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Open-access fishing rent and efficiency—The case of gillnet vessels in Nha Trang, Vietnam

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ABSTRACT

This paper first discusses vessel behaviour and efficiency theoretically and then applies this knowledge to evaluate the economic performance of an open-access fishery. The case of the Nha Trang, Vietnam, gillnet fishery is surveyed with respect to the earnings, costs and technical characteristics and efficiency of 58 offshore vessels in 2008. On average, these vessels proved to be heterogeneous with a gross profit margin of 17.3% and a profit margin of 3.8% despite the open-access characteristics of this fishery. However, adding the calculated interest of 9% per annum on the owner's capital to the costs significantly worsens the economic results. Engine capacity (HP), gear size and days of fishing best reflect the fishing effort of vessels in the production function, and these were used to compute standardised effort and cost efficiency. An application of the Salter diagram shows that a large number of vessels with high relative standardised effort are the most cost-efficient, but not without exception. The majority of these vessels earned intra-marginal rent, while the smallest vessels are most dependent on the government's 2008 quasi-lump-sum fuel subsidy scheme.

1. Introduction

This paper investigates the economic efficiency and performance of vessels in an open-access fishery. Three main hypotheses are tested: first, that the vessel owner has a positive gross cash flow from his fishing operation; second, that the calculated opportunity cost of capital is not covered in full because of the special characteristics of the fishing industry; and third, that fishing efficiency variation is higher than cost efficiency variation among vessels. It is well known in the fisheries economics literature that in equilibrium the potential resource rent is wasted under open access if the fleet consists of homogeneous vessels (Clark, 1990). However, it is also well known that a producer's surplus, called intra-marginal rent in fisheries, may exist even under open-access equilibrium (Copes, 1972). Since fisheries management has both benefits and costs, it may be appropriate to know whether an open-access fishery creates any net benefits, such as intra-marginal rent, before instigating costly management systems (Wallis and Flaaten, 2003).

The empirical focus is a Vietnamese open-access gillnet fishery in the South China Sea, which is fished competitively by vessels from more than 10 countries. Vietnam has a coastline of about 3260 km and its exclusive economic zone (EEZ) extends over more than one million square kilometres (FAO, 2005). In Vietnam's marine waters, there are about 3.1 million tonnes of standing stock of marine fish with more than 2000 fish species and around 1.4 million tonnes of potential sustainable yields (FAO, 2004).

Owing to the fear of the overexploitation of coastal resources, a programme investing in offshore fishing vessels has been implemented since 1997. The Vietnamese government, therefore, has emphasised the need to develop its offshore fleet with great caution to avoid the development of an economically unsustainable fleet (FAO, 2005). In 2005, the Ministry of Fisheries proposed two new major development goals for offshore fisheries[1]: (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 Vietnam" and (2) "to enhance income, create new occupations and improve the living standards of fishing communities that depend on offshore fisheries" (FAO, 2005). In order to assess whether these two development goals are being achieved, the monitoring and reporting of annual performance indicators were introduced at a conference on the national strategy for marine fisheries

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[1] The Ministry of Fisheries has now merged with the Ministry of Agriculture and Rural Development.

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management and development in Vietnam (FAO, 2005).[2] These indicators are referred to as measures to assist when drafting policies for marine resource management. Thus, Vietnamese policymakers require not only reliable assessments of offshore resources, but also an understanding of the economic realities of offshore fishing (FAO, 2005; Long et al., 2008).

To the best of our knowledge, official government institutions do not regularly collect costs and earnings data for the evaluation of the economic performance and efficiency of offshore fishing fleets despite the stated need for this. However, some independent research papers have been published in recent years for offshore vessels (Long et al., 2008; Flaaten, 2008). This study addresses the economic performance and efficiency of gillnet vessels in South Central Vietnam in the 2008 season through a costs and earnings survey. The home port of these vessels, the city of Nha Trang in the province of Khanh Hoa, is one of the main ports for Vietnamese offshore vessels fishing the South China Sea. The gillnet fleet was selected for this research mainly for two reasons: (1) gillnet is one of the main Vietnamese gear types for offshore fisheries and (2) gillnet is a fishing gear which has high selectivity and is considered to be less likely than trawl to damage the sea floor (King, 1995). A representative survey of all Vietnamese offshore vessels would have been the preferred approach for this research. However, owing to both financial and time constraints this work had to be limited to a smaller geographic area.

It is now a rather standard procedure to conduct costs and earnings surveys and measure basic economic performance indicators for a fishery. The same applies to this case. However, this paper contributes to the further development of the methods of comparing economic performance and efficiency of vessels by the standardisation of fishing effort and the estimation of a Salter diagram for this fleet. This method makes it possible to estimate intra-marginal rent for each vessel and for the fishery. Further, the profitability effects of the 2008 government fuel cost compensation subsidy are estimated and discussed. This subsidy scheme was introduced to compensate fishing vessels for the large increase that year in fuel and lubricant oil costs, but was abolished after one year.[3]

The remainder of this paper is organised as follows. Section 2 gives background information on the investigated fishery. Section 3 describes the theory and methods used and developed. Section 4 focuses on the data from the costs and earnings survey. Section 5 is devoted to the research results. Section 6 highlights the key features of the results, and the findings and recommendations are summarised in Section 7.

2. Background

Vietnam's coast has many bays and estuaries as well as diverse coastal and marine resources, and thus the EEZ of Vietnam contains an abundant number of species (FAO, 2005). These have created good potential for the development of mainly multi-species marine capture fisheries as well as marine aquaculture. The fisheries sector, including marine capture fisheries, has become an important sector in the national economy, contributing 4% to GDP in 2006 (Pomeroy et al., 2009). However, Vietnam's marine fisheries are considered to be small scale (Pomeroy et al., 2009; Raakjaer et al., 2007) and open access (Long et al., 2008; FAO, 2009). Marine fisheries' production levels have increased continuously over time (GSO, 2008), and the number of fishing vessels has increased significantly and far beyond the control of fisheries managers (FAO, 2005). Coastal fishing capacity has exceeded the sustainable limit (FAO, 2004, 2005),[4] and coastal resources have thus been overexploited and seem to be decreasing.

Most offshore fishing vessels of the Khanh Hoa province are located in the provincial capital Nha Trang. In 2009, the Nha Trang offshore gillnet fleet amounted to 233 of 290 vessels that have engines larger than 50 horsepower (HP), more than 80%, and 178 of 208 vessels whose engines are larger than 90 HP, nearly 86% (DECAFIREP, 2009[5]). Most gillnet vessels with engines of more than 250 HP are also located in this city. The offshore fishery has been open access since its inception and a minor resource tax was abolished in 2008 (Flaaten, 2008).

