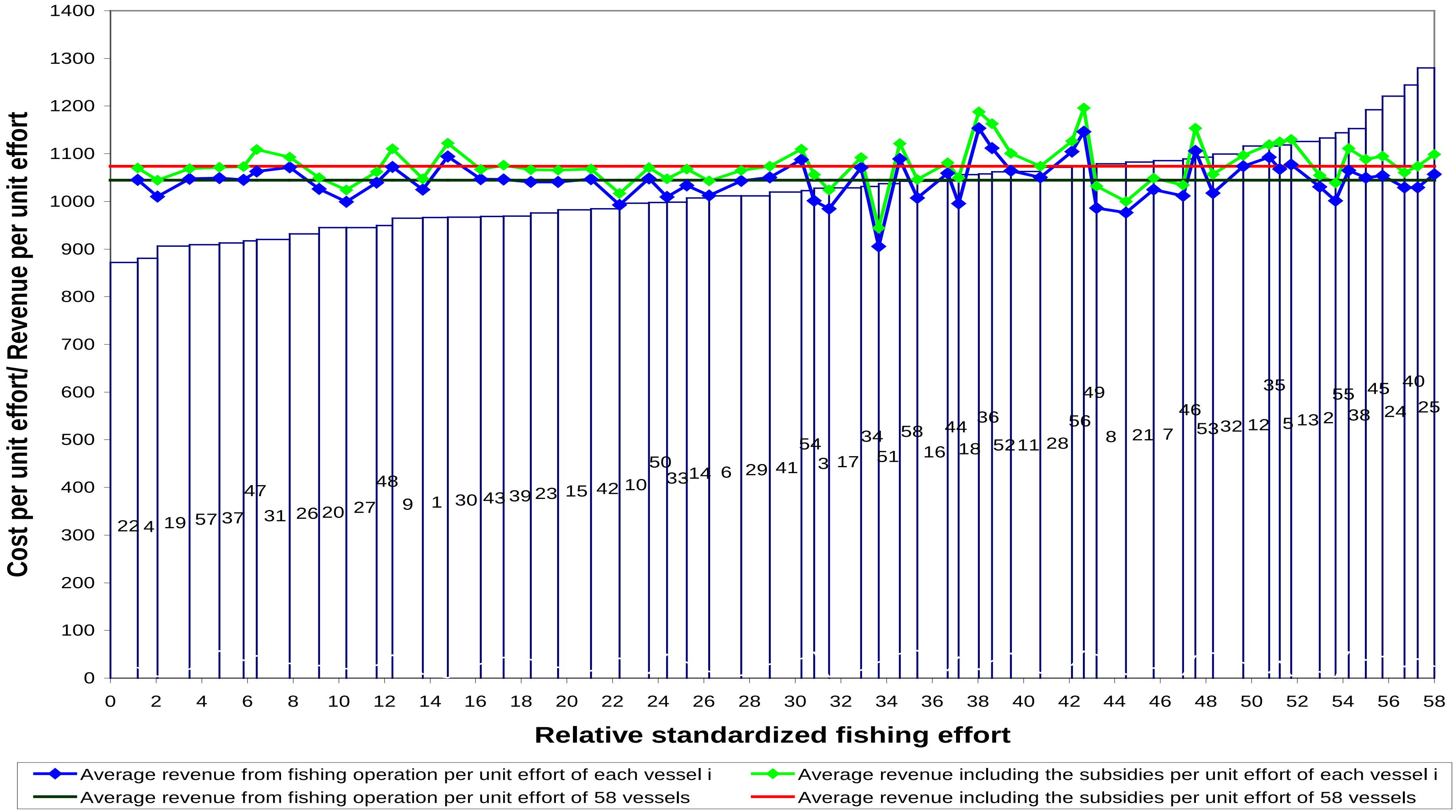


Figure 5.7: The cost efficiency of relative standardized effort in the long run, excluding opportunity cost of owner's capital, and average revenue per unit of relative standardized effort among the 58 gillnet vessels. Unit: million VND per vessel per year. Source: own data and calculations

Also shown in Figures 5.7, the majority of the vessels with high relative standardized efforts (more than one) belonged to the most cost efficient vessel group, whereas a high percentage of the vessels with low relative standardized efforts (less than one) comprised the medium or least cost efficient vessels. In 33 vessels which their atc_i were less than $AR_{os}(E)$ of 1044.6 million VND (see Figure 5.7), there were 22 vessels with a relative standardized effort above one. Of those 22, 15 vessels had a relative standardized effort of more than 1.20, and 11 vessels had a relative standardized effort of less than one (see Figure 5.8). A contrast picture is described in Figure 5.9 for the least cost efficient vessels with an atc_i more than $AR_{os}(E)$ of 1044.6 million VND.

When including the 2008 subsidies, there were 18 vessels with an atc_i of more than $AR_{ws}(E)$ = 1073.7 million VND. Therefore, the number of vessels with their atc_i less than $AR_{ws}(E)$ = 1073.7 million VND increased to 40 vessels, 24 of which 40 had a relative standardized effort above one.

The average all atc_i of 58 vessels was about 1034.8 million VND. This value was more than atc_{34} = 1031.4 million VND of vessel 34, but less than atc_{51} = 1037.3 million VND of vessel 51, and smaller than $AR_{os}(E)$ = 1044.6 million VND. Additionally, there were fewer vessels turning a negative profit at $AR_{ws}(E)$ = 1073.7 million VND when including fuel subsidies compared. Therefore, the majority of the vessels with a relative standardized effort of less than one might have operated at a negative profit unless they received government subsidies.

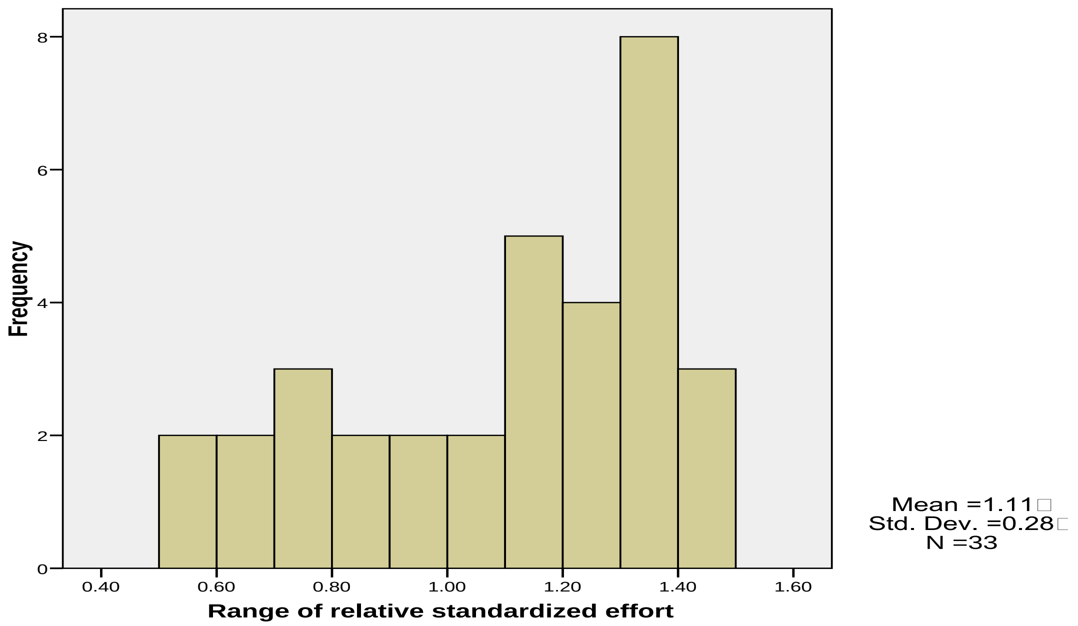


Figure 5.8: Frequency of the 33 most cost efficient vessels in the long run by range of relative standardized effort, excluding opportunity cost of owner's capital. Source: own data and calculations.

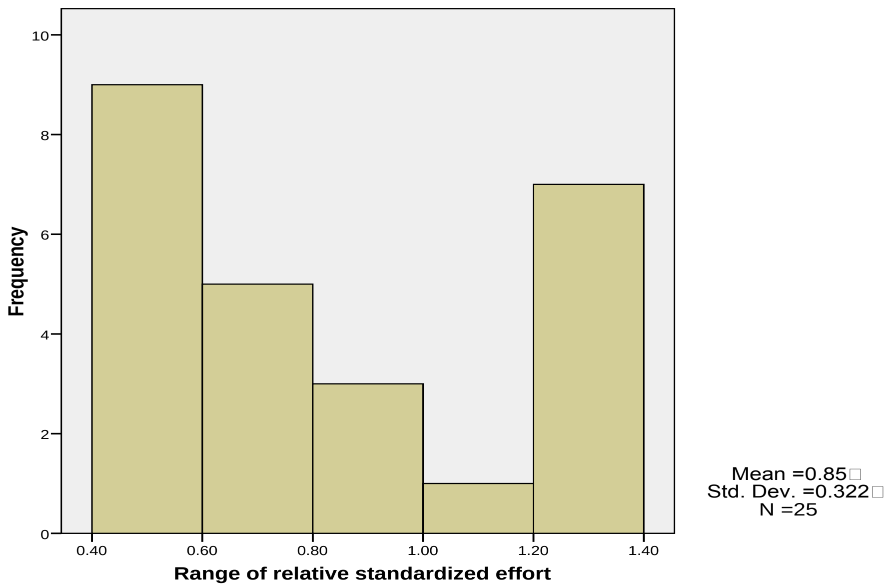


Figure 5.9: Frequency of the 25 least cost efficient vessels in the long run by range of relative standardized effort, excluding opportunity cost of owner's capital. Source: own data and calculations

