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The Economics of Open-Access Fisheries

Subsidies and Performance of Vietnamese Fisheries

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List of papers

Paper I:

Nguyen Ngoc Duy, Ola Flaaten, Nguyen Thi Kim Anh and Quach Thi Khanh Ngoc (2012). Open-access Fishing Rent and Efficiency - The Case of Gillnet Vessels in Nha Trang, Vietnam. *Fisheries Research*, 127-128:98-108.

Paper II:

Nguyen Ngoc Duy, Ola Flaaten and Le Kim Long (2015). Government Support and Profitability Effects – Vietnamese Offshore Fisheries. *Marine Policy*, 61:77-86.

Paper III:

Nguyen Ngoc Duy and Ola Flaaten. Profitability Effects and Fishery Subsidies: Average Treatment Effects based on Propensity Scores. *Resubmitted to the Journal of Marine Resource Economics.*

Paper IV:

Nguyen Ngoc Duy and Ola Flaaten. Efficiency Analysis of Fisheries using Stock Proxies. *The paper will be resubmitted to the Journal of Fisheries Research.*

Abbreviations and acronyms

CPUE	Catch per unit of effort
DARD	Department of Agriculture and Rural Development
DEA	Data Envelopment Analysis
DECAFIREP	Department of Capture Fisheries and Resources Protection
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization
GPS	Global Positioning System
GSO	General Statistics Office
IUU	Illegal, Unregulated and Unreported
HP	Horsepower
LME	Large Marine Ecosystem
MSY	Maximum Sustainable Yield
OECD	Organization for Economic Co-operation and Development
SCS	South China Sea
SEAFDEC	Southeast Asian Fisheries Development Center
SPF	Stochastic Production Frontier
TE	Technical efficiency
TPP	Trans-Pacific Partnership
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
VND	Vietnamese dong
WTO	World Trade Organization

Summary

This dissertation focuses on analysing the economics of an open-access fishery and on evaluating the effects of government subsidy programmes on the fishing industry. The dissertation adopts a sustainable development perspective for assessing the effects of subsidies. Although the key focus of the research is on the economic effects of subsidies, the ecological and social dimensions are taken into account. The dissertation integrates the theoretical frameworks of bioeconomics and vessel economics of fisheries and empirical investigations to examine the research problems. The empirical analyses are applied to Vietnam's open-access offshore fisheries operating in the South China Sea (SCS).

The first result is that open-access fisheries can create net benefits for society, which are termed intra-marginal rent. Regarding the economic dimension, the Vietnamese Government's subsidy programmes had positive effects on the profitability of the investigated vessels in the years of the analysis. However, the profits were eroded over the years. The results indicate that the Government's intervention by use of subsidies led to a reduction in the actual surpluses of the investigated offshore fisheries compared with the situation with no intervention. Therefore, the offshore fisheries could be profitable for the vessel owners in the short term without being socially optimal in the long term. Regarding the ecological dimension, the estimate of fish stock proxy indices shows that the fish resources in Vietnam's offshore waters are most likely to be biologically overfished. In relation to the social dimension, the dissertation addresses the area of human well-being, particularly concerning the aspect of income and rent distribution. The larger vessels (i.e., those with a larger engine) received relatively more support from the 2010 subsidy programme than the smaller ones and earned most of the super-profit as well as the intra-marginal rent generated. The 2010 subsidy schemes provided relatively more benefits for large vessels than for small ones, and this is the opposite case to the 2008 arrangements. However, the bigger subsidies

for larger vessels did not help all of them to achieve a higher level of economic performance. The average treatment effect of the subsidies on the rent of the largest vessels was negative. In addition, the Government subsidy programmes generated benefits for the vessel owners rather than for the crewmembers. The large-scale vessels generally provided a greater annual income for crewmembers, although insignificant effects of the subsidy arrangements on the income for crewmembers were found.

Overall, the dissertation indicates that the Government's subsidy interventions have had a negative impact on the sustainable development of the offshore fisheries. The design of such subsidy programmes provides incentives for fishers to invest in their fishing effort and capacity. The policy goal of improving the income and profitability of the fisheries by the use of subsidies can be achieved only in the short term under the open-access fishing scheme. In the long term, the environmental deterioration will counter the effect of the subsidies on economic and social sustainability.