Nha Trang's offshore gillnet operators often operate in waters 50–70 nautical miles from the coastline, along the territorial waters of the Khanh Hoa province, and move towards the east and southwest waters (6°00′–8°00′N; 104°30′–108°00′E) and southwest of the Spratly Islands (Truong Sa) (6°00′–9°00′N; 110°30′–114°00′E), as well as to fishing grounds of high sea waters (6°00′–7°00′N; 109°00′–110°00′E) (Fig. 1). The actual fishing grounds depend on the movement direction of fish and the aggregation of migratory species. The target fish species are mainly tuna and mackerel. Offshore gillnet vessels operate from September (or October) to July (or August) of the following year. The major fishing season for tuna runs from February to July (called the southwest monsoon), when fish are found in the offshore waters from Khanh Hoa to the Ba Ria-Vung Tau province, while the fishing season for mackerel species ranges from February to June. The second season is normally called the northwest monsoon, ranging from October (or November) to January of the following year. Tuna is concentrated in the extreme south of Vietnam in the second season and only gillnet vessels with a large amount of engine power can venture further into this fishing ground. Offshore gillnet vessels often stay onshore for repairs and maintenance from August to September. The majority of them are tuna gillnet vessels, as it is difficult to find mackerel gillnetters in Nha Trang because of mackerel stock depletion and the weak fishing experience and capacity of prediction of the fishing ground (Kim Anh et al., 2006).

3. Theory and methods

The economic performance of fisheries is often assessed from economic surveys of vessels participating in the fishery. From a fisheries management perspective with heterogeneous vessels, the level of economic rent accruing in the open-access fishery can be estimated from the economic profits of the vessels surveyed and it consists of two components: resource rent and intra-marginal rent (Copes, 1972; Coglan and Pascoe, 1999). Resource rent is dissipated under open-access conditions because of the common property problem discussed in Gordon (1954), Hardin (1968) and Munro and Scott (1985). With heterogeneous vessels under an open-access regime, the profits generated could be considered to be intra-marginal rent gained by the factors of production, such as capital, variable inputs and labour, through more efficient vessels and practices (Coglan and Pascoe, 1999).

In this study, the main economic performance indicators (Table 1) are used to estimate the level of intra-marginal rent generated by each vessel in the open-access gillnet fishery.[6] The

[2] See these performance indicators in FAO (2005).

[3] The Vietnamese Government 2008 fuel cost support for fishers was outlined and discussed in Decision (2008a,b).

[4] In the fisheries context, the coastal sea areas are measured from the coast to the line connecting points of 24 nautical miles from the coast. Fishing in the sea areas outside the 24 nautical mile limit, to the outer limit of Vietnam's sea areas, is referred to as offshore fishing (Decree, 2006).

[5] For this and other references in the Vietnamese language further information can be obtained from the corresponding author.

[6] This rent is not relevant to the rent gained by preventing excessive harvesting capacity that is caused by the Class I and II forms of the common property problem discussed in Munro and Scott (1985).

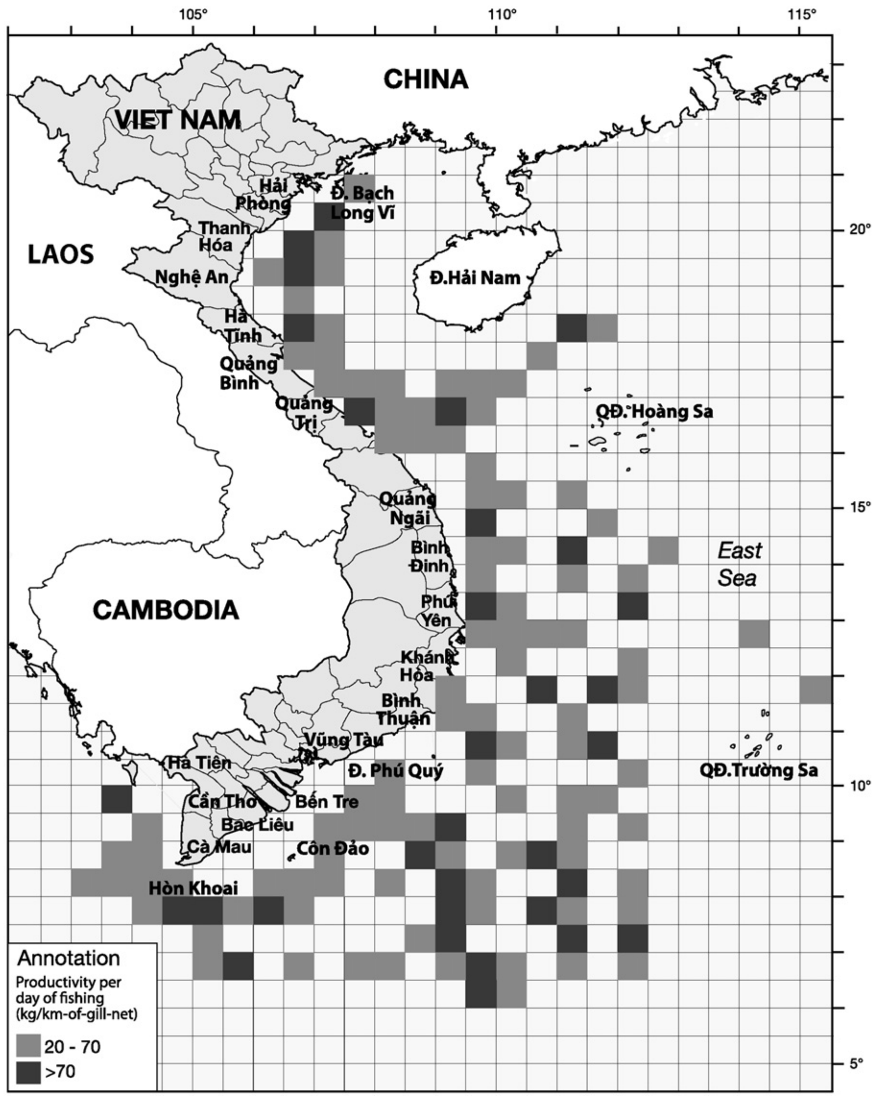

Fig. 1. The distribution of fishing grounds and fishing productivity of gillnet vessels in the southwest monsoon, 2008.

Source: RIMF (2011).

main indicator added for this analysis is gross cash flow. This indicator is referred to as a good short-term indicator in fisheries (European Commission, 2004). A positive gross cash flow means that vessel owners are able to pay for all their operating costs and meet at least part of their obligations to creditors. A reasonable *first hypothesis* here is that the vessel owner has a positive gross cash flow in the fishing operation year, including the fuel cost quasi-lump-sum subsidy.

The surveyed gillnet vessels are owner-operated, and the skipper–owners, as well as other family members, receive remuneration through the share system as crew members. Even though the opportunity cost of the owner's capital may be "high", the opportunity cost of the skipper–owner and family members' labour may be "low". The trade-off between these two opportunity cost factors implies that skipper–owners do not necessarily include the full opportunity cost of capital. A relatively high amount of capital invested is often seen as a higher priority for fisheries management and policymaking. Moreover, the effect of the opportunity cost of labour on the measure of net profit may be less problematic since owner–operators receive an explicit crew share (Boncoeur et al., 2000). Thus, a *second hypothesis* is that the calculated opportunity cost of capital is not covered in full in an open-access fishery. Vessels may be different with respect to technical characteristics and catch efficiency, but in the end they all have to meet their economic obligations to survive as economic units. Thus, a *third hypothesis* is that the fishing efficiency variation is higher than cost efficiency variation among vessels.

The following subsections describe the economic performance assessment and the method for comparing vessel economic efficiency. The theory of heterogeneous fishing vessels in an open-access fishery is also presented briefly as discussions for background in this empirical research.

Table 1
Definition of performance indicators.