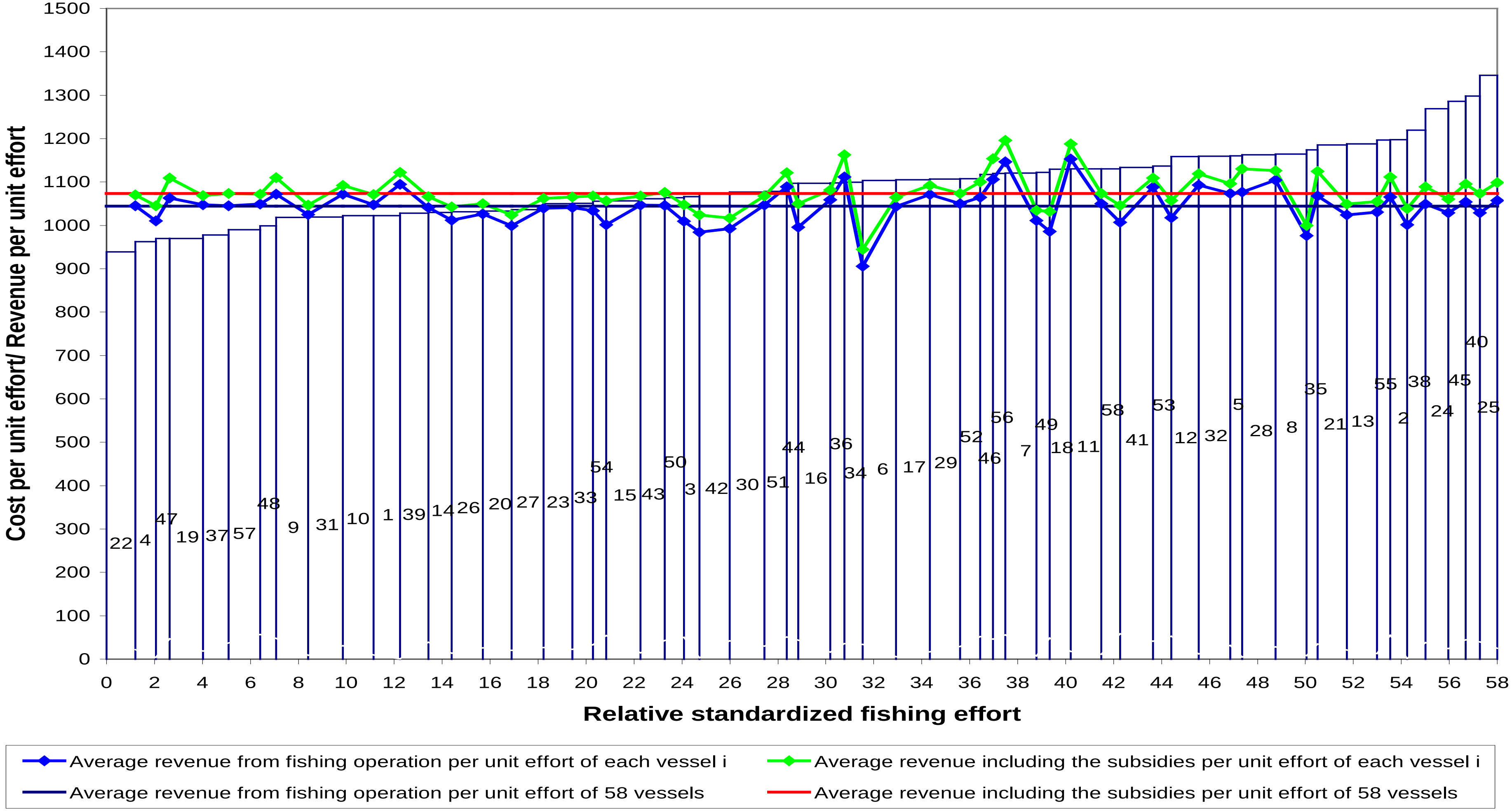


Figure 5.10: The cost efficiency of relative standardized effort in the long run, including the opportunity cost of owner's capital, and average revenue per unit of relative standardized effort among the 58 gillnet vessels. Unit: million VND per vessel per year. Source: own data and calculations

Economic efficiency of the vessel in long run for the case of including the opportunity cost of owner's capital

Figure 5.10 shows vessel cost efficiency including opportunity cost of owner's capital. Generally, compared with Figure 5.7, there is some movement in vessels between the high and medium cost efficiency groups for the vessels with high relative standardized efforts, and the low and the medium cost efficiency groups for the vessels with low relative standardized efforts. However, vessels 25, 40, 45, 24, 38, 2 and 55 remained the least cost efficient while having low relative standardized efforts (less than one). There were only 16 vessels which their ac_i were less than $AR_{os}(E)$ = 1044.6 million VND (see Figure 5.10), of which 12 vessels had relative standardized effort of more than one (accounted for 75% of total 16 vessels) (see Figure 5.11). The number of vessels which their ac_i were lower than $AR_{ws}(E)$ increased to 23, of those 23 vessels, 15 had a relative standardized effort of above one. Nevertheless, each vessel of out the 58 gillnet, on average, did not cover its whole costs either through fishing operation gross revenue or through gross revenue including the subsidies.

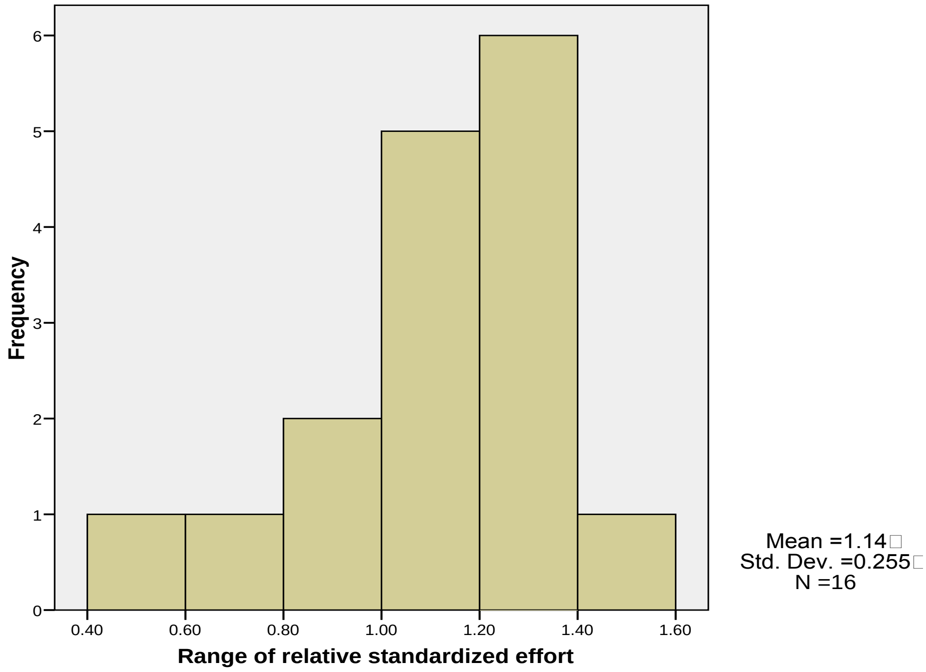


Figure 5.11: Frequency of the 16 most cost efficient vessels in the long run by range of relative standardized effort, including opportunity cost of owner's capital. Source: own data and calculations.

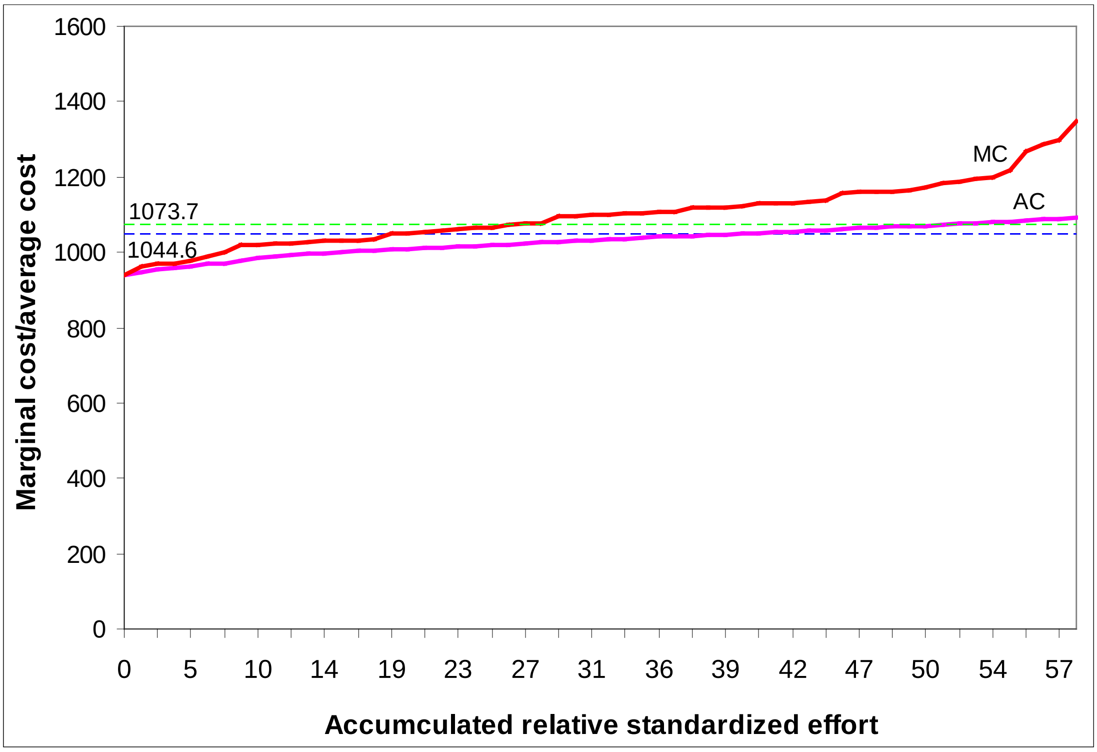


Figure 5.12: Marginal cost (MC) and average cost (AC) of relative standardized effort curves for a fishery assumed with the 58 gillnet vessels. Source: own data and calculations

Figure 5.12 presents an illustration of the gillnet fishery assumed with the 58 vessels, which is extrapolated from vessel economic efficient analysis in long run including the opportunity cost of owner's capital, given only 2008 data. The marginal cost of relative standardized effort curve, MC, for the fishery with the 58 vessels is inferred from substitution by a curve enveloping the bars on Figure 5.10. In addition to Figure 5.12 is the average cost of relative standardized effort curve of the fishery, AC, which is plotted basing on the formula (3.20) defined in chapter 3. Two dotted lines show two levels of $AR_{os}(E)$ = 1044.6 million VND (excluding the 2008 fuel subsidies) and $AR_{ws}(E)$ = 1073.7 million VND (including the 2008 fuel subsidies).

Figure 5.12 shows that MC is equal to $AR_{os}(E)$ at the level of total relative standardized efforts of about 19, and equals $AR_{ws}(E)$ at the level of total relative standardized efforts of about 25. However, the 58 vessels were operating at where $AR_{os}(E)$ and $AR_{ws}(E)$ were not only lower than MC, but smaller than AC. This is a problem that will be discussed more in next chapter.

Chapter 6

DISCUSSION

6.1. KEY ECONOMIC PERFORMANCES

The study carried out in 2008, based on a survey of costs and earnings data of a sample of 58 offshore gillnet vessels in Nha Trang, Khanh Hoa province, shows that the 58 vessels, on average, had positive income, gross value added, gross cash flow and profit both including and excluding the 2008 government fuel subsidies. One average, the vessels earned a gross profit margin of 17.3% and a profit margin of 3.8% including the subsidies; excluding the subsidies, these percentages dropped to 14.7% and 0.08%, respectively. This implies that the owner of an average gillnet vessel was not only capable of covering the variable, fixed and labor, depreciation and loan interest payment costs, but also turned a profit for the operating year (not withstanding the opportunity cost of owner's capital) even excluding fuel subsidies. This may somewhat attract additional private investments in the near future.

The results above may highlight the advantages of fisheries under open access conditions versus the offshore gillnet fishery, which is exposed to high risks. The offshore fishery's capital investment and operational expenses are great, while capital rationing is actually limited in an imperfect capital market. Risks of damaging and losing fishing gear, which often represents half of capital invested, are quite large for this fishery due to high density of various types of vessel activities in fishing grounds. Moreover, difficult weather and the remoteness of the fishing grounds cause obstacles for operations. Additionally, the 2008 world economic crisis's effects on economy resulted in high expenses for fishing operations in 2008.

However, there were still two gillnet vessels unable to cover their total of variable, fixed and labor costs despite receiving the 2008 fuel subsidies, resulting in negative gross cash flows (one with 55 HP engine, the other a 90 HP engine). In 2008, these two vessels had high minor fishing gear repair costs compared with other vessels in the group because their number of pieces of gill net damaged and lost was higher relative to others. This may potentially be explained by bad management, an inexperienced skipper and/or poor crew skills. Additionally, these two vessels had built before 1995; the age of the vessel no doubt increased probability and frequency and high costs of repairs for hull, engine and mechanical equipment relative to newer vessels. Nevertheless, they may continue operations in next the few years without contradicting the economic theory of fishing vessel because the loss may be perceived as arising from bad luck or a poor year. If this loss persists in next the few years, these vessel owners will eventually be forced out from the fishery.

Besides, 27.6% of vessels surveyed (16/58 vessels) operated at a loss (profit before the opportunity cost of owner's capital) including the 2008 fuel subsidies. When excluding subsidies, this increases to 40% (23/58 vessels). These vessels may again operate as long as the loss is not expected to persist over a number of years; the loss may be attributed bad luck or a poor year resulting in a low catch. Additionally, for fishermen in Nha Trang, Khanh Hoa, the vessel and fishing gear are considered to be great assets that create opportunities for employment and income for most family members.