The dissertation recommends that it would be wise for Vietnam to seek to operate a fisheries management system that is designed to prevent overfishing and overcapacity and to promote the recovery of overfished stocks for offshore fisheries, hence approaching the goals of sustainable development. It also important for Vietnam to enhance its offshore fishing programmes to reduce the pressure on the already-overfished coastal resources through support that does not contribute to overfishing and overcapacity. However, international negotiations and the existing dispute settlements based on international law should firstly be used to identify an internationally recognized delineation of the SCS to avoid encouraging the presence of countries' own vessels in this region with the use of subsidies. The establishment of an effectively cooperative fishing regime in the SCS region should be promoted. The calls for sharing the total allowable catch among the involved countries should be considered.

Finally, the dissertation contributes to the further development of the methods for comparing the economic performance and efficiency of vessels by the standardization of fishing effort and the estimation of a Salter diagram. It extends the traditional economic model of Gordon to illustrate the existence of intra-marginal rent for an open-access fishery with heterogeneous vessels and to model the static effects of revenue-enhancing lump sum subsidies on the fishery and individual vessels. It provides the first contribution to the literature regarding the treatment effect evaluation of a subsidy programme on a Southeast Asian fishery. It also uses different fish stock measures to estimate the technical efficiency of vessels due to the lack of stock estimates, which have been ignored in the previously published studies on Vietnam's fisheries. For future work, the subsidy policies should be reviewed and assessed at national levels. A proper analysis framework for assessing the effects of fisheries subsidies, including consistent methodologies, should be developed for the SCS fisheries. This review and assessment should address the economic, environmental and social outcomes, potential trade-offs and cost-effectiveness, as well as taking into account the size of the impacts and the probabilities associated with the potential outcomes.

PART 1. INTRODUCTION

1. Background, research problems and objectives

In fisheries economics, it is generally accepted that commercial fishers are profit-seekers. The existence of any positive economic profit will thus attract new entrants. For an open-access fishery in which the property rights of fish resources are not defined, the potential resource rent is wasted and dissipated (Clark, 1990; Gordon, 1954). This is described as a consequence of the "tragedy of the commons" introduced by Hardin (1968). However, a producer's surplus, called intra-marginal rent in fisheries, may exist even under open-access equilibrium (Coglan and Pascoe, 1999; Copes, 1972; Flaaten, 2016). Therefore, it may be appropriate to determine first whether an open-access fishery creates any net benefits, such as intra-marginal rent. It is thus important to examine the economic dimension to address this issue. In other words, this dissertation emphasizes the economic analysis of an open-access fishery.

The empirical focus of this dissertation is on Vietnamese offshore fisheries in the East Sea, internationally known as the SCS, which are fished competitively by vessels from more than 10 countries. Vietnam has a coastline of about 3,260 km and its exclusive economic zone (EEZ) extends over more than 1 million square kilometres (FAO, 2005b). Vietnam's marine capture fisheries are characterized by open access (UNEP et al., 2009) and are generally referred to as small scale since a large number of small vessels equipped with engines of less than 90 horsepower (HP) operate in its coastal waters (Pomeroy et al., 2009). These have resulted in increasing pressure on already-overfished near-shore resources (FAO, 2005b). To reduce this pressure, since 1997, the Vietnamese Government has made strenuous efforts to develop its offshore fishing industry (FAO, 2005b; UNEP et al., 2009). In 1997, Vietnam introduced an investment programme for offshore vessels, and in 2008, it introduced fuel cost compensation subsidies, along with another subsidy programme in 2010. As a result, Vietnam's offshore fishing industry has been characterized as an open-access fishery subsidized by the Government's financial transfers or support in recent years.

In principle, fisheries subsidies have an impact on the profits of fishing vessels by either increasing their revenues or reducing their costs (Flaaten and Wallis, 2001; OECD, 2006; Schrank, 2003; Sumaila, 2013; von Moltke, 2011; Westlund, 2004). It is thus important to ask whether, and to what extent, the revenues are enhanced or the costs lowered by the subsidies. Therefore, this dissertation mainly focuses on evaluating the economic effects of the Government's subsidy programmes for Vietnam's offshore fisheries. This implies that it analyses the impacts of subsidies on key aspects of the economic dimension, that is, the economic performance and efficiency of offshore fishing vessels. This issue is addressed through the following questions:

i. What is the economic performance of offshore fishing vessels? (Papers 1, 2 and 3)
ii. What is the technical efficiency of offshore fishing vessels? (Paper 4)
iii. Which vessels earn intra-marginal rent? (Papers 1, 2 and 3)
iv. Which vessels are economically more efficient than others? (Paper 1)
v. What is the income of crewmembers? (Papers 1, 2 and 3)
vi. How do subsidies affect the economic profitability of vessels? (Papers 1, 2 and 3)