Gross revenue = landings value
Income = gross revenue − variable costs (except labour cost)
Gross value added = income − fixed operating costs
Gross cash flow = gross value added − labour cost
Profit = gross cash flow − depreciation − interest payment on loans
Net profit (rent) = profit − calculated interest on owner's capital
Gross profit margin = gross cash flow/gross revenue
Profit margin = profit/gross revenue
Return on capital value = profit/net capital value
Return on owner's capital = profit/vessel owner's capital

3.1. Economic performance indicators

The economic performance indicators are presented in Table 1. Most definitions of these indicators are the same as those used in European Commission (2004) and Long et al. (2008). These definitions also correspond in principle to those used in several previous profitability analyses of fishing vessels in industrialised countries (Flaaten et al., 1995; Pascoe et al., 1996; Whitmarsh et al., 2000; Le Floc'h et al., 2008).

The gross revenue is calculated for two cases: one including and one excluding the fuel subsidies. The 2008 fuel cost support appears as quasi-lump-sum subsidies per trip, payable directly to fishers for a limited number of trips per year. Vessels with an engine of 90 HP or larger can be supported with 10 million VND per trip, to a maximum of three trips per year. Vessels with an engine from 40 HP to 90 HP can receive 6.5 million VND per trip, to a maximum of four trips per year, and others correspondingly 4 million VND per trip to a maximum of five trips per year (Decision, 2008b). Fishers have to accept the market fuel price in their fishing operations. Although the 2008 fuel cost support may seem like a fishing effort subsidy, in reality it was income support for fishers; hence, this subsidy item has been added to gross revenue instead of subtracting it from costs in this study.

As the purpose of the present study is to calculate economic performance indicators, non-cash costs are taken into account. For this study, depreciation is calculated based on the fixed capital value of vessels and gear, valued at current prices. This means that assets acquired in an earlier period (historic prices) have to be revalued to convert them into 2008 prices. Annual average consumer price indices are used for this revaluation.[7] Depreciation is obtained using a straight-line depreciation plan based on the owner's estimated lifespan of the fixed capital items.

The opportunity cost of the owner's capital is defined as the calculated interest (I) on the owners' capital in the year of the profitability analysis (2008), which is calculated by the formula $I = [(TK - D) - L]r$. TK is the total fixed capital stock revalued at 2008 prices and D is the accumulated depreciation in 2008. Thus, $TK - D$ is the net capital value of the vessel in 2008. L is the remaining debt or the remaining balance on the loan in 2008 and $[(TK - D) - L]$ is the vessel owner's capital or level of equity in 2008. r is the rate of interest, which is defined as the Vietnamese lending interest rate. For this fishing year, the interest rate is 9% per annum,[8] which was chosen to reflect the opportunity cost of the owner's capital.

The lack of malleability of fisheries investments brings about economic accounting difficulties. In practice, vessels and fishing equipment cannot easily be modified or altered to participate in other sectors of the economy; thus, adjustment out of the fishery is likely to be a long-run phenomenon (Clark et al., 1979). Although this is deemed appropriate, the interest rate above can be taken into account for the opportunity cost of the owner's capital. This is in line with previous research that used the interest rate of government bonds to assess the economic performance of fisheries (Flaaten et al., 1995).

3.2. Behaviour of heterogeneous fishing vessels in an open-access fishery

When one vessel's landing is considered to be a small proportion of the total landing of fish, it is firstly assumed that each vessel is not able to impact on the market price of fish in the competitive market. It is reasonable to consider fishers as price-takers and assume that the price of fish is the same for all vessels. Second, since fish stocks are considered to be constant from one vessel's point of view, it is assumed that the activity of the vessel hardly affects the total stock biomass. Therefore, the vessel's harvest function is a function of its effort, given the period of time and the stock level. It is assumed that this function is the Schaefer harvest function, $h(e;X) = qeX$, where h is the landed catch, e is the effort of an individual fishing vessel, given the stock level of fish, X, and the catchability coefficient, q. In what follows, it is assumed that fishing effort can be measured and compared among vessels. How this can be achieved empirically is demonstrated below.

The profit of the vessel is $\Pi(e;X) = ph(e;X) - tc(e)$ or $\Pi(e;X) = pqeX - tc(e)$, where p is the market price of fish and $tc(e)$ is the total cost of effort. In the long-term, $tc(e)$ consists of the total variable costs of effort, $tvc(e)$, and a fixed cost, f, whereas in the short-term it is only the total variable cost of effort. The total revenue of a vessel, $pqeX$, is a function of the vessel's effort, given p, q and X.

For the objective of profit maximisation, the profit of one vessel is maximised at the level of effort at which its marginal cost equals its marginal revenue, $mc(e) = pqX$. The marginal revenue of effort equals the product of the price of fish, catchability coefficient and level of stock, pqX. All vessels have the same marginal revenue of standardised effort, equal to fishery average revenue, at a given point in time.

In the short-term, the vessel operates at a positive level of effort only if $pqX \geq tvc(e)/e = avc(e)$, where $avc(e)$ is the average variable cost of the vessel's effort. The marginal revenue of effort has to be more than the minimum average variable cost of the vessel's effort. In the long-term, the condition for the existence of the fishing operations of individuals is that the marginal revenue of effort has to be larger than the minimum average total cost of effort in order to cover the fixed capital cost, f. This means $pqX \geq tc(e)/e = [tvc(e) + f]/e = atc(e)$, where $atc(e)$ is the average total cost of the vessel's effort. The fixed capital cost, f, equals depreciation and interest payments on loans as discussed above. It also includes the calculated interest on the owner's capital since we are discussing net profit.

From the Schaefer harvest function $h = qeX$, the catch per unit of effort (CPUE), $h/e = qX$, may be calculated. This implies that the CPUE of each vessel is qX since the fishing effort of heterogeneous vessels is standardised, and the fish stock level is assumed to be constant in the short-term. Since fish price is considered to be the same for all vessels, the average revenue of the vessel's standardised effort is thus similar among fishing vessels, and equals the average revenue of the effort of the fishery. As a result, the economic efficiency of the vessel is referred to as the cost efficiency of the vessel's effort. Heterogeneous vessels with different cost structures are thus different with respect to cost efficiency, resulting in the generation of differences in rent under unregulated open-access conditions – in the short as well as in the long run. Coglan and Pascoe (1999) and Flaaten (2010) discussed in more detail the behaviour of heterogeneous fishing vessels from these perspectives.

3.3. The economic efficiency method

3.3.1. Fishing effort standardisation

In this study, to compare the economic efficiency of vessels the fishing effort of vessels is standardised. Standardised fishing effort

[7] Price indices for the relevant types of assets should be used. However, constructing constant quality price indices for capital goods is a difficult task and, moreover, information on the price indices for the relevant asset types is unavailable in most developing countries, including Vietnam. Information on annual average consumer price indices is available from IMF (2009).

[8] The interest rate of 9% p.a. is based on information from the annual reports of the State Bank of Vietnam (SBV, 2008, 2009).

indicators for vessels are estimated using the production function approach to effort. Hannesson (1983) and Campbell (1991) applied this method to the estimation of fishing effort in the Lofoten winter cod fishery and in the Tasmanian rock lobster fishery, respectively. Eide et al. (2003) also included a seasonal term to take care of intra-annual variation in the CPUE. Padilla and Trinidad (1995) applied the production function to fishing effort standardisation in the small-pelagic fishery in the central Philippines, the catch of which was referred to as a measure of fishing effort.