When all costs are considered, including the opportunity cost of owner's capital and subsidies, 33/58 vessels (57%) were found to be making economic losses. Excluding subsidies, 42/58 vessels (72%) make economic losses. Thus, the net profit indicator, on average, was negative for both cases. This implies that, from society's perspective, higher returns could have been earned if owner's capital would been invested in the next best alternative activity.

The analysis demonstrates that in 2008, the average larger engine vessels had better annual economic performance indicators (including income, gross value added, gross cash flow and profit) than smaller engine vessels. Overall, vessels with engines 400 HP and greater had the best economic performance. Some explanations for these include:

Firstly, vessels with engines of larger than 250 HP, especially those 400 HP and above, often earned larger annual gross revenues than those with smaller engines. Large engines can afford go to further into deep sea fishing grounds where fish stocks are abundant. These fishing grounds were allocated in the South of Vietnam, where it borders Malaysian and Indonesian waters, as well as the Gulf of Thailand. Because of the large vessel size, these vessels could carry more gill nets. They might also have utilized much time for fishing since the number of days fished, including the time for moving, was greatest in 2008. Moreover, middle-buyers were often available in the fishing grounds, the fishing vessels can thus spend more time fishing instead of transporting their catch to landing for sale. As a result, the larger engine vessels catch a greater fish volume, therefore achieving a larger amount of gross revenue.

By contrast, the vessels with engine smaller than 250 HP were restricted to fishing grounds of offshore waters from Khanh Hoa to Ba Ria – Vung Tau provinces, where a large number of vessels were operating. Hence, these vessels not only caught a lower fishing quantity compared to the larger engine vessels, but also incurred greater repair and replacement costs for fixing and mending nets since risks of damaging and losing fishing gear were high.

Secondly, the large engine vessels spent higher absolute amounts of the operational expenses than small engine vessels because large engine vessels operated for more days, with greater number of gill nets and crew members, and higher fuel consumption. Additionally, larger engine vessels incur high depreciation and interest payment on loans due to relatively larger investments. Furthermore, the majority of the large engine vessels are new with more modern equipment. 10/11 vessels with engine 400HP and larger were the newest boats surveyed, between 2 to 5 years of old. Thus, these vessels may be considered as the higher cost efficient than other vessel groups.

Thirdly, as obtained information from interviewing, the fishing grounds from Khanh Hoa to Ba Ria – Vung Tau often face with more difficult conditions of weather than areas of the extreme South of Vietnam. In these fishing grounds, the capture is often exposed to bad weather conditions from September to January of the following year. Therefore, large engine vessels had flexibility insofar as being able to re-route from Khanh Hoa – Ba Ria Vung Tau region for the more abundant fish stocks of the extreme South of Vietnam. Smaller engine vessels were restricted to the overexploited or offshore fishing grounds from Khanh Hoa to Ba Ria – Vung Tau waters.

By comparison, the average gross cash flow and profit (including the 2008 fuel subsidies) of the 58 vessels are lower than those of Nha Trang 50 vessels that carried out in 2005 costs and earnings survey in Kim Anh et al. (2006). Although the 2008 annual gross revenue of the 58 vessels, on average, is about 23% higher than that of the 2005 study of Kim Anh et al. (2006), cost growth outpaced the increasing rate of gross revenue. There are two key reasons for this:

Firstly, striped tuna prices (*Sarda orientalis*), considered as a major target specie of Nha Trang gillnet fleet, increased to between 13 to 15 thousand VND per kg in 2008, from 8.5 to 9.5 thousand VND per kg in 2005 (Kim Anh et al., 2006). This means striped tuna prices increased about 55.5% between 2005 and 2008. However, as can be obtained from survey, all respondents admitted that their catch decreased about 20-50% compared with previous years.

Most of them were aware of depletion of the fish stocks due to increased fishing activities over time.

Secondly, inputs prices increased to high levels in 2008. From interviewing, fishers bought fuel at average levels between 11.5 to 12.5 thousand VND per liter, higher than the fuel price of 7.5 thousand VND per liter in 2005 (Decision 58/2005/QD-BTC) – corresponding increasing rates from 53.3 - 66.7% between 2008 and 2005. Prices of food and foodstuff increased nearly 1.65 times between these periods of time (GSO, 2009, p.165). The labor cost for mending nets was 70-80 thousand VND/labor/day in 2008, instead of 40-50 thousand VND/labor/day in 2005. These increases may be caused by Vietnam’s recent consumer price inflation, stemming perhaps in part some effects of the world economic crisis. Therefore, the operational costs of the 58 gillnet vessels remained at high.

6.2. FISHERMAN INCOME

For remuneration, the average annual crew member’s share was about 17.1 million VND. This figure was about 74.5% more than the 2008 average income per capita in Khanh Hoa province (9.8 million VND per capita per year of 2008 (GSO of Khanh Hoa, 2008)), and 43.2% higher than the 2008 national average income per capita (monthly average income per capita at current prices of 2008 was 995 thousand VND for whole country – corresponding to 11.94 million VND per capita per year of 2008 (GSO, 2009, p.214)). For the average vessel operating 10.31 months per year, the average crew share per month during the fishing season was more than 2 times and 1.65 times of the monthly average income per capita of Khanh Hoa province and national scale, respectively. This demonstrates that crew members may be earned an opportunity cost of labor or above in the fishing season of 2008.

For the vessels surveyed, the average annual income per fisherman increased with engine sizes. The two groups of larger than 400 HP and 250-400HP paid highest annual incomes for crew members. This may not be unexpected since these large engine vessels spent a greater amount of time for fishing than small engine vessels. From a societal perspective, fishing activities that provide lower income levels might not be preferable to those that provide larger incomes, given other things constant. For Nha Trang’s 58 offshore gillnet vessels, the owner-operators and the owner’s family-crew members received their explicit crew- share. Thus, the owner-operator derived income from both the crew-share as a crew member, and the profit (residual profit) as the vessel owner. Since the average annual profit indicator and crew income increased with engine sizes, there may be incentives for owner-operators to adopt technologies in order to provide them with the highest income.

Annual crew remuneration of the 58 gillnet vessels in 2008 was larger than that of the 50 gillnet vessels in Kim Anh et al. (2006). If the 2005 average income per fisherman is revalued at 2008 prices via either average consumer price indices or the annual increasing rate of income per capita (this rate is estimated by the author on the basic of information from GSO, 2009), the 2008 average income per fisherman was lower than that the 2005 average crew income valued at 2008 prices. This may imply that the purchase power of the 2008 crew income was less than that of the 2005 crew income, and perhaps the average income per fisherman in 2008 may be undervalued in comparison with that in 2005.

Traditionally, there are three main ways of sharing income for crew members at Nha Trang gillnet fishery. The first method gives whole crew 35% of revenue less variable costs. Of the surveyed vessels, 40 use this method, the majority of which are small engine vessels (less than 250 HP). The second method calculates wages basis of 50% of revenue less both variable costs and withholding 10% of revenue. This 10% is expensed for annual vessel repair and maintenance. 13 vessels surveyed use this method, of which most have large engine capacity. The final method distributes 60% of income to the owners and 40% to whole crew. However, as obtained by investigating, a majority of the 58 vessel owners distribute to crew members at a rate higher than their traditional sharing rate.

Most vessel owners noted it was difficult to encourage crew members jointing in the fishing activity with them during the fishing season since there was the large number of vessels with different fishing activities. Fishing crews often bargained the income sharing rate obtained and compared the other vessel’s crew income. Therefore, vessel owners often had to either accept the high sharing rate of income or grant a reward adding to crew members. Two small engine vessel groups almost met with this difficult situation. Consequently, labor costs accounted for a high amount in gross revenue in 2008 compared with previous years.

6.3. THE STANDARDIZED FISHING EFFORT OF THE VESSEL

In order to measure vessels’ relative economic efficiency, the study estimates vessels’ standardized fishing effort through the production function approach. Engine power, fishing gear and fishing days are factors best reflecting vessel effort standardization. As an expected result, the rate of contributions in the capital input of fishing gear is more than that in the capital input of engine power. This result is somewhat reasonable with results from interviewing. All respondents admitted, for gillnet fishery, that investment for fishing gear is the most important for an increase of fishing quantities. Griffin et al. (1973) also found this in relationship between the horsepower and the sum of the length of the footrope measured in yards in the case of the Gulf of Mexico shrimp fishery.

The effect of the nominal fishing effort (fishing time) on the effective fishing effort is to some extent valid for this study since Padilla and Trinidad (1995) found coefficients estimated of a composite input between number of crew and the length of the fishing time fluctuating from 0.417 to 0.549 for the encircling gill net and Danish seine vessels in Philippine in the same manner of the function form. Another explanation may be that the number of fishing days may be restricted by other technical parameters of the fishing vessel.

Regardless of the fishing time variable, the two physical factors exhibited the diminishing return to scale in a vessel's fishing effort. This implies that any increase in total these two inputs would have resulted in a smaller increase in the vessel fishing effort.

The vessels' relative standardized effort indicators have a quite wide range from 0.46 to 1.45. Results show that the 58 vessels were different in relative fishing power, implying they were heterogeneous in the effort and cost structure. Therefore, they differed in efficiency of relative standardized effort.

6.4. ECONOMIC EFFICIENCY AND INTRA-MARGINAL RENT OF THE VESSEL

The 58 gillnet vessels' cost efficiency of relative standardized effort had few differences between the short and long-term. A large number of vessels with high relative standardized effort (more than one) were the most cost efficiency in both perspectives.

For short run perspective

In 2008, most vessels with relative standardized effort of more than one earned large gross cash flows compared low relative standardized effort vessels (less than one). In other words, the large numbers of intra-marginal rents in the short run were generated by mostly vessels with high relative standardized effort (above one). There were only two vessels earning extra-marginal rents from this perspective, including the subsidies.

For long run perspective excluding the opportunity cost of owner's capital

22 out of the 30 vessels with relative standardized effort above one were in the 33 most cost efficient vessels (their atc_i less than $AR_{os}(E)$). This implies that most intra-marginal rents (excluding subsidies) are generated by vessels with high relative standardized effort (above one). Here, the most cost efficient vessels are viewed from a viewpoint that a vessel's average cost of relative standardized effort is less than the average revenue per unit of relative standardized effort of the fishery assumed with the 58 gillnet vessels.

When including subsidies, 24 of 30 vessels with relative standardized effort above one were among the 40 most cost efficient vessels (their atc_i less than $AR_{ws}(E)$). However, rents were generated by the additional 7 vessels were the results of subsidies rather than technological efficiency in fishing operation.

For long run perspective including the opportunity cost of owner's capital

In total, 15 out of 23 most cost efficient vessels (their ac_i lower than $AR_{ws}(E)$), had a relative standardized effort above one. 12 out of 16 most cost efficient vessels (their ac_i lower than $AR_{os}(E)$), also had relative standardized efforts above one. This also implies that the majority of intra-marginal rents, which is more than zero net profit of the marginal vessel, are generated by vessels with high relative standardized effort (more than one).

The results above indicate that there might still be attractive for additional private effort investments in this fishery in the near future. Either improvement/investment in engine capacity and fishing gear or an additional increase in fishing time may be able to continue expanding. This will result in diminishing catch of individuals as fish stocks are decreasing over time, resulting in potentially forcing currently profitable vessels to become unprofitable. This seems to somewhat reflect the situation of Khanh Hoa's fishery since total engine power of the fishing fleet increased in 2009 (see chapter 2).

Nevertheless, a great number of the most cost inefficient vessels (their ac_i more than $AR_{ws}(E)$) had a low relative standardized effort (under one). Thus, the number of extra-marginal vessels was higher than intra-marginal vessels in the long run, including opportunity cost of owner's capital, resulting in economic losses on average for the 58 vessels.