The subsidies of offshore fishing vessels are investigated and quantified, mainly through representative costs and earnings surveys; then, the study examines the effect of these subsidies on the economic profitability of the vessels. Economic performance indicators are used to evaluate the vessel profitability and to investigate whether intra-marginal rent exists in the investigated fleets. The effects of the Government subsidies are analysed by a static comparison of the economic performance of vessels including and excluding subsidies (Papers 1 and 2). Following the analysis principles introduced by Westlund (2004), this is referred to as an assessment that constitutes a snapshot of the current situation. However, it is appropriate to ask what would have happened to the vessel profitability if a subsidy programme had not been implemented. To deal properly with this research problem, the dissertation undertakes evaluations by comparing the profitability when the Government's subsidy action takes place with that without this action (Paper 3).

By answering the research questions, the distributional impacts of the subsidies are also explored. What is the effect on rent generation and distribution? Who is affected more and who less by the subsidies? Since the subsidies will have a certain impact on the distribution of incomes (Munro and Sumaila, 2002), identifying those beneficiaries who are affected by a subsidy is an important step in determining the likely effects of a subsidy and the effectiveness of a subsidy programme (OECD, 2006). The aspect of human well-being (the social dimension of the subsidies) is thus addressed within the aspect of income distribution (Papers 1, 2 and 3).

The effects of subsidies on resources will depend on the state of the fish stocks, as well as on the type of the fisheries management regimes (OECD, 2006; von Moltke, 2011). In open-access fisheries, in which entry to the fisheries is not restricted, the abnormal profit generated by subsidies will distort the economic incentives and encourage overinvestment in the fisheries, resulting in a negative impact on fisheries' resources – an aspect of the environmental (ecological) dimension (OECD, 2006). The effects of subsidies on resources are probably from a long-term perspective. With the knowledge and information currently available, a proper analysis of the effects of subsidies on resources is difficult to conduct. Nevertheless, the dissertation attempts to estimate fish stock proxy indices and to provide reasonable discussions on the status of fisheries' resources (Paper 4).

It can be seen that although the key focus of the research is on the economic effects of subsidies, the ecological and social dimensions are taken into account. This means that the dissertation adopts a sustainable development perspective for assessing the effects of the

Government subsidies. It is generally accepted that subsidies in open-access fisheries can be considered unsustainable, especially in economic and resource terms (OECD, 2006; Sumaila, 2013; von Moltke, 2011). However, based on the dimensions of a sustainable development framework, the dissertation attempts to provide an insight into the extent to which open-access fisheries are affected by the Government subsidy programmes.

The remainder of the dissertation is organized as follows. Section 2 provides background information on the SCS fisheries, followed by information on Vietnam's offshore fisheries and subsidy programmes in Section 3. Section 4 gives a brief overview of the concepts of subsidy and sustainable development. Section 5 explains the theoretical frameworks used in the papers, followed by the methodology in Section 6 and the data in Section 7. Section 8 focuses on the research results. This section describes the connection between the four papers. The main achievements, concluding remarks and future works are summarized in Section 9. Finally, the four papers are presented in detail in Part 2.

2. The fisheries in the South China Sea

"The South China Sea" refers to a semi-enclosed sea that is part of the Pacific Ocean and is located in Southeast Asia. It encompasses an area of around 3.5 million km^2 (Pauly and Christensen, 1993). It is formed from the marine, coastal and hinterland river catchments of ten nations: China, Vietnam, Cambodia, Thailand, Malaysia, Singapore, Indonesia, Brunei, the Philippines and Taiwan. The SCS is also recognized as a large marine ecosystem (LME), excluding the Gulf of Thailand, with specific characteristics of oceanography, biogeography and ecology (Sherman and Hempel, 2009). The SCS LME covers an area of 3.1 million km^2 and contains 7.27% and 0.93% of the world's coral reefs and seamounts, respectively (Pauly and Zeller, 2015).