The Schaefer production function of each vessel discussed above is a special form of the Cobb–Douglas function, $h = qe^{\beta_1}X^{\beta_2}$, namely with $\beta_1 = \beta_2 = 1$. The general form of the economic production function is $h = f(e,X)$, where e is a vector of inputs consisting of capital (K), labour (L) and other variable inputs (V). With cross-sectional vessel data for one year being used for the short-term, an assumption of constant stock resources is reasonable. This assumption implies that the production function is separable. This separability allows for the aggregation of individual inputs into the aggregate variable fishing effort. The production function can thus be rewritten $h = f(g(e),X)$. The effort function of each vessel, $g(e)$, can also be presented in the form of the Cobb–Douglas function:

$$e = Ax_1^{\alpha_1}x_2^{\alpha_2}\ldots x_k^{\alpha_k} \tag{1}$$

where e is now the standardised fishing effort; $x_1, x_2, \ldots, x_k$ are the k inputs of the vessel; and A is a constant. The Cobb–Douglas function has been widely used in analyses of the fisheries sector, including in Hannesson (1983), Campbell (1991) and Padilla and Trinidad (1995). In practise, Eq. (1) can be estimated through a log-linear function.

In previous research, it seems most common to estimate a production (catch) function, such that the estimated catch function also can be considered to be an effort function (Hannesson, 1983; Eide et al., 2003; Andersen, 1999). Padilla and Trinidad (1995) estimated fishing effort equations, which were used to derive standardised measures of fishing effort, through using the catch interpreted as effective fishing effort. By assuming that the prices of fish are fixed and the same for all vessels and months within one year, annual gross revenue is considered to be a proxy for the annual quantity of fish, for which actual data are lacking. Thus, annual gross fishing revenue per vessel can be interpreted as a fishing effort indicator, which usually varies across vessels.

3.3.2. Relative standardised fishing effort and vessel economic efficiency

Adapting the definition of relative fishing power by Beverton and Holt (1957), the relative standardised fishing effort of vessel i can be determined by the following formula:

$$\varepsilon_i = \frac{e_i}{\bar{e}} \tag{2}$$

where ε_i is the relative standardised fishing effort of vessel i, e_i is the standardised fishing effort of vessel i and $\bar{e}$ is the average standardised effort of all vessels. This definition of ε_i is used below to analyse the economic efficiency of vessels. By nature, using the results of "standardised effort" estimated in Eq. (1) or "relative standardised effort" calculated from Eq. (2) should lead to the same conclusions. The notion of "relative standardised effort" is applied in this study. Calculating "relative standardised effort" also gives indices of relative fishing power. These indices can be expressed as the relative fishing power efficiency of vessels.

In this study, the ratio of cost to relative standardised effort reflects the cost efficiency and economic efficiency of the vessel. The relationship between cost efficiency and the relative standardised effort of each vessel will be graphed using a Salter diagram, with relative standardised effort along the horizontal axis and the average cost per unit of relative standardised effort on the vertical axis.[9] For each vessel, relative standardised fishing effort is measured by the width of the bar, whereas the height of the bar measures cost per unit effort (Fig. 3). All vessels are arranged from left to right according to their cost efficiency levels, from the most cost-efficient one to the least cost-efficient.

4. Data

The 2008 data were obtained by a survey of costs and earnings as well as the technical and operational characteristics of offshore gillnet vessels in Nha Trang (Appendix A, Tables A.1 and A.2).[10] These data were collected through direct face-to-face interviews with fishing households, which were represented by the vessel owner and/or his wife. They consist of detailed information on various aspects of the gillnet fishery such as vessel technical and operational characteristics and cost and landing value information.

From a population of 225 registered offshore gillnet vessels in Nha Trang, a sample of 58 gillnet vessels was selected for investigation. The sample of gillnet vessels investigated comprises about 25.8% of the population. The investigation process was performed with the aim of obtaining a representative sample. Hull length was the physical characteristic used to test the sample representativeness because of available data. A comparison of the hull length of the sample with that of the offshore gillnet fleet in Nha Trang as a whole suggests that the sample was fairly representative of the fleet (Appendix B). Although there would be some uncertainties about the reliability of the results of any survey (Pascoe et al., 1996), the statistical results presented below are those of the sample.

5. Results

5.1. Economic performance indicators

5.1.1. The subsidies case

Table 2 shows that the average vessel's annual gross revenue from fishing operations was 1044.6 million VND.[11] Because all 58 surveyed gillnet vessels received the 2008 quasi-lump-sum fuel subsidy, the average gross revenue increased by 2.8%. The results show that income, gross value added, gross cash flow and profit are positive for an average vessel, whereas net profit is negative because of the calculated interest on the owner's capital (Table 2). The average annual crew share was about 17.1 million VND, resulting in the average monthly crew share during fishing season of 1.65 million VND, with the average annual total operating months of a gillnet vessel being 10.3.

Also shown in Table 2, the averages of vessels' gross profit margin and profit margin were 17.3% and 3.8%, respectively, with wide ranges for both indicators. However, by using the sample mean values in Table 2, these two indicators would increase to 18.2% and 4.7%, respectively. The averages of vessels' return on capital value and return on the owner's capital were 5.3% and 6.1%, respectively, also with large ranges. The large variance of the return on capital value and return on the owner's capital was caused not only by great differences in profit, but also by wide ranges in the net capital value and net owner's capital of vessels.

On the positive gross cash flow hypothesis: The average vessel's gross cash flow was 195.8 million VND (Table 2). There were only

[9] Other types of software programs, such as GLIM (e.g. Healy, 1988), could of course have been used for this type of analysis.

[10] A copy of the questionnaire may be obtained from the corresponding author on request.

[11] VND: Vietnamese dong, the unit of Vietnamese currency. The average exchange rate for 2008 was 1 USD = 16,302.3 VND (GSO, 2009).

Table 2
Economic performance indicators, in million VND, 2008.

Criteria	The subsidies case		The non-subsidies case	
	Mean	S.D.	Mean	S.D.
Gross revenue from fishing	1044.6	341.2	1044.6	341.2
Subsidy	29.2	1.6		
Gross revenue with subsidy	1073.7	342.3		
Variable costs	604.4	174.5	604.4	174.5
Income	469.3	193.8	440.2	192.9
Fixed costs	89.4	30.1	89.4	30.1
Gross value added	379.9	172.3	350.7	171.4
Labour costs	184.1	78.4	184.1	78.4
Gross cash flow	195.8	121.2	166.6	120.5
Depreciation	136.4	45.8	136.4	45.8
Interest payment on loans	8.9	13.9	8.9	13.9
Profit	50.5	93.1	21.4	92.7
Calculated interest on owner's capital	68.9	39.2	68.9	39.2
Net profit	−18.4	84.4	−47.6	84.4
Net capital value	862.8	454.7	862.8	454.7
Net owner's capital	766.1	435.3	766.1	435.3
Gross profit margin[a]	0.173	0.083	0.147	0.089
Profit margin[a]	0.038	0.085	0.008	0.092
Return on capital value[a]	0.053	0.127	0.007	0.128
Return on owner's capital[a]	0.061	0.139	0.007	0.142
Average income per fisherman	17.1	5.8	17.1	5.8

Source: Own data and calculations.
[a] These indicators are estimated with relative to standard deviation, and measured in decimal numbers.

two vessels (vessel numbers 25 and 40) whose gross revenue with the 2008 subsidies did not offset their variable, fixed operating and labour costs. However, the positive gross cash flow hypothesis is not statistically rejected for the sample of 58 vessels since the average vessel's gross cash flow was positive and sufficiently far from zero.