Additionally, since the average vessel return on owner's capital of 6.1% was less than the opportunity cost of owner's capital, the average gillnet vessel was making economic losses in 2008 including subsidies. This implies that there was also the larger number of vessels earning extra-marginal rents in 2008, whereas the smaller number of vessels was earning intra-marginal rents. However, profits increased with engine sizes, and average returns on owner's capital were highest for the two groups with largest engines. This means that most intra-marginal rents generated come from the vessels with large engine capacity: the majority of the rents generated by the group with 400 HP engines and larger because they earned the highest average return on owner's capital of 9.3% and positive net profit on average, including the subsidies.

The results above may not contradict each other because engine power is one of factors affecting vessel's standardized fishing effort. Vessel cost efficiency analyses provide information on which vessels earned an intra-marginal rent or extra-marginal rent. The majority of vessels with high relative standardized effort belonged to the two groups with greatest horsepower (see appendix G). Thus, a large amount of vessels with low relative standardized effort (under one) and/or small engine power were extra-marginal vessels in the long run, including opportunity cost of owner's capital.

Further, investigation revealed that a large number of large engine vessels or high relative standardized effort vessels were recent entrants (from 2 to 5 years earlier) with new fishing gears and modern equipments. This might have led to pressure on fish stock over time, resulting in reduced catch rates and increasing costs for all remaining vessels in 2008. This problem seems to be a "fisheries treadmill" phenomenon discussed in Whitmarsh (1998), and a consequence of the "tragedy of the common" problem presented in Hardin (1968).

An average gillnet vessel's economic loss may not contradict with the open access fisheries theory with heterogeneous vessels when the results are analyzed with only a single year's data, but may in a multi-year analysis. Moreover, the effects of the world economic crisis on the national economy combined with 2008's peak demand returned in substantial input price index increases. Nevertheless, if vessels' looses in this study persist over many years, they will eventually be forced out from the fishery.

The survey results can also be extrapolated to provide an indication of the fishery (Figure 5.12), given only one year's data. An assumption behind this extrapolation is that the vessels in the sample are representative. However, this study's economic analyses are conducted using sample formula rather than population. Moreover, relationship between marginal cost (MC) and average cost (AC) of the fishery are in long term, which stock levels have varied over time, requiring time serious data. Thus, this model should be viewed with caution, and as indicative only. Nevertheless, this model (Figure 5.12) is probative that this fishery was overcapitalized from an economic perspective, and that the 2008 fuel subsidies may have led to an increase in fishing efforts. This may reflect to some extent the status of Khanh Hoa's fishery, since the number of fishing vessels and total engine power of the fishing fleets in Khanh Hoa province increased a large amount in 2008 and 2009 (see Figure 2.2).

Using Anderson's definition (1989) that resource rent only exist since all vessel are making positive economic profits, there was no resource rents generated; only negative resource rents for a fishery including the 58 gillnet vessels. Therefore, the offshore fishery is still considered as "pure" open access in this country. Moreover, there was also not an intra-marginal rent for the fishery in the long run. This may imply that fisheries management controls have been inefficient. However, this statement is only based on analysis results with 2008 data.

Long run economic performance indicators for the fishing vessels are affected by capital valuation (Le Floc'h et al., 2008). This is subject misinterpretation of what capital costs (depreciation and opportunity cost of owner's capital), profit, and net profit actually mean. In this study, capital costs are calculated assuming that capital invested (fixed capital stock) is re-valued at 2008 prices using the annual consumer price indices on a historical price basis (price of assets acquired in earlier period). Annual asset price indices should be taken into calculations of capital invested for it. However, this information is unavailable; hence the annual consumer price indices are used for all vessel fixed assets. This method of capital valuation was used by Vietnam's IFEP-Institute of Fisheries Economics and Planning (1998) in a summary report namely "*Assessment of the Living Marine Resources in Viet Nam*". Thanh Thuy et al. (2008) also applied this method for the purse seine fishery of Khanh Hoa.

Depreciation[22] is calculated on a straight-line basis over the owner's estimated lifespan of assets, starting from the first year of assets acquired (either new or second-hand assets). Since major repair and maintenance costs are excluded in depreciation but included in the annual fixed cost, lower depreciation offsets the higher annual fixed cost. Depreciation is described in details for hull, engine, fishing gear and other equipments (see section 4.5 in chapter 4).

There are alternative methods for capital valuation and depreciation. Book value (or historical value) can be used as the starting point of evaluating fishing capital. However, net worth (results from the difference between book value and accumulated depreciation) that can be seen on a balance sheet did not correspond with economic value (when selling on the second hand market) because Vietnamese accounting standards, for example, allow lifespan of 7 –

[22] With the vessels surveyed, the rates are from 4 to 6.7% for hull, 5 – 14.3% for engine, 10 – 14.3% for fishing gear, the average of 21% for mechanical equipment, 11% for electronic devices, and 20% for storage facilities (source: own data)

15 years for hull, 8 – 10 years for engine (Decision 206/2003/QD-BTC). Therefore, some fishing assets were fully depreciated from an accounting stand point of view while still in use. In practice, the survey of the fishermen indicated an average lifespan of 24 years for hull, 17 years for engine. As a result, vessel economic depreciation should not be based on pure financial consideration with the low lifespan for the vessel assets.

The market value or replacement value, which equals to the current building costs of a similar new one, may give a high depreciation costs and a high calculated interest on owner’s capital for the vessel surveyed. This would lead to a lower profit and net profit compared to the method applied in this study. Also, current building costs of a new vessel are much greater than the vessel fixed capital re-valued at 2008 prices because construction material and equipment prices increased dramatically as a consequence of both the world economic crisis and the government’s policies involved in forest conservation.

The survey could not have the calculated capital value based on acquisition value (called the estimated current value by the owner at the year of survey, 2008). The vessel’s acquisition value could be a reasonable method of reflecting a vessel’s capital value since it includes improvements and new equipment purchases post vessel construction. This may also be the reason why most vessel owners answered that their vessel’s lifespan is more than 30 years, inversely a shorter lifetime. However, in order to get this information, more much money and time would be spent while these conditions were limited. Moreover, the majority of respondents lacks abilities estimating accurately their acquisition value of the vessel with many fixed asset items at the time of 2008.

The capital valuation method used in this study is not markedly different from the acquisition value method in Kim Anh et al. (2006)’s research on gillnet vessels in Nha Trang in 2005. The average consumer price index between 2005 and 2008 is adduced for comparison purspose. The average investment capital and depreciation of a vessel in 2008 are 48% and 20% more than those in 2005, respectively, while the average consumer price index is 43.4% between these two periods (estimated by the author basing on IMF’s data, 2009). Nevertheless, the long run economic performance indicators in this study are still viewed on the basis of the assumption that the investment capital re-valued at prices of 2008 through annual average consumer price indices, and that straight-linear depreciation plan is applied. In the future, research on capital valuation methods should be performed in accordance with characteristics of Nha Trang fishery and Vietnam fishery as well.

6.5. THE EFFECT OF THE SUBSIDIES ON PROFITABILITY OF THE VESSEL

When all 58 vessels received the 2008 subsidies, annual economic performance indicators (including income, gross value added, gross cash flow, profit and net profit) of individual vessels increased adding an amount equaling the subsidy that they received in 2008. Gross cash flow and profit of an average gillnet vessel increased about 17.5% and 36%, respectively.

Thanks to the 2008 subsidies, there were only 2 vessels failed to cover their total variable, fixed and labor costs. Without the subsidies, there are three cases in total. The number of the vessels failed to cover all costs (excluding the opportunity cost of owner's capital) reduced from 23 to 16 vessels – corresponding to a decrease of 30%. With the 2008 fuel cost support, two vessel groups of 50-90HP and 90-250HP were able to cover their depreciation and loan interest payment to earn a positive profit, inversely a negative profit. When all costs are considered, 33 vessels suffered economic losses, instead of 42 vessels in the non-subsidies case – cutting down 21.4%. In four engine groups, only the vessels with engine capacity above 400 HP, on average, could cover the opportunity costs of owner's capital when receiving the 2008 subsidies.

From cost efficiency analysis in the long run exclusive of the opportunity cost, among 58 vessels, those with their atc_i below average revenue of the fishery assuming with 58 vessels increased to 21.2% (from 33 vessels in the non-subsidies to 40 vessels in the subsidies). More than 70% of the additional 7 vessels had relative standardized efforts below one.

Therefore, small-scale vessels may have received the most significant benefits from the 2008 fuel cost support program. These small-scale vessels are defined in this study based on either low engine capacity or low relative standardized effort (below one).

Obviously, the direct fuel cost subsidy had a good impact on profitability of the vessels in the 2008 fishing season. However, this subsidy is considered as a bad subsidy as it triggers potential impacts on growth of fishing effort, leading to fishing overcapacity and therefore putting fish stocks at threat of rapid depletion (Sumaila et al., 2007). This problem will not ensure for a sustainable income of fishermen in the long run. Thus, a question for Vietnamese policy-makers is whether it is necessary to maintain direct subsidies.

In order to ensure the sustainable and efficient offshore fishery and to enhance fisher's income, some recommendations should be addressed. *Firstly*, instead of implementing bad subsidies, good subsidies such as fisheries management, monitoring and enforcement programs should be implemented in order to enhance the growth of fish stocks. Supports such as forecasting weather, training fishermen, providing information of fish stock and rescue and life-saving activities in sea may also be good subsidies that do not expand fishing effort and capacity. *Secondly*, potential entrants who would like to enter the gillnet fishery should be limited for a registration. This is expected that fishing overcapacity will not be more serious. *Thirdly*, gillnet vessels that were the least cost efficient making economic losses or even negative profits in persistence of many years should be removed out fishing activities. These vessels may belong with vessels with engine power below 250HP or low relative standardized effort (below one). In practice, no little vessels have still operated over time since their gross cash flow uncovered depreciation costs. Additionally, the government should plan to make vocational guidance or training for them as well as their family members to ensure a stable income and life. *Fourthly*, engine capacity, fishing gear and fishing time may be major factors creating fishing efforts of the gillnet fishery. Regulations for fisheries management should be also considered basing on these inputs. *Finally*, fisheries managers should concern about average performance of all vessels and engine size class. The average values may reflect the likely incentives for potentially new entrants to the fishery as well as efficiency of management controls. Besides, analysis of economic efficiency between the vessels may give good information for managers in planning the development of an economically sustainable offshore fleet.

Chapter 7

SUMMARY AND CONCLUSION

The marine fishing fisheries in Vietnam in general and in Nha Trang-Khanh Hoa in particular are small scale, multi-species, multi-gear and open access. However, the sector is under the overcapacity pressure. Marine fisheries production and fishing fleet have continuously increased over time, resulting in overexploitation in the coastal areas. In response, the offshore fishing fleets have expanded rapidly, but gone far beyond the control. The questions emerged are whether the offshore fisheries development program is efficient and whether the offshore fleet performs profitably or not.

The purpose in this study is to present the results of a cost and earnings survey carried out in Nha Trang city of Khanh Hoa province. These results were used to assess the vessels' economic performance, to determine economic efficiency of individual vessel, and to find out which vessel group gets intra-marginal rents. The impact of the 2008 subsidies on vessels' profitability was also assessed. In addition to these objectives, the methods of measuring vessels' standardized fishing effort were discussed.

The study reviewed literature on fisheries economic performance in the world as well as in Vietnam, and defined concepts of costs and earnings used for this study. Theories of open access fishery and fishing vessel economics were presented briefly, and the production function application for fishing effort standardization was also mentioned.

A sample of the 58 offshore gillnet vessels was chosen for survey. Descriptive statistics showed that the vessels were quite heterogeneous because they were quite different in some technical and operational characteristics, capital structure and cost structure.