The SCS region is described as the global centre of biodiversity for marine species with a tropical climate (Pauly and Christensen, 1993; UNEP, 2005b). The region provides some of the world's most diverse sea grass beds and mangrove forests, as well as more than 2,500 species of marine fishes and 500 species of reef-building corals (UNEP, 2005b). It is considered to be a moderate-productivity ecosystem (150–300 $mgCm^{-2}day^{-1}$) (Sherman and Hempel, 2009, p.297). More details on the ecosystems in the SCS can be found in the documents of Pauly and Christensen (1993) and the UNEP (2005b).

The fisheries in the SCS are of great local, national and international importance (UNEP, 2005b). The marine fisheries are a major contributor to the food security and economy of the bordering countries. The reported landings from the SCS have increased from 0.6 million tonnes in 1950 to over 8.6 million tonnes in 2010 (Pauly and Zeller, 2015). Illegal, unregulated and unreported (IUU) fishing is also a characteristic of this region (UNEP, 2005b). The unreported landings are estimated to have been almost half (4.2 million tonnes) of the reported landings in 2010 (Pauly and Zeller, 2015).

The total catch production (both the reported and the unreported landings) in the SCS increased significantly during the period from 1950 to 2003, dramatically decreased in the period from 2003 to 2008 and rose slightly again in the years 2008 to 2010 (see Figure 1). China, Thailand and Vietnam have the greatest fishing volumes (Figure 1), with landings of 3.7, 3.4 and 2.8 million tonnes in 2010, respectively (Pauly and Zeller, 2015).

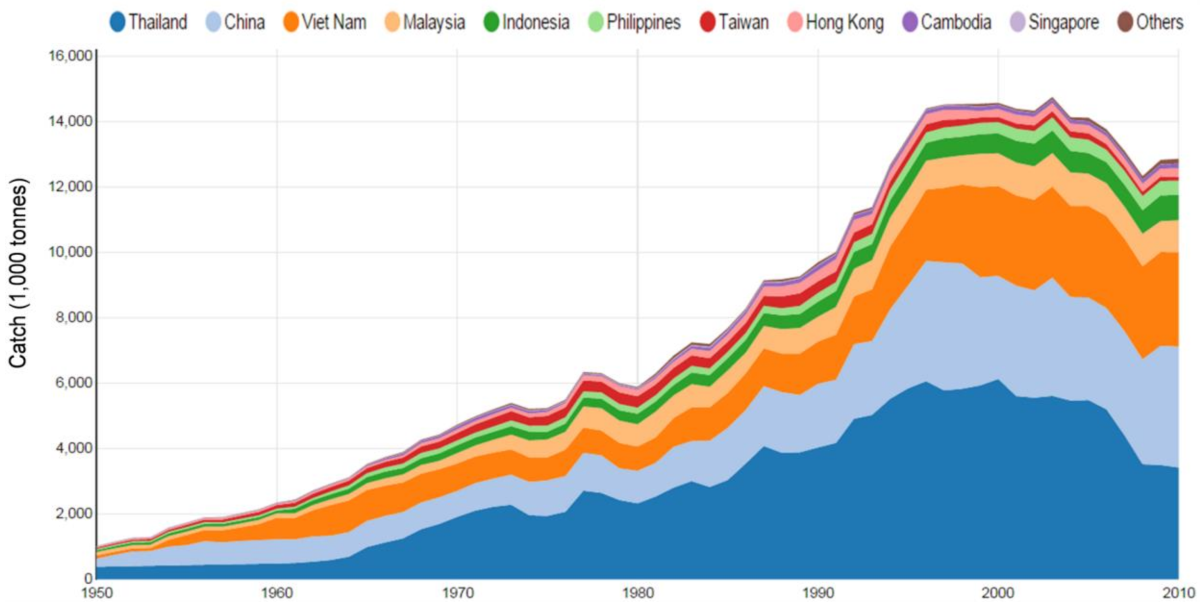

Figure 1. Total landings by fishing country in the South China Sea LME.

Source: Pauly and Zeller (2015), available from http://www.seaaroundus.org/data/#/lme/36?chart=catch-chart&dimension=country&measure=tonnage&limit=10 (cited 14 November 2015).