A breakdown of the sample according to the engine size of vessels shows that most annual performance indicators increase on average with engine size (Appendix A, Table A.3). Costs follow the same trend as gross revenue and vessel engine size. An average gillnet vessel of each group covered the cash cost as well as the depreciation. In 2008, the two vessel groups with larger engines had economic performance indicators far better than those of the two vessel groups with smaller engines. However, while vessels with more than 400 HP on average for 2008 barely covered all their expenses and received only a very small surplus with a net profit (rent) of 0.3 million VND, other vessels attained a negative net profit (Appendix A, Table A.3).

5.1.2. The non-subsidies case

The average quasi-lump-sum subsidy was 29.2 million VND per vessel (Table 2). Without the subsidy, one more vessel would have had a negative gross cash flow and seven additional vessels would have had a negative profit. The average gillnet vessel was earning a profit of 21.4 million VND from its actual fishing operations at market prices, but 50.5 million VND including the fuel cost subsidy. Only vessels with more than 250 HP on average were able to cover depreciation and interest payments on loans from their gross fishing revenue (Appendix A, Table A.4).

On the opportunity cost of capital not covered-in-full hypothesis: It may be concluded that the second hypothesis, in which the calculated opportunity cost of capital is not covered in full in this open-access fishery, cannot be rejected. The net profit is negative for an average vessel both in the case of subsidies and non-subsidies (Table 2). Additionally, all vessel groups on average earn negative net profits in the two cases, except for the vessel group with engines of 400 HP and larger in the subsidies case (Appendix A, Tables A.3 and A.4). Thus, vessel owners do not consider the opportunity cost of the owner's capital in full as a regular fishing cost.

5.2. Standardised fishing effort – econometric results

Initially, many factors were considered to be an input bundle to generate fishing effort. However, some of them were excluded from 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, engine capacity and fishing gear, as proxies for capital inputs, and fishing days in a year, as the proxy for variable inputs, were identified as the factors affecting the fishing effort of the vessel. The estimated coefficients are presented in Table 3.

The econometric results indicate that the effect of independent variables in explaining variations in fishing effort is significant for the sample vessels with an R^2 of 98.7%. The F-statistic of 1419.4 specifically shows that the estimated relationship is significant. All the coefficients estimated for the explanatory variables are significantly different from zero at the 1% level or better based on the OLS estimation with White's procedure for correcting for heteroskedasticity.

The equation used to standardise fishing effort for each vessel is

$$e_i = \exp(-0.018) * HP_i^{0.251} GEAR_i^{0.541} DAY_i^{0.474} \quad (3)$$

where HP is horsepower, $GEAR$ is the number of pieces of gillnets and DAY is the number of fishing days in 2008. The results estimated from Eq. (3) show that vessel number 35 has the lowest standardised effort of 478.53, whereas the highest standardised effort of 1514.77 is for vessel number 30. Average standardised fishing effort is 1043.18 (units of effort).

Table 3
Parameter estimate and test statistics of the standardised effort function.

Variable name	Estimated coefficient	t-Value	P-value	White t-value	White P-value
ln HP	0.251	16.400	0.000[a]	20.570	0.000[a]
ln $GEAR$	0.541	12.530	0.000[a]	12.330	0.000[a]
ln DAY	0.474	9.649	0.000[a]	10.600	0.000[a]
Constant	−0.018	−0.060	0.952	−0.063	0.950

Source: own data.
R^2 = 0.987; F-statistic = 1419.4.
[a] Statistically significant at the level of 1%.

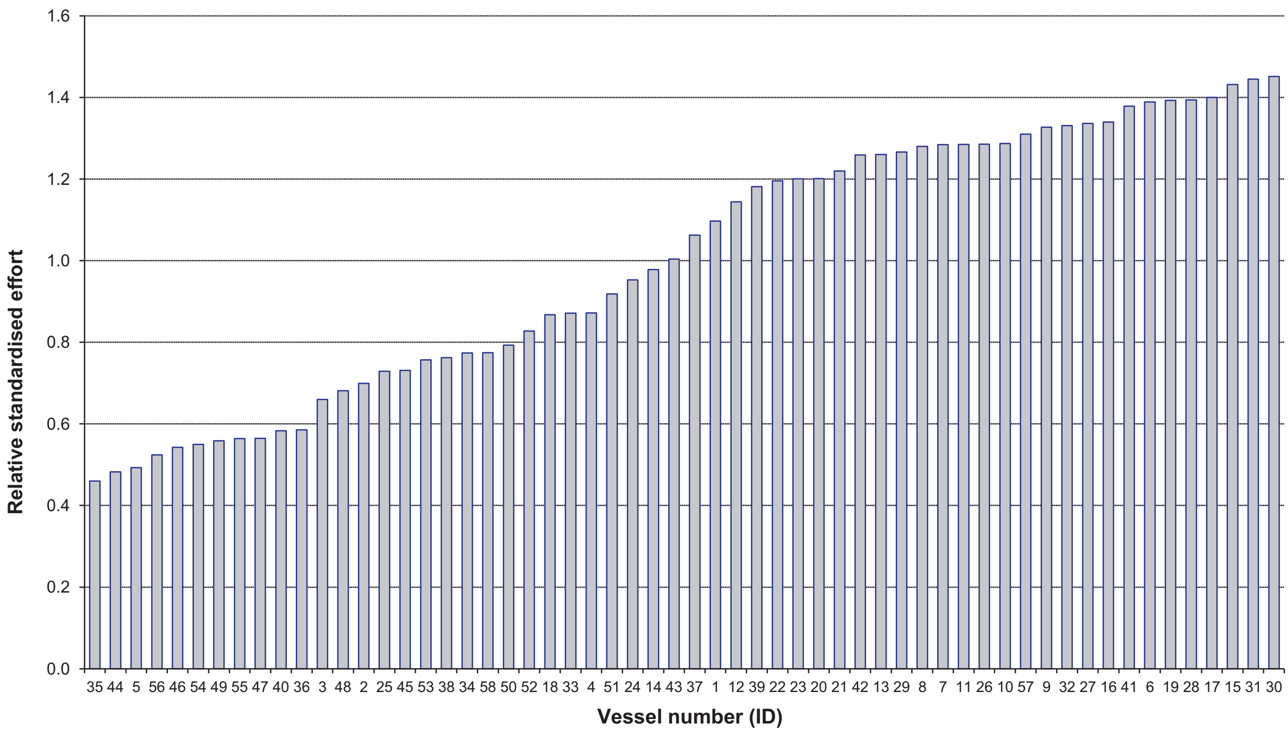

Fig. 2. The relative standardised effort of the 58 gillnet vessels, 2008.

Source: Own data.