The econometric result showed that horsepower, fishing gear and fishing days affected significantly on the vessel fishing effort. The testing results indicated that the combination of these parameters was reasonable for measuring vessels' standardized fishing effort. The relative fishing power indices were different between the vessels. Vessels equipped with high engine power, number of pieces of gill nets, and large number of fishing days would have large relative standardized effort. Even though this does not come as a surprise, it is useful for the economic analysis to calculate the fishing power of each vessel and to compare them. The results proved that vessels were heterogeneous in the fishing effort.

From results of economic analyses noted that a gillnet vessel covered its variable, fixed and labor costs as well as depreciation and loan interest, and earned a gross profit margin of 17.3% and a profit margin of 3.8%, including the 2008 subsidies, but made an economic loss of 18.4 million VND. The average crew income was 17.1 million VND per year – corresponding to 74.5% higher than the 2008 average income per capita in Khanh Hoa province. However, the level of economic performance varied significantly between across engine groups. The vessel group with engine power 400HP and above had best economic performances.

Including subsidies, most operators covered their variable, fixed and labor costs. Only two vessels were not able to cover their costs. About 27.6% vessels could not cover their depreciation and loan interest payment. When all costs are considered, 57% of the vessels suffered negative economic profits. Low catch, high operational expenses and large capital investment were important reasons for this.

The majority of vessels with high relative standardized effort (above one) were the most cost efficient vessels. In the short run, these vessels were able to earn more intra-marginal rents than others. In the long run, two-thirds of the 33 most cost efficient vessels had relative standardized effort of more than one. When all costs are included, the vessels with relative standardized effort above one accounted for three-quarters of the 16 most cost efficient vessels. The vessels with high relative standardized effort (above one) occupied a large amount of intra-marginal vessels in the long run.

The number of intra-marginal vessels was smaller than extra-marginal vessels, and an average return on owner's capital of 6.1% was less than the expected return of 9%, resulting in an economic loss in average. However, the average profit was positive, and the large amount of intra-marginal rents was generated by the vessels with high relative standardized effort. Under open access condition, this may still attract additional private investments in fishing power/capacity in the fishery.

The government 2008 fuel cost support had a good impact on vessels' economic performance and efficiency. The average gross cash flow and profit increased about 17.5% and 36%, respectively. The number of vessels with negative profit reduced 30%. The number of the vessels uncovered all costs decreased 21.4%. This subsidy program was to bring more benefits for the vessels with small engine power or low relative standardized effort. However, this direct subsidy may cause the growth of fishing effort and fishing overcapacity, resulting in rapid fish stock depletion in the future.

From the management perspective, the assessment of vessels' economic performance and efficiency may be a key element in understanding economic status of the fishery. Further, it may help to understand economic incentives existing in the fishery.

Limitation and future research suggestions

It is difficult to conclude whether a sample surveyed is representative or not. This is because population data is not often available and in update in developing countries, as in the case of Vietnam. Improving the national database and capacity of statistics organizations in the future should become a priority. A manageable solution may increase the sample size in future research. Another alternative is to stratify by class of characteristics which their available information from population data is reliable. Then, each stratified sample of vessels is selected for interview with condition that it is representative for population subset of each stratum. Pascoe, Robinson and Coglan (1996) applied this method for the English Channel fleet.

As mentioned, heteroskedasticity often encounter when using cross-sectional data in a regression model. The outcome of White's procedure for correcting for heterokedasticity showed that values of t-test of all coefficients estimated are not significantly different. Thus, tests for heterodekasticity were not performed in this study. However, future researches should have tests for heterodekasticity, and have formal treatments such as application of the generalized least squares (GLS) estimator.

In addition, since the objectives of this study are to focus on vessels' economic performance and efficiency, it did not cover in detail different effects of explanatory variables on vessels' standardized fishing effort. Future researches should specify these effects, and measure marginal productivity as well as marginal rate of substitution of physical inputs in the production of fishing effort in this fishery. Moreover, quality and age of the physical inputs were not mentioned in the fishing effort model. In fact, these characteristics may affect on vessel's effort. Thus, they were considered as constant for all vessels. The future works address this concern using various scenarios.

There are alternative methods for constructing vessel's economic efficiency. They can be DEA (Data Envelopment Analysis) and SPF (Stochastic Production Frontier) methods. The future study should examine these for a comparison.

Capital valuation is vital for measuring long run economic performance. The performance indicators should be viewed with caution when taking the assumptions into consideration. Additionally, opportunity cost equaling zero is determined for fixed assets depreciated fully in this study while still in use. However, in fact these assets could have a positive opportunity cost. These assets were owned by a few vessels. This may only cause a slight variation in the opportunity cost of owner's capital. Future research should be performed to choose the most reasonable method of capital valuation that best reflects characteristics of the local gillnet fishery.

With only one year's data, the overall economic performance of the gillnet fleet is difficult to determine. Moreover, an ambition of establishing the open access bioeconomic model for the fishery is hard to become a reality with this single year sample data. Future work therefore requires collecting cross-sectional and time-series data.

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APPENDICES

APPENDIX A: Questionnaire

ANNUAL SURVEY ON OFFSHORE GILLNET VESSELS
IN NHA TRANG CITY, VIETNAM

I. General information:

1. Data of the year: ……................Period of data from month…………to month........................
2. Time of survey: Date............month...........year......... ....
3. Name of interviewer:………...
4. Address...
....
5. Phone number of interviewer…………………………………………………….....................
6. Main fishery ………………… ………… Other……………………………...........................
7. Level of subsidy received from the government in year: ....

II. Information of vessel and owner

1. Name of Vessel Owner..Age:..
   Vessel owner is skipper or not? Yes ☐ No ☐
2. Address ………………………………………………………. ……………………………...
   Phone number: ……………………………………………………………………………….
3. Registered Number of vessel...
4. Hull length (m):…………………………………………………………………………
5. Engine (HP):……………………………………………………………………………
6.a. Year of construction (with new building vessel)……………………………………………
6.b. or Year of purchase (with second hand vessel)……………………………………………
   Do you know about your vessel-building year?…..

III. Information about labour

Skipper	Crew (including skipper)
1. Skipper information a. Does skipper have license? Yes ☐ No ☐ b. Skipper educational level................................ c. Skipper age:.. d. Skipper experience.. e. Skipper vocational training time..................... f. Does skipper come from traditional fishing household? Yes ☐ No ☐	2.Average annual crew size (persons):…….. ……………………………………………… 3. Income/person (1000 VND) a. Average income/trip in main season:............. b. Average income/trip in other season:...........

IV. Information about season, operating time, fishing ground and weather

Items	Main season	Other season
1. Season time (from month to month)		
2. Number of trips in year		
3. Average duration per trip (days)		
4. Number of operating months in year		
5. Fishing ground (and show in Figure A)		
6. Special weather? (serious storms)		

V. Information about harvested quantity, average revenue and income share method for crew

Items	Main season	Other season
1. Average quantity of harvested species per trip		
a. Main species 1 (kg)		
b. Main species 2 (kg)		
c. Main species 3 (kg)		
d. Main species 4 (kg)		
2. Total revenue for all (1000 VND)		
3. Average revenue per trip (1000 VND)		
4. Average annual price (1000 VND/kg) of	-	
a. Main species 1		
b. Main species 2		
c. Main species 3		
d. Main species 4		
5. Way of sharing income for crew members:		

VI. Average variable costs/trip

Items	Main season		Other season	
	Quantity	Value (1000 VND)	Quantity	Value (1000 VND)
1. Fuel				
2. Lubricant				
3. Ice				
4. Provisions				
5.Minor repairs				
6. Others				
Total (from 1-6)				

VII. Capital items

Items	Year of purchase	Physical units	Value per unit (1000 VND)			Asset status (new/old)	Estimated Lifespan
			Purchase value	Current estimated value	Current value of a similar new one		
1. Hull							
2. Engine							
3. Mechanical equipment							
a. Winch							
b. Normal lighting system: + Battery + Lamps + Dynamo							
c. Lighting system for fishing							
d. Others							
4. Electronic equipment							
a. GPS							
b. Compass							
c. Short range radio							
d. Long range radio							

e. Radar							
f. Others							
5. Fishing gear							
a. Gill net							
+ Piece of net							
+ Float							
+ Main line							
+ Branch line							
b. Others							
6. Storage equipment							
7. Other equipments							
a. Anchor							
b. Sub-small boat							
c. Others							

VIII. Annual Repair and Maintenance

Items	Costs (1000VND)
1. Hull	
2. Engine	
3. Equipments	
4. Fishing gear	
5. Others	
Total	

IX. Improvement/ Big maintenance (more than 1 year)

	Last year of improvement	Costs (1000 VND)	Duration (years)
1. Hull			
2. Engine			
3. Equipments			
4. Fishing gear			
5. Others			

X. Insurance and charge

Items	Costs (1000 VND)
1. Insurance	
a. Vessel	
b. Crews	
2. Annual registration charge	
3. Other charge	
Total	

XI. Loan

Source of loans	Monetary value	Year of borrowing	Debt at end of year (1000 VND)	Interest payment in year	
				Total per year (1000 VND)	% per month
1. Project/ program					
2. Bank					

3. Private loan					
Total					

XII. Income and characteristics of household

1. Total income of household in year (million VND):...
   a. From fishing operation:..
   b. From other operation: ....
2. Which income source is the most important? ....
3. Household size (person):...
4. Characteristics of family-members:

Age	< 18	18-30	31-40	41-50	51-60	> 60
No. people +Male +Female						
No. people participate in fishing operation						

XIII. Assessments of interviewer

1. The harvested quantity in this year compared with previous years: ....
   a. More than:……..% b. Less than: ………% c. No change:………….
   Give reasons (If can):...
2. Operational expenses in this year compared with previous years:...
   a. More than:……..% b. Less than: ………% c. No change:………….
   Give reasons (If can):...
3. The vessel-owner's income from fishing in this year compared with previous years:
   a. More than:……..% b. Less than: ………% c. No change:………….
   Give reasons (If can):...
4. The following reasons affecting on your fishing performance in the year:
   a. Input price (Fuel……..): decrease ☐ increase ☐ b. Fish price: decrease ☐ increase ☐
   c. Quantity caught: decrease ☐ increase ☐ d. Engine power: small ☐ large ☐
   e. Length size: small ☐ large ☐ f. Fishing gear:………………………….
   g. Experience of crews and skipper:……………….. k. Weather:………………………………
5. For gillnet fishery, in order to increase fishing harvest, which are the most important following things (tick number in order of priority: 1 – the most important. No tick if it is not important)
   ☐ Investment capital for large vessel
   ☐ Investment for fishing gear
   ☐ Investment for modern fishing equipments
   ☐ Experience of crews and skipper
   ☐ Fishing techniques
   ☐ Ability of forecasting fishing grounds
   ☐ Cooperation among different vessel owners, middle-buyers