5.2.1. *Relative standardised fishing effort*

Fig. 2 shows that the minimum and maximum values of relative standardised effort are 0.46 and 1.45, with corresponding vessel numbers 35 and 30, respectively. Thus, the highest relative standardised effort, thereby also fishing efficiency, is more than three times the lowest. There were 28 vessels with a relative standardised effort of less than one, whereas 30 vessels had a relative standardised effort greater than one (Fig. 2). The majority of vessels with relative standardised effort indices above one had engines with more than 250 HP and 300 pieces of gillnets or more (Appendix A, Tables A.1 and A.2).

5.3. *Economic efficiency of vessels*

5.3.1. *Short-term results with operating costs*

Fig. 3a shows the relative cost efficiency of the 58 gillnet vessels in the short-term, ranked by the height of the bar, which measures the average operating cost per unit of relative standardised effort.[12] The width of each bar in Fig. 3 displays the estimated relative standardised effort, ε_i, of one vessel. To compare the level of rent generated among the sample vessels the average revenue per unit of relative standardised effort is also shown in Fig. 3a, both for the case of excluding subsidies (solid line[13]) and the case of including subsidies (dashed line[14]). In general, the majority of the most cost-efficient vessels in the short-term were those with large relative standardised efforts (above one), while there were many vessels with smaller relative standardised efforts (below one) belonging to the group of lower cost-efficient vessels.[15]

5.3.2. *Economic efficiency of vessels in the long-term*

Fig. 3b presents the estimated long-run cost efficiency. The height of the bars measures the average total cost (excluding the calculated interest on the owner's capital), atc_i, per unit of the relative standardised effort of each vessel.[16] It was seen in Fig. 2 that 30 vessels have a relative standardised effort above one, and in Fig. 3b the details show that 22 of these vessels are among the 34 cost-efficient ones (atc_i is less than or equal to $AR_{os}(E)$). Thus, eight vessels that are among the most efficient half in effort terms are not among the most cost-efficient half when comparing average total costs. From a vessel profitability point of view, government subsidies should be included on the revenue side. Fig. 3b shows that 24 of the 30 vessels with relative standardised effort above one were among the 40 cost-efficient vessels (atc_i is less than or equal to $AR_{ws}(E)$).

On the hypothesis of greater variation in fishing efficiency than in cost efficiency: This hypothesis is clearly not rejected when comparing Fig. 3 with Fig. 2. Whereas the fishing efficiency of the most effective vessel is more than three times that of the least effective one (Fig. 2), the corresponding ratio for cost efficiency variation is about half of this (Fig. 3). Of course, in Fig. 2 the most fishing-efficient vessels are found to the right, while in Fig. 3 the most cost-efficient vessels are found to the left.

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[12] *The average operating cost per unit of relative standardised effort of vessel* i = [*total variable, fixed, labour costs of vessel* i]/ε_i, where ε_i is shown vertically in Fig. 2.

[13] The average revenue per unit of relative standardised effort, without the 2008 fuel cost subsidy, is $AR_{os}(E) = \left[\sum_{i=1}^{58} \text{total revenue of vessel } i, \text{ without subsidy} / \sum_{i=1}^{58} \varepsilon_i\right]$.

[14] The average revenue, including the 2008 fuel subsidy per unit of relative standardised effort is $AR_{ws}(E) = \left[\sum_{i=1}^{58} \text{total revenue of vessel } i, \text{ with subsidy} / \sum_{i=1}^{58} \varepsilon_i\right]$.

[15] For example, in Fig. 3b the eight lowest cost vessels furthest to the left have all in all nine units of standardised effort, whereas the eight highest cost vessels to the right have all in all only about six units of standardised effort.

[16] In this case, total costs consist of variable cost, fixed operating and labour costs, depreciation and interest payment on loans, but without the calculated interest on the vessel owner's capital. The average total costs per unit of the relative standardised fishing effort of vessel i are atc_i = [*total costs of vessel i, excluding the calculated interest*]/ε_i.

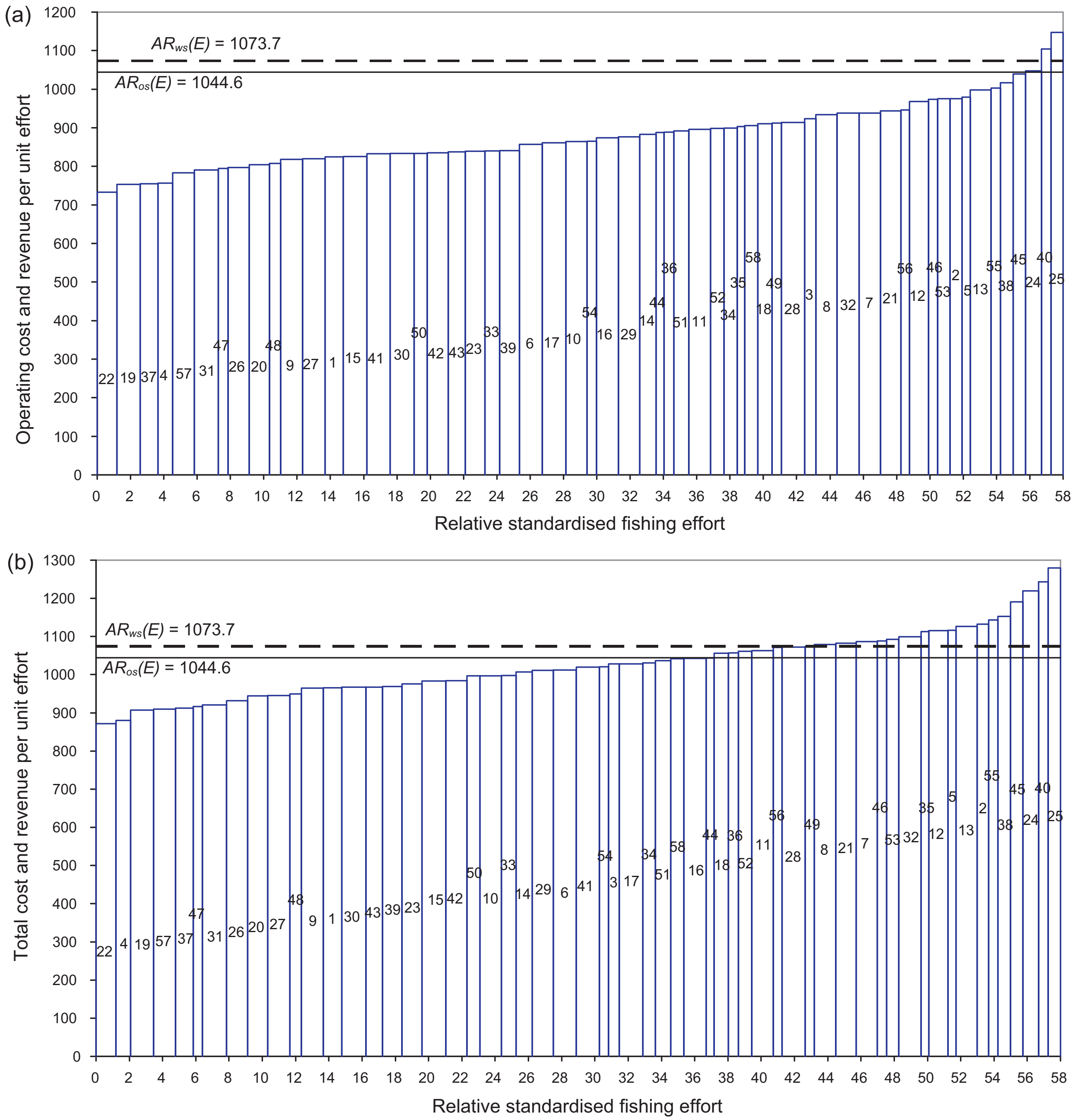

Fig. 3. The cost efficiency among the 58 gillnet vessels in the short run (a), and in the long run (b). The horizontal solid lines are the average revenue from fishing per unit effort of the 58 vessels, $AR_{os}(E)$; the horizontal dashed lines are the average revenue including subsidies per unit effort of the 58 vessels, $AR_{ws}(E)$. The figure within each bar shows the vessel ID number. Unit: million VND per vessel per year.

6. Discussion

As shown in Table 2, the offshore gillnet vessels in the sample of this study, on average in 2008 turned a profit for the operating year. From an efficiency point of view, the design of the subsidy scheme, financial support per trip, was better than support of direct price reduction per litre of fuel. Fishers still had to face the market price of oil. All in all, the fuel cost quasi-lump-sum subsidy contributed to increasing the profit of the gillnet vessels, relatively more for the smallest vessels (Appendix A, Tables A.3 and A.4). This is implicitly based on the assumption that the fuel cost subsidy did not change the behaviour of vessels. This seems reasonable for vessels in this survey since the average number of trips in 2008 was 13.5 and the government support per trip could be paid for a maximum of four trips per year for the smallest (in this survey) and for a maximum of three trips for the biggest engine vessels. The 2008 quasi-lump-sum fuel cost support would be considered to be an unfavourable subsidy in the long run. It could have added to the expansion of effort, in principal leading to stock depletion (Sumaila et al., 2007). However, in hindsight the very high oil price in 2007 so far seems to be an exception from the long-run price development. Vietnamese policymakers decided to abolish the arrangement after only one year.

In 2008, the larger engine vessels showed a better annual economic performance than smaller engine vessels. There are mainly two reasons for this. First, larger engine vessels have higher gross revenue (higher fishing efficiency and higher catches). Second, they are on average more cost-efficient than smaller vessels. In addition, the two groups of 250–400 HP and larger than 400 HP earned the highest annual income for crew members. This is partly because of the overall longer fishing season of the bigger vessels than the small ones. For the Nha Trang gillnet vessels surveyed, the owner–operator derived income from both being a skipper/crew member and from the profit as the vessel owner. Since the average annual profit indicator and crew income increase with HP, there may be incentives for owner–operators to adopt technologies that expand fishing efficiency.

The average annual income per crew member, 17.1 million VND, is about 75% more than the 2008 average income of 9.8 million VND in the Khanh Hoa province (GSO of Khanh Hoa, 2008) and about 43% higher than the 2008 national average income of 11.9 million VND per capita (GSO, 2009). This also corresponds well with the findings reported for 2004 for offshore long-liners of Khanh Hoa in Long et al. (2008) with 14.5 million VND per crew member, although CPI inflation was 55.4% from 2004 to 2008. This demonstrates that crew members may have earned their opportunity cost of labour, or above, in 2008. However, without further investigation it is not possible to tell if lower crew remuneration would still provide sufficient manpower for this offshore fishery.

Capital investment and operating expenses are relatively high in this offshore fishery, and the risk of damaging and losing workers, vessels and fishing gear is high. Gillnets often represent half of the capital invested and the risk of damage is quite large for this fishery because of the high density of various types of vessel activities in fishing grounds as well as difficult weather conditions and the remoteness of grounds. These risk factors are of course also valid for vessels and crew, and they may result in serious outcomes. In principle, risk-induced private costs, such as insurance, gear maintenance and replacement costs, are included in the costs of this study.

The short- and long-term ranking of the 58 gillnet vessels were not very different. A large number of vessels with high relative standardised effort (more than one) were the most effective, both from a fishing efficiency and from a cost efficiency point of view. As a result, the large quasi-rent generated in the short-term and intra-marginal rent gained in the long-term were mostly earned by the same vessels.[17] This result indicates that private fishing investors may still find this fishery attractive in the near future. Either investments in engine capacity and fishing gear or an additional increase in fishing time may continue this growth. This seems to reflect somewhat the situation of Khanh Hoa's fisheries since the total engine power of the fishing fleet continued to increase in 2009 (DECAFIREP, 2009). Of the vessels surveyed, two gillnet vessels had (estimated) negative gross cash flows and 16 out of 58 (27.6%) operated at a loss (profit before the calculated opportunity cost of the owner's capital) even after receiving the 2008 fuel subsidies. These vessels may continue operations as long as the owners consider capital costs as sunk. The loss may be perceived as arising from bad luck or a poor year and not being expected to persist over time. The long-run resource effect of the expansion/contraction of capacity in this vessel group is probably marginal since their resources mainly are internationally open-access resources in the East Sea (South China Sea).

The average return on the owner's capital of 6.1% was less than the presumed opportunity cost rate of 9%. A large number of vessels made economic losses, after calculated capital costs, whereas a smaller number of vessels were generating intra-marginal rent. In general, the largest vessels (high HP) earned a higher rent than the smaller ones, but there are some exceptions. The exceptions, namely that some of the smaller vessels perform well, economically speaking, are important when it comes to policymaking. It is not always the case that "big is beautiful" and that the smaller vessels should be forced or bought out if the fishery is transformed from open access to management of some sort. It should also be noted that the average gillnet vessel's economic loss, including the calculated interest on the owner's capital, does not necessarily contradict the open-access fisheries theory with heterogeneous vessels since the results of this study are based on data for only one year. Moreover, the effects of the world economic crisis on the national economy combined with 2007s peak oil prices may have created special economic problems for Vietnam as well as for other developing countries' fisheries.

7. Conclusion

This study demonstrates that for offshore gillnet vessels the engine HP effect, the amount of gear and the days of operation are the factors that best produce indicators of vessel efficiency. Relative standardised effort was developed and estimated for surveyed vessels. To the best of our knowledge, this method for comparing vessel efficiency has not been published previously. The presented economic analysis shows that an average gillnetter in 2008 earned a positive gross profit margin and profit margin, even when the quasi-lump-sum fuel subsidies are excluded. This is close to what was expected based on the discussion of the theory of open-access fisheries. However, the average gillnet vessel would not have been able to meet all the calculated interest on the owner's capital as well. The most economically efficient vessels are mainly, but not only, those with high relative standardised effort. These vessels earned most of the intra-marginal rent generated. The 2008 fuel subsidies brought relatively more benefits for small-scale vessels than for large-scale ones. The results also demonstrate that on an annual basis, average crew income is almost the same as for the workers with higher educational levels or technical/vocational training working in the most profitable registered enterprises in Khanh Hoa, and on a monthly basis, it is even more.