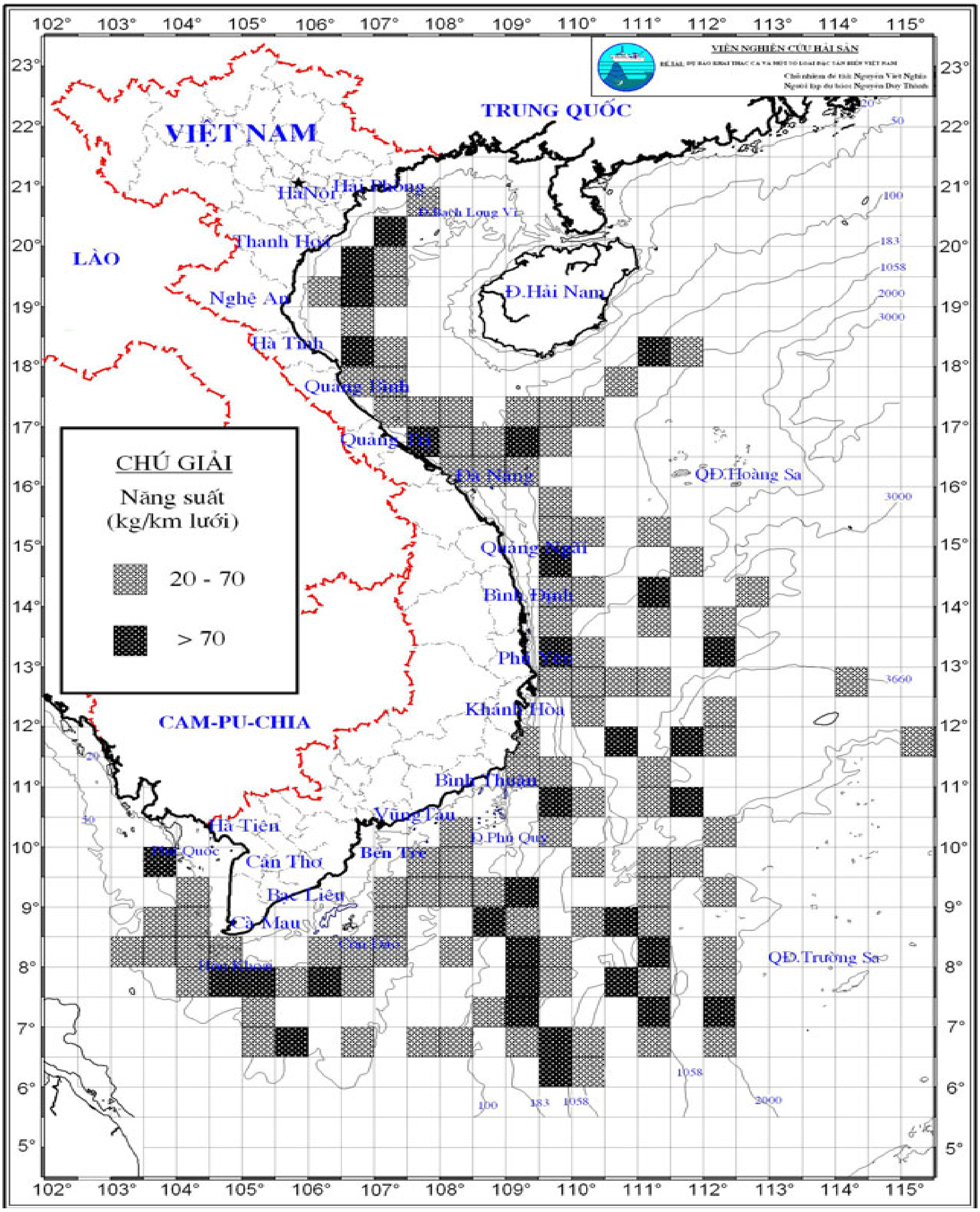


Figure A: The distribution of fishing grounds and fishing productivity of gillnet vessels in South-West monsoon, 2008. *Notes:* VIỆT NAM (in Vietnamese) = VIETNAM (in English); TRUNG QU ỐC, LÀO, CAM-PU-CHIA = CHINA, LAO, COMBODIA, respectively; Low letters (blue) are provinces of Vietnam (except Đ. H ả i Nam); CHÚ GI ẢI = ANNOTATION; Năng suất (kg/km lưới) = Productivity (kg/km of gill net). This Figure is used in survey process. *Source*: website of RIMF-Research Institute for Marine Fisheries. Available from http://rimf.org.vn/DuBao/2008/SW/Nghe/B200/2008_SW_B200_All.jpg . Cited July, 2009.

APPENDIX B: Fisheries production of Vietnam

Table B1: Fisheries Production during 1995- 2008 in Vietnam.

Year	Total	Of which	
		Capture	Aquaculture
1995	1584.4	1195.3	389.1
1996	1701.0	1278.0	423.0
1997	1730.4	1315.8	414.6
1998	1782.0	1357.0	425.0
1999	2006.8	1526.0	480.8
2000	2250.5	1660.9	589.6
2001	2434.7	1724.8	709.9
2002	2647.4	1802.6	844.8
2003	2859.2	1856.1	1003.1
2004	3142.5	1940.0	1202.5
2005	3465.9	1987.9	1478.0
2006	3720.5	2026.6	1693.9
2007	4197.8	2074.5	2123.3
Prel.2008	4602.0	2136.4	2465.6

Source: General Statistic Office (GSO), 2008. Note: units of thousand tones; fisheries quantity in 2008 is estimated preliminarily by GSO.

Table B2: Fisheries capture production by kinds of activity during 1995- 2008 in Vietnam.

Year	Total capture	Of which		
		Marine capture		Inland capture
		Total marine capture	Of which: fish	
1995	1195.3	990.3	722.1	205.0
1996	1278.0	1058.7	808.2	219.3
1997	1315.8	1098.7	835.3	217.1
1998	1357.0	1155.2	856.7	201.8
1999	1526.0	1314.6	974.7	211.4
2000	1660.9	1419.6	1075.3	241.3
2001	1724.8	1481.2	1120.5	243.6
2002	1802.6	1575.6	1189.6	227.0
2003	1856.1	1647.1	1227.5	209.0
2004	1940.0	1733.4	1333.8	206.6
2005	1987.9	1791.1	1367.5	196.8
2006	2026.6	1823.7	1396.5	202.9
2007	2074.5	1876.3	1433.0	198.2
Prel.2008	2136.4	1946.7	1475.8	189.7

Source: General Statistic Office (GSO), 2008. Note: units of thousand tones; fisheries quantity in 2008 is estimated preliminarily by GSO.

APPENDIX C: Fisheries production and fishing fleet in Khanh Hoa

Table C1: Fisheries production, number of vessels and horsepower during 2001-2009 in Khanh Hoa province

Criteria	Year								
	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total fisheries production:	78.3	82.3	75.1	71.0	83.4	84.2	91.6	na	na
- Marine capture	66.1	67.6	66.1	59.7	66.2	65.0	66.9	68.6[a]	72.3[c]
-Aquaculture and inland capture	12.2	14.7	9.0	11.3	17.2	19.2	24.7	na	na
Number of fishing vessel:	4812	4901	4944	4995	5075	5155	6334	10660[b]	12802[b]
-Number of vessel powered	3100	3401	3444	3495	3575	3655	4862	10578[b]	12737[b]
Total engine capacity	109778	123900	132260	127260	137000	147000	218935	349517[b]	369334[b]

Sources: Khanh Hoa's DARD (2009a). *Notes*: [a] information from Khanh Hoa's DARD (2009b); [b] information from DECAFIREP of Khanh Hoa (2009); [c] information from Khanh Hoa's DARD (2009c); unit of thousand tones for quantity, horsepower for engine capacity.

Table C2: Marine catch per unit of vessel (in tones/vessel) and per unit of engine power (in tones/HP) during 2001-2009

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009
Catch/hp	0.6	0.55	0.5	0.47	0.48	0.44	0.31	0.196	0.195
Catch/vessel	13.74	13.79	13.37	11.95	13.04	12.61	10.56	6.44	5.65

Sources: Khanh Hoa's DARD (2009a, 2009b, 2009c); DECAFIREP of Khanh Hoa (2009); and the author's calculations.

Table C3: The distribution of vessels by districts and engine power in Khanh Hoa, 2009

District	Range of engine power						Total	Rate
	0-<20	20-<50	50-<90	90-<250	250-<400	400-<4000		
Nha Trang	2046	1205	471	423	128	22	4295	33.5%
Van Ninh	2053	1145	128	51	1	0	3378	26.4%
Ninh Hoa	1152	342	47	12	1	1	1555	12.1%
Cam Lam	568	64	6	0	0	0	638	5.0%
Cam Ranh	2206	543	114	64	6	2	2935	22.9%
Dien Khanh	0	0	1	0	0	0	1	0.0%
Total	8025	3299	767	550	136	25	12802	100%
Rate	62.7%	25.8%	6.0%	4.3%	1.1%	0.2%	100%	

Source: DECAFIREP of Khanh Hoa (2009)

APPENDIX D: Some economic quantities of interest of the Cobb-Douglas function

The Cobb-Douglas function has some economic quantities of interest in the following (reference from Coelli T. et al., 2005):

The marginal product (MP) of input x_i (i = 1, 2,…,k) is the change in output since the input x_i changes with a very small quantity. The Cobb-Douglas function has property of non-negative marginal product.

$$MP_{x_i} = \frac{\partial e}{\partial x_i} \qquad \text{(D1)}$$

The second property is concave in x_i, this implies the existence of diminishing marginal productivity or the marginal product is non-increasing with respect to an increase of input x_i. That means

$$\frac{\partial MP_{x_i}}{\partial x_i} = \frac{\partial^2 e}{\partial x_i^2} \leq 0 \qquad \text{(D2)}$$

The marginal rate of substitution (MRTS) is the ratio of the substitutability between two factors of production, given keeping the output level constant. The *MRTS* measures the slope of an isoquant.

$$MRTS_{ij} = \frac{dx_i}{dx_j} = -\frac{\partial e / \partial x_j}{\partial e / \partial x_i} = -\frac{MP_j}{MP_i} \qquad \text{(D3)}$$

where $MRTS_{ij}$ is marginal rate of substitution of input x_i and input x_j (i, j = 1, 2,…,k)..

The direct elasticity of substitution (DES) measures the percentage change in the input ratio relative to the percentage change in the MRTS.

$$DES_{ij} = \frac{d(x_j / x_i)}{d(MP_i / MP_j)} \frac{MP_i / MP_j}{x_j / x_i} \qquad \text{(D4)}$$

The DES is sometime regarded as a short-run elasticity because it measure substitutability between input x_i and input x_j while holding all other inputs fixed. In Cobb-Douglas production function, DES = 1.

The output elasticity of production or the elasticity of scale (E) depends on the value of the coefficients of all input.

$$E = \sum_{i=1}^{k} \frac{\partial e}{\partial x_i} \frac{x_i}{e} = \sum_{i=1}^{k} \alpha_i \qquad \text{(D5)}$$

The Cobb-Douglas function can exhibit decreasing returns to scale or constant returns to scale or increasing returns to scale. The analysis of scale economies is essentially a long run phenomenon since the assumption that all factors are variable.

APPENDIX E: Capital structure and items of capital costs of the 58 gillnet vessels

Vessel number	Investment capital or fixed capital stock	Annual depreciation	Net capital value: Debt	Net capital value: Owner's capital	Net capital value: Total	Interest: Interest payment on loans	Interest: Calculated interest on owner's capital
1	1679.4	146.2	150	685.1	835.1	9.0	61.7
2	1162.7	103.7	100	503.6	603.6	5.9	45.3
3	745.7	68.8		280.7	280.7		25.3
4	1162.3	107.3		791.5	791.5		71.2
5	559.1	60.5	53	226.9	279.9	7.2	20.4
6	2450.5	215.0		1421.6	1421.6		127.9
7	1528.3	158.9	300	503.1	803.1	31.2	45.3
8	1888.8	186.4		1217.3	1217.3		109.6
9	1920.3	195.3		790.2	790.2		71.1
10	1544.4	158.3	150	369.2	519.2	12.5	33.2
11	2057.0	185.8	250	962.9	1212.9	29.2	86.7
12	1593.0	168.3		538.3	538.3		48.4
13	1632.2	162.0		868.1	868.1		78.1
14	1444.2	121.9	460	238.4	698.4	0.0	21.5
15	2079.9	190.0	400	1179.7	1579.7	36.0	106.2
16	1966.3	183.9	400	818.1	1218.1	42.0	73.6
17	2107.8	194.8	400	1194.0	1594.0	40.0	107.5
18	1353.1	125.9		706.2	706.2		63.6
19	1858.8	173.9	400	978.8	1378.8	40.0	88.1
20	1792.3	168.3		1173.1	1173.1		105.6
21	2113.5	169.9		1394.9	1394.9		125.5
22	1828.0	165.8		892.1	892.1		80.3
23	1753.9	164.3		985.7	985.7		88.7
24	1527.8	127.8	150	511.3	661.3	36.8	46.0
25	1155.7	96.7		534.1	534.1		48.1
26	2032.5	173.4		1417.6	1417.6		127.6
27	1943.2	167.9		1354.7	1354.7		121.9
28	2231.0	200.4	300	1405.6	1705.6	20.0	126.5
29	1904.6	171.7		1335.5	1335.5		120.2
30	2269.7	193.9		1771.5	1771.5		159.4
31	2186.7	188.9		1588.2	1588.2		142.9