The 2007 strong oil price increase sparked outcries in many countries from frustrated fishers and other small businesses depending on this input. Some governments reduced petroleum or climate change taxes or other compensation schemes to mitigate the income-reducing effects on oil-dependent businesses. This also happened in Vietnam with the introduction of quasi-lump-sum fuel cost support. As discussed in this paper, this arrangement had a significant positive effect on the net earnings of the surveyed gillnet vessels. However, the incentive for fishers to save costly fuel oil was mainly retained, even though in the long run such a revenue-enhancing scheme would most likely have kept or added capacity to the fleet compared with the situation with no support. The actual crude oil price decline during 2008 eliminated the arguments for further support scheme.

The economic efficiency and performance of vessels in an open-access fishery have been investigated and it has been demonstrated

[17] In practice, the differences in rent may arise from the differences in catch composition. Mackerel species often bring higher revenue than tuna species in this fishery. However, as mentioned above, the majority of Nha Trang's offshore gillnet operators are tuna gillnet vessels, which were surveyed. The investigation found that, in fishing grounds of high sea waters, skipjack tuna is the major target species occupying over 90% of the total catch and with little variation among vessels. Therefore, it may be appropriate to assume that the catch composition is the same for all vessels.

that some vessels make good earnings. These are the intra-marginal vessels in the heterogeneous fleets. This could imply that even in equilibrium in an open-access fishery with heterogeneous vessels, some of them may improve their economic performance by the introduction of cost saving practices. It is important to note that even in open-access fisheries many vessels may create net benefits to society as demonstrated in this paper. Before instigating costly management systems, a thorough consideration of the alternatives with their benefits and costs is a big challenge to any fishing nation, not least to a developing country such as Vietnam. How to govern and manage fisheries in a cost-efficient way is still an important question for governments, fishing industries and researchers.

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Appendices A and B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.fishres.2012.04.008.

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Appendix A.

Technical and operational characteristics and economic performance among vessel groups

Table A.1:

Technical and operational characteristics of the surveyed vessels, 2008

Criteria	N	Mean	Min	Max	S.D.
Engine (HP)	58	249.6	50.0	630.0	149.3
Length (m)	58	16.4	13.5	20.1	1.6
Age of vessel (years)	58	8.7	2.0	21.0	5.2
Gear [a]	58	267.7	150.0	350.0	63.6
Total operating months (months)	58	10.3	7.0	12.0	1.1
Number of trips fished (trips)	58	13.5	7.0	33.0	5.4
Number of days fished (days)	58	231.2	140.0	288.0	28.6
Fuel consumption (1000 litres)	58	31.9	11.0	55.0	11.8
Crews (persons)[b]	58	10.5	8.0	12.0	1.4

Notes: All parameters are per vessel.

[a] "Gear" indicates the average number of pieces of gillnets.

[b] Crew size includes captain.

Source: own data and calculations

Table A.2:

Technical and operational characteristics of the surveyed vessels by ranges of engine, 2008

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	SD	Mean	SD	Mean	SD	Mean	SD
Engine (HP)	64.6	*12.0*	148.4	*54.7*	333.9	*33.3*	452.7	*63.7*
Length (m)	14.7	*0.7*	15.5	*0.9*	17.2	*1.0*	18.2	*0.7*
Age of vessel (years)	14.2	*3.4*	10.0	*4.6*	7.0	*4.2*	3.8	*3.3*
Gear [a]	184.3	*29.0*	240.3	*46.6*	307.5	*31.4*	330.1	*15.3*
Total operating months (months)	9.8	*1.2*	10.0	*1.2*	10.6	*1.0*	10.7	*0.5*
Number of trips fished (trips)	21.0	*5.7*	12.6	*4.5*	11.2	*2.3*	10.7	*0.5*
Number of days fished (days)	212.7	*32.4*	219.6	*20.5*	240.5	*27.5*	252.4	*15.7*
Fuel consumption (1000 litres)	17.3	*4.5*	26.9	*7.9*	37.8	*7.1*	45.1	*6.5*
Crews (persons)[b]	8.6	*0.7*	9.9	*0.8*	11.3	*0.8*	11.9	*0.3*

Notes: All parameters are per vessel.

[a] "Gear" indicates the average number of pieces of gillnets.

[b] Crew size includes captain.

Source: own data and calculations

Table A.3:

Economic performance indicators among vessel groups, including the 2008 fuel subsidies, in million VND

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	SD	Mean	SD	Mean	SD	Mean	SD
Gross revenue from fishing	594.2	*75.6*	848.1	*168.3*	1,249.7	*125.1*	1,467.3	*70.9*
Subsidy	26.0	*0.0*	30.0	*0.0*	30.0	*0.0*	30.0	*0.0*
Gross revenue with subsidy	620.2	*75.6*	878.1	*168.3*	1,279.7	*125.1*	1,497.3	*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*	0.3	*69.3*
Net capital value	344.5	*108.1*	633.0	*185.7*	1,024.6	*274.1*	1,483.1	*314.2*
Net owner's capital	308.5	*81.6*	537.5	*209.1*	937.7	*326.5*	1,301.3	*330.4*
Gross profit margin[a]	0.145	*0.088*	0.145	*0.101*	0.187	*0.069*	0.219	*0.043*
Profit margin[a]	0.015	*0.095*	0.011	*0.103*	0.053	*0.072*	0.078	*0.046*
Return on capital value[a]	0.046	*0.178*	0.021	*0.152*	0.068	*0.096*	0.081	*0.052*
Return on owner's capital[a]	0.046	*0.185*	0.031	*0.169*	0.077	*0.113*	0.093	*0.063*
Average income per fisherman	12.2	*4.2*	14.2	*3.7*	19.2	*4.8*	23.1	*4.6*

[a] These indicators are estimated with relative to standard deviation, and measured in decimal numbers.

Source: Own data and calculations.

Table A.4:

Key economic performance indicators among vessel groups, excluding the 2008 subsidies, in million VND

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	SD	Mean	SD	Mean	SD	Mean	SD
Gross revenue from fishing	594.2	*75.6*	848.1	*168.3*	1,249.7	*125.1*	1,467.3	*70.9*
Income	227.8	*50.8*	316.8	*137.0*	535.1	*81.6*	687.3	*79.9*
Gross value added	169.7	*49.7*	244.9	*125.6*	424.5	*78.8*	574.9	*83.7*
Gross cash flow	64.0	*59.7*	103.5	*110.1*	207.7	*88.0*	299.5	*71.2*
Profit	-16.1	*62.6*	-13.6	*100.9*	36.2	*92.8*	87.4	*71.2*
Net profit	-43.9	*65.1*	-62.0	*97.6*	-48.2	*94.8*	-29.7	*69.3*
Gross profit margin[a]	0.107	*0.092*	0.114	*0.107*	0.167	*0.070*	0.203	*0.044*
Profit margin[a]	-0.029	*0.099*	-0.025	*0.109*	0.030	*0.073*	0.059	*0.047*
Return on capital value[a]	-0.036	*0.170*	-0.033	*0.150*	0.037	*0.095*	0.060	*0.050*
Return on owner's capital[a]	-0.044	*0.179*	-0.036	*0.165*	0.040	*0.111*	0.068	*0.062*

[a] These indicators are estimated with relative to standard deviation, and measured in decimal numbers.

Source: Own data and calculations.

Appendix B.

Sample representativeness

Table B.1:

Sample representativeness test

Variable	N	Sample mean	S.D.	Mean of the population	t-test statistic	P-value
Hull length (m)	58	16.426	1.550	16.140	1.413	0.163.