32	1837.4	175.7	300	894.7	1194.7	39.6	80.5
33	1121.0	107.6	250	507.0	757.0	29.5	45.6
34	1005.7	101.9		582.3	582.3		52.4
35	1021.1	86.4	70	295.5	365.5	10.1	26.6
36	887.2	98.6		261.6	261.6		23.5
37	1614.4	157.4	100	767.9	867.9	10.0	69.1
38	1139.4	104.0		562.9	562.9		50.7
39	1536.2	151.8	50	774.3	824.3	0.0	69.7
40	897.1	81.0		349.4	349.4		31.4
41	2513.0	215.4	200	1754.0	1954.0	42.0	157.9
42	1959.4	187.6		1263.5	1263.5		113.7
43	1570.9	130.9		1038.3	1038.3		93.4
44	711.0	75.2		279.3	279.3		25.1
45	1379.1	110.8		762.1	762.1		68.6
46	564.1	61.9		171.5	171.5		15.4
47	760.8	68.8		329.5	329.5		29.7
48	931.1	82.0	50	371.5	421.5	14.4	33.4
49	805.9	78.4	60	293.9	353.9	12.2	26.4
50	1301.9	118.3	100	584.2	684.2	11.0	52.6
51	1522.3	133.3	500	418.4	918.4	0.0	37.7
52	1148.2	118.6	110	423.1	533.1	15.8	38.1
53	938.3	82.8	107	372.4	479.4	5.6	33.5
54	692.7	69.7	100	202.0	302.0	16.0	18.2
55	849.6	76.1	100	327.7	427.7	2.8	29.5
56	635.8	65.8		272.0	272.0		24.5
57	1788.6	166.4		1177.5	1177.5		106.0
58	1312.8	105.8		758.2	758.2		68.2
Average	1481.3	136.4	96.7	766.1	862.8	8.9	68.9

Source: own data and calculations

APPENDIX F: Regression results of standardized fishing effort model

F1) Regression results (by the statistical package SPSS version 15.0)

Descriptive Statistics

	Mean	Std. Deviation	N
lnEFFORT	6.8924	.35988	58
lnHP	5.2814	.75839	58
lnGEAR	5.5584	.26114	58
lnDAY	5.4353	.13121	58

Correlations

		lnEFFORT	lnHP	lnGEAR	lnDAY
Pearson Correlation	lnEFFORT	1.000	.962	.937	.634
	lnHP	.962	1.000	.873	.518
	lnGEAR	.937	.873	1.000	.472
	lnDAY	.634	.518	.472	1.000
Sig. (1-tailed)	lnEFFORT	.	.000	.000	.000
	lnHP	.000	.	.000	.000
	lnGEAR	.000	.000	.	.000
	lnDAY	.000	.000	.000	.
N	lnEFFORT	58	58	58	58
	lnHP	58	58	58	58
	lnGEAR	58	58	58	58
	lnDAY	58	58	58	58

Variables Entered/Removed [b]

Model	Variables Entered	Variables Removed	Method
1	lnDAY, lnGEAR, lnHP[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: lnEFFORT

Model Summary[b]

					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.994[a]	.987	.987	.04174	.987	1394.375	3	54	.000	2.027

a. Predictors: (Constant), lnDAY, lnGEAR, lnHP

b. Dependent Variable: lnEFFORT

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.288	3	2.429	1394.375	.000[a]
	Residual	.094	54	.002		
	Total	7.382	57			

a. Predictors: (Constant), lnDAY, lnGEAR, lnHP

b. Dependent Variable: lnEFFORT

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	-.045	.295		-.153	.879	-.637	.547					
	lnHP	.251	.015	.528	16.229	.000	.220	.282	.962	.911	.249	.223	4.488
	lnGEAR	.542	.044	.393	12.451	.000	.455	.629	.937	.861	.191	.237	4.228
	lnDAY	.478	.049	.174	9.704	.000	.380	.577	.634	.797	.149	.730	1.369

a. Dependent Variable: lnEFFORT

Coefficient Correlations [a]

Model			lnDAY	lnGEAR	lnHP
1	Correlations	lnDAY	1.000	-.048	-.245
		lnGEAR	-.048	1.000	-.834
		lnHP	-.245	-.834	1.000
	Covariances	lnDAY	.002	.000	.000
		lnGEAR	.000	.002	-.001
		lnHP	.000	-.001	.000

a. Dependent Variable: lnEFFORT

Collinearity Diagnostics [a]

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions			
				(Constant)	lnHP	lnGEAR	lnDAY
1	1	3.987	1.000	.00	.00	.00	.00
	2	.012	17.953	.01	.25	.00	.00
	3	.000	94.763	.00	.34	.75	.29
	4	.000	143.161	.99	.41	.25	.70

a. Dependent Variable: lnEFFORT

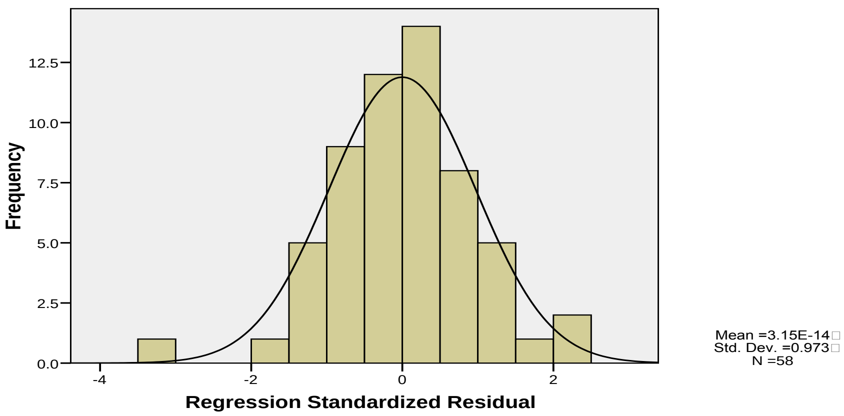
Residuals Statistics [a]

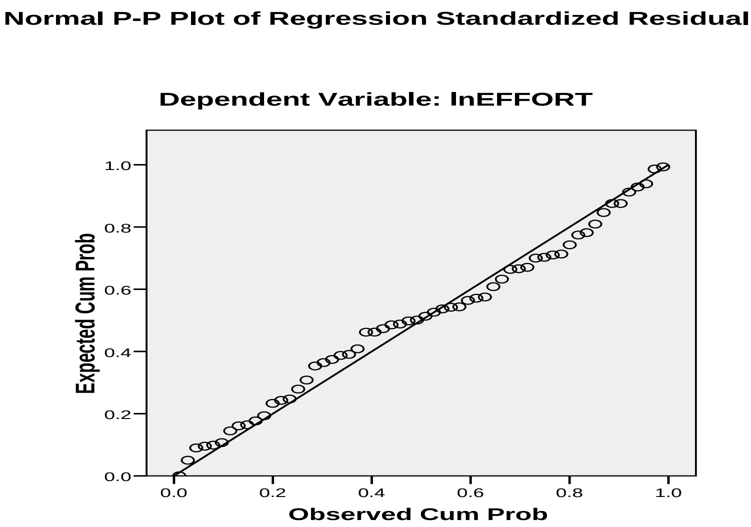
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	6.1716	7.3261	6.8924	.35758	58
Residual	-.14339	.10308	.00000	.04063	58
Std. Predicted Value	-2.016	1.213	.000	1.000	58
Std. Residual	-3.435	2.469	.000	.973	58

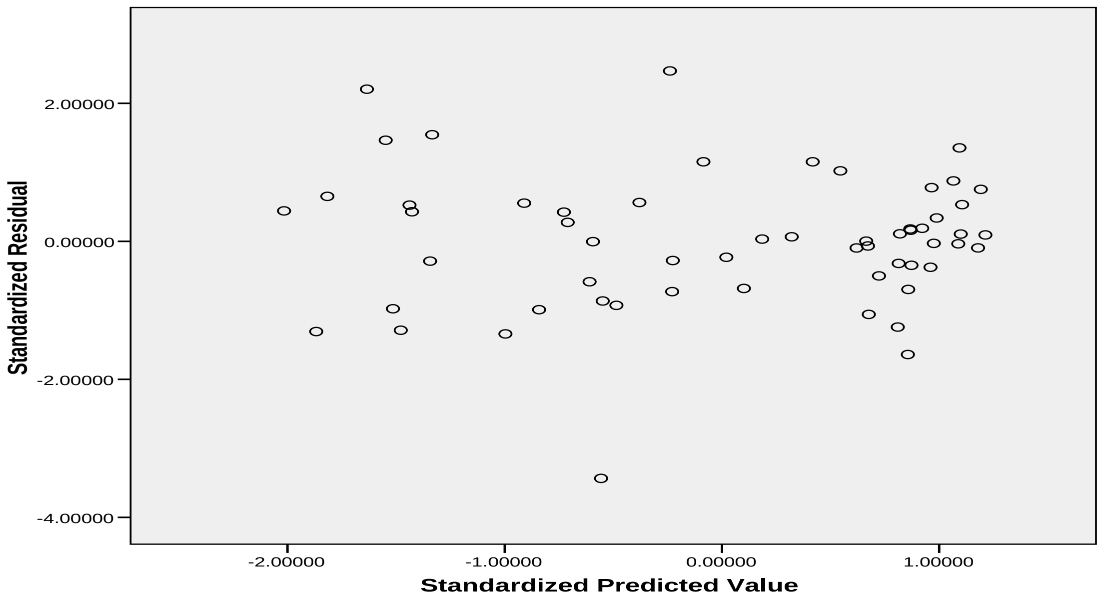
a. Dependent Variable: lnEFFORT

Histogram

Dependent Variable: lnEFFORT







F2) Get the heteroskedasticity corrected standard errors (by the econometric and statistical package SHAZAM version 10.)

```
OLS ESTIMATION
        58 OBSERVATIONS     DEPENDENT VARIABLE= LNEFFORT
 ...NOTE..SAMPLE RANGE SET TO:      1,     58

USING HETEROSKEDASTICITY-CONSISTENT COVARIANCE MATRIX

  R-SQUARE =   0.9873     R-SQUARE ADJUSTED =   0.9865
 VARIANCE OF THE ESTIMATE-SIGMA**2 =  0.17423E-02
 STANDARD ERROR OF THE ESTIMATE-SIGMA =  0.41741E-01
 SUM OF SQUARED ERRORS-SSE=  0.94086E-01
 MEAN OF DEPENDENT VARIABLE =   6.8924
 LOG OF THE LIKELIHOOD FUNCTION =  103.997
```

ANALYSIS OF VARIANCE - FROM MEAN

	SS	DF	MS	F
REGRESSION	7.2884	3.	2.4295	1394.375
ERROR	0.94086E-01	54.	0.17423E-02	P-VALUE
TOTAL	7.3825	57.	0.12952	0.000

VARIABLE NAME	ESTIMATED COEFFICIENT	STANDARD ERROR	T-RATIO 54 DF	P-VALUE	PARTIAL CORR.	STANDARDIZED COEFFICIENT	ELASTICITY AT MEANS
LNHP	0.25064	0.1246E-01	20.12	0.000	0.939	0.5282	0.1921
LNGEAR	0.54205	0.4443E-01	12.20	0.000	0.857	0.3933	0.4371
LNDAY	0.47849	0.4328E-01	11.06	0.000	0.833	0.1744	0.3773
CONSTANT	-0.45047E-01	0.2805	-0.1606	0.873	-0.022	0.0000	-0.0065

DURBIN-WATSON = 2.0266   VON NEUMANN RATIO = 2.0621   RHO = -0.01500

F3) The RESET Test (by the econometric and statistical package SHAZAM version 10.)

```
REQUIRED MEMORY IS PAR=      10 CURRENT PAR=   11000
 DEPENDENT VARIABLE = LNEFFORT             58 OBSERVATIONS
 REGRESSION COEFFICIENTS
   0.250644472130   0.542048838258  0.478490707480   -0.450471586587E-01


 RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
   RESET(2)=  1.6515     - F WITH DF1=   1 AND DF2=  53 P-VALUE= 0.204
   RESET(3)=  0.82417    - F WITH DF1=   2 AND DF2=  52 P-VALUE= 0.444
   RESET(4)=  0.53923    - F WITH DF1=   3 AND DF2=  51 P-VALUE= 0.658
```

APPENDIX G: The relative standardized effort of the 58 gillnet vessels

Vessel number	HP	GEAR	DAY	Standardized effort	Relative standardized effort/ RFP index
35	50	200	140	478.53	0.46
44	50	160	200	502.83	0.48
5	70	160	175	513.31	0.49
56	60	160	216	546.10	0.52
46	70	150	231	566.01	0.54
54	90	155	200	572.83	0.55
49	80	155	220	582.06	0.56
55	60	196	200	587.58	0.56
47	50	200	216	588.74	0.56
40	55	200	220	608.31	0.58
36	90	160	220	609.93	0.58
3	80	180	264	688.68	0.66
48	80	200	250	710.40	0.68
2	70	250	220	729.35	0.70
25	90	240	220	759.84	0.73
45	100	250	200	762.14	0.73
53	120	200	252	789.51	0.76
38	90	240	242	795.26	0.76
34	165	220	200	806.36	0.77
58	105	230	242	807.78	0.77
50	140	240	208	826.50	0.79
52	180	220	220	862.58	0.83
18	165	250	220	904.50	0.87
33	260	222	200	908.30	0.87
4	220	270	175	908.61	0.87
51	140	300	220	958.10	0.92
24	240	250	220	993.69	0.95
14	200	280	225	1020.28	0.98
43	320	251	210	1046.87	1.00
37	250	300	220	1108.20	1.06
1	340	300	200	1143.80	1.10
12	350	320	200	1193.17	1.14
39	340	280	253	1232.85	1.18

22	240	340	250	1247.86	1.20
23	340	300	242	1252.91	1.20
20	380	310	220	1253.08	1.20
21	320	320	240	1272.86	1.22
42	345	340	230	1313.46	1.26
13	350	300	264	1315.66	1.26
29	420	300	242	1321.16	1.27
8	340	340	240	1335.55	1.28
11	340	340	242	1340.86	1.29
7	320	300	288	1341.03	1.29
26	320	350	242	1341.52	1.29
10	350	300	276	1343.92	1.29
57	340	315	275	1367.55	1.31
9	400	350	230	1384.73	1.33
32	410	320	253	1389.15	1.33
27	390	330	253	1394.89	1.34
16	350	324	275	1398.73	1.34
41	450	340	242	1438.59	1.38
6	410	350	250	1449.99	1.39
28	470	340	242	1454.38	1.39
19	420	320	275	1454.40	1.39
17	450	340	250	1461.13	1.40
15	450	326	275	1494.78	1.43
31	470	325	275	1508.67	1.45
30	630	320	242	1514.77	1.45

Notes: “HP” is horsepower; “GEAR” is the number of pieces of gill net; “DAY” is the number of days fished in year 2008. Source: own data and calculations.

APPENDIX H: Results of testing hypothesis 2

H1) Result of testing hypothesis 2 by OLS estimation for the simple linear regression model.

Variables Entered/Removed [b]

Model	Variables Entered	Variables Removed	Method
1	e[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: ar_e

Model Summary[b]

					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.008[a]	.000	-.018	42.17346	.000	.004	1	56	.952	2.002

a. Predictors: (Constant), e

b. Dependent Variable: ar_e

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.442	1	6.442	.004	.952[a]
	Residual	99601.644	56	1778.601		
	Total	99608.086	57			

a. Predictors: (Constant), e

b. Dependent Variable: ar_e

Coefficients[a]

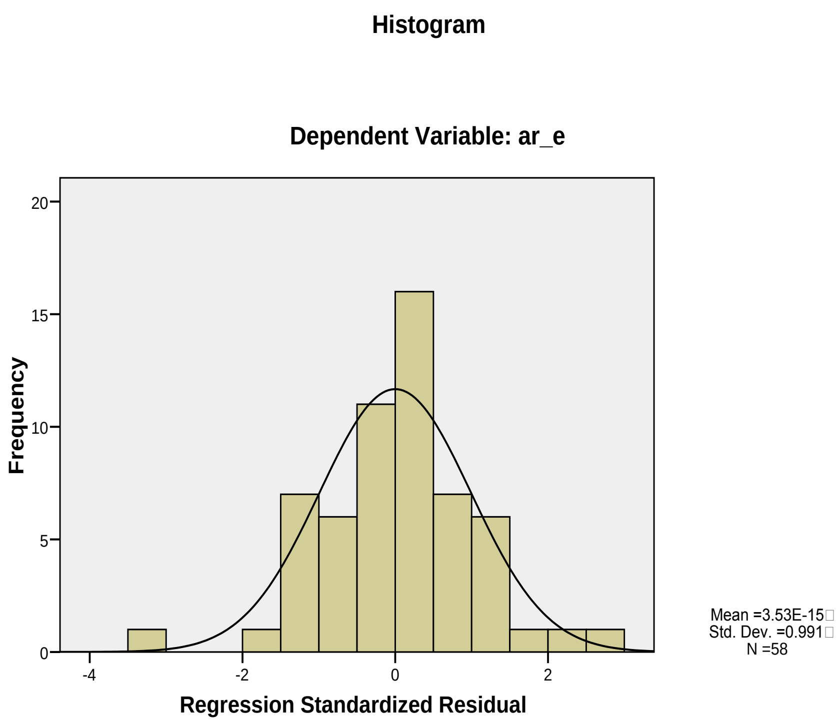
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	1043.416	18.134		57.538	.00000
	e	1.040	17.274	.008	.060	.95222

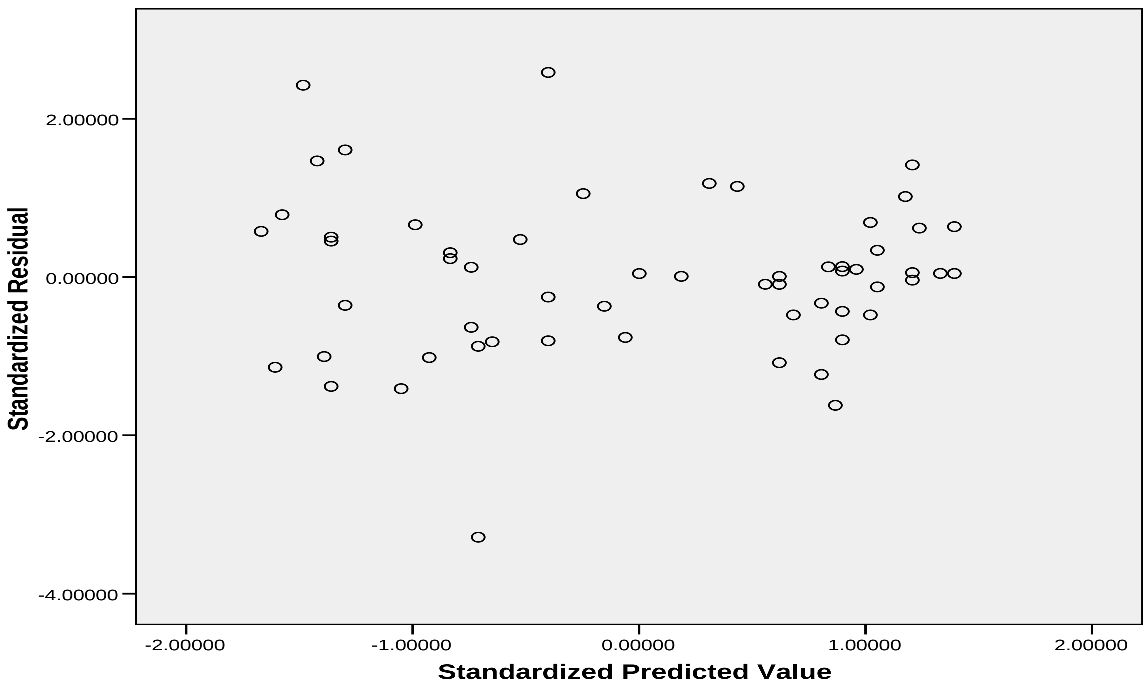
a. Dependent Variable: ar_e

Residuals Statistics [a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1043.8945	1044.9237	1044.4555	.33619	58
Residual	-138.637	109.00928	.00000	41.80188	58
Std. Predicted Value	-1.669	1.393	.000	1.000	58
Std. Residual	-3.287	2.585	.000	.991	58

a. Dependent Variable: ar_e


Histogram
Dependent Variable: ar_e
Frequency
20
15
10
5
0
-4
-2
0
2
Regression Standardized Residual
Mean =3.53E-15
Std. Dev. =0.991
N =58


Standardized Residual
2.00000
0.00000
-2.00000
-4.00000
-2.00000
-1.00000
0.00000
1.00000
2.00000
Standardized Predicted Value

H2) Get the heteroskedasticity corrected standard errors (by the econometric and statistical package SHAZAM version 10.) for the simple linear regression model.

```
OLS ESTIMATION
        58 OBSERVATIONS     DEPENDENT VARIABLE= AR_E
 ...NOTE..SAMPLE RANGE SET TO:      1,     58

USING HETEROSKEDASTICITY-CONSISTENT COVARIANCE MATRIX

  R-SQUARE =   0.0001     R-SQUARE ADJUSTED =  -0.0178
 VARIANCE OF THE ESTIMATE-SIGMA**2 =   1778.6
 STANDARD ERROR OF THE ESTIMATE-SIGMA =   42.173
 SUM OF SQUARED ERRORS-SSE=   99602.
 MEAN OF DEPENDENT VARIABLE =   1044.5
 LOG OF THE LIKELIHOOD FUNCTION = -298.305

                       ANALYSIS OF VARIANCE - FROM MEAN
                     SS            DF            MS                   F
 REGRESSION        6.4424          1.         6.4424                0.004
 ERROR             99602.         56.         1778.6              P-VALUE
 TOTAL             99608.         57.         1747.5                0.952


VARIABLE ESTIMATED   STANDARD T-RATIO       PARTIAL    STANDARDIZED ELASTICITY
  NAME   COEFFICIENT ERROR    56 DF      P-VALUE CORR.  COEFFICIENT AT MEANS
 E         1.0396     17.20   0.6043E-01  0.952  0.008   0.0080     0.0010
 CONSTANT  1043.4     20.43   51.06       0.000  0.989   0.0000     0.9990

 DURBIN-WATSON = 2.0023    VON NEUMANN RATIO = 2.0374    RHO = -0.00198
```

Notes: AR_E is dependent variable “ar_e”; E is independent variable “e”

H3) The RESET Test (by the econometric and statistical package SHAZAM version 10.) for the simple linear regression model.

```
DEPENDENT VARIABLE = AR_E              58 OBSERVATIONS
 REGRESSION COEFFICIENTS
    1.03962982161       1043.41624591

RAMSEY RESET SPECIFICATION TESTS USING POWERS OF YHAT
  RESET (2) = 2.0498 - F WITH DF1=   1 AND DF2= 55 P-VALUE= 0.158
```