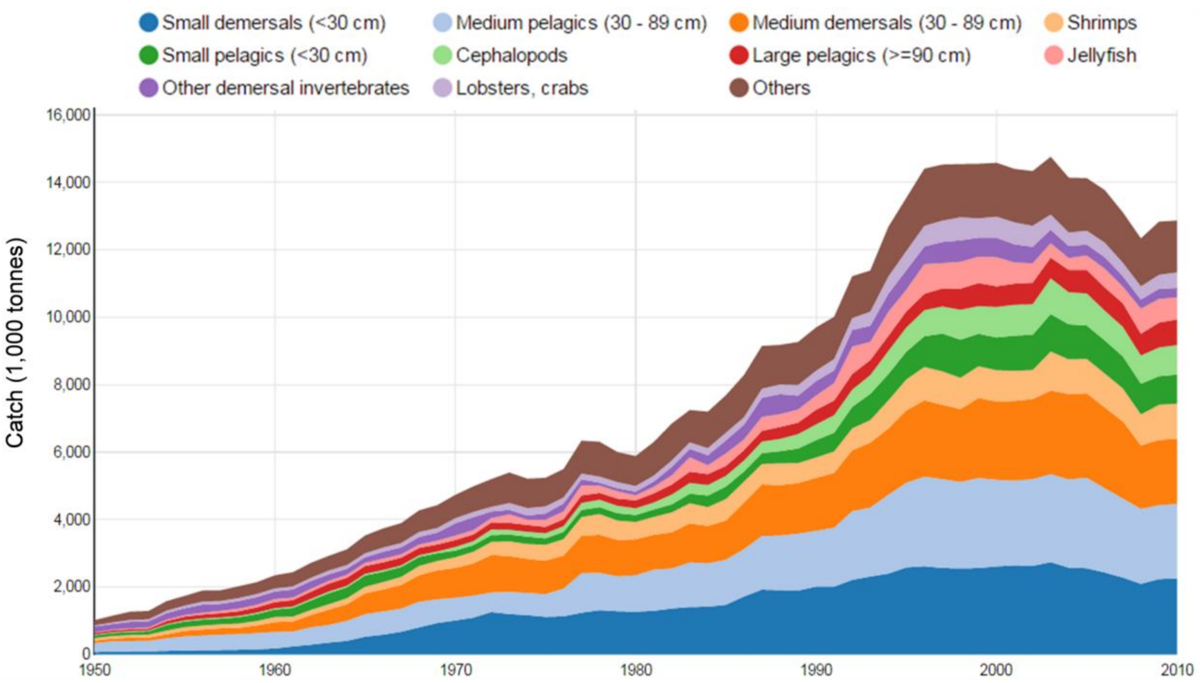

Figure 2. Catches by functional groups in the South China Sea LME.

Source: Pauly and Zeller (2015), available from http://www.seaaroundus.org/data/#/lme/36?chart=catch-chart&dimension=functionalgroup&measure=tonnage&limit=10 (cited 14 November 2015).

The targeted groups for harvesting in the SCS include tuna, mackerel, scad, flying fish, billfish and sharks for the pelagic species along with a large array of demersal fish and invertebrates, especially penaeid shrimps (Sherman and Hempel, 2009). Small demersals (< 30 cm) and medium pelagics (30–89 cm) both accounted for the largest amounts, almost half of the total landings, in the years 1950–2010 (Figure 2). In 2010, the catches of these two functional groups were around 2.2 million tonnes each (Pauly and Zeller, 2015). The most economically important species being exploited from the SCS's pelagic fish stocks as well as from demersal and high-sea resources include, among others, tuna, mackerel, round scad, anchovies and sardines (SEAFDEC, 2012, 2013). The catches of pelagic fish species are estimated to be about 3.9 million tonnes (accounting for 45.3% of the total landings) in 2010 (Pauly and Zeller, 2015). These highly migratory fish species are generally recognized as migrating across the EEZs of more than one country and international waters and thus are also known as shared stocks (Ablan and Garces, 2005).

However, the majority of the catches are supplied by overexploited and exploited stocks (Figure 3a). Meanwhile, the stock–catch status plots indicate that about 40.9% of the stocks in the SCS LME are overexploited or collapsed (Figure 3b). The primary driving force of biomass change in this region comes from intensive fishing (Sherman and Hempel, 2009). The SCS is characterized by overexploitation and overcapacity due to increasing fishing effort over the years (Ablan and Garces, 2005; UNEP, 2005b). As a result, there are indications of overfishing in the SCS (Pauly and Zeller, 2015; Sherman and Hempel, 2009). The UNEP's (2006) assessment of the SCS highlights the range and severity of the socioeconomic effects of overfishing. Throughout the region, reduced economic returns and loss of income and employment as well as of livelihoods have resulted from the fisheries' collapse (UNEP, 2006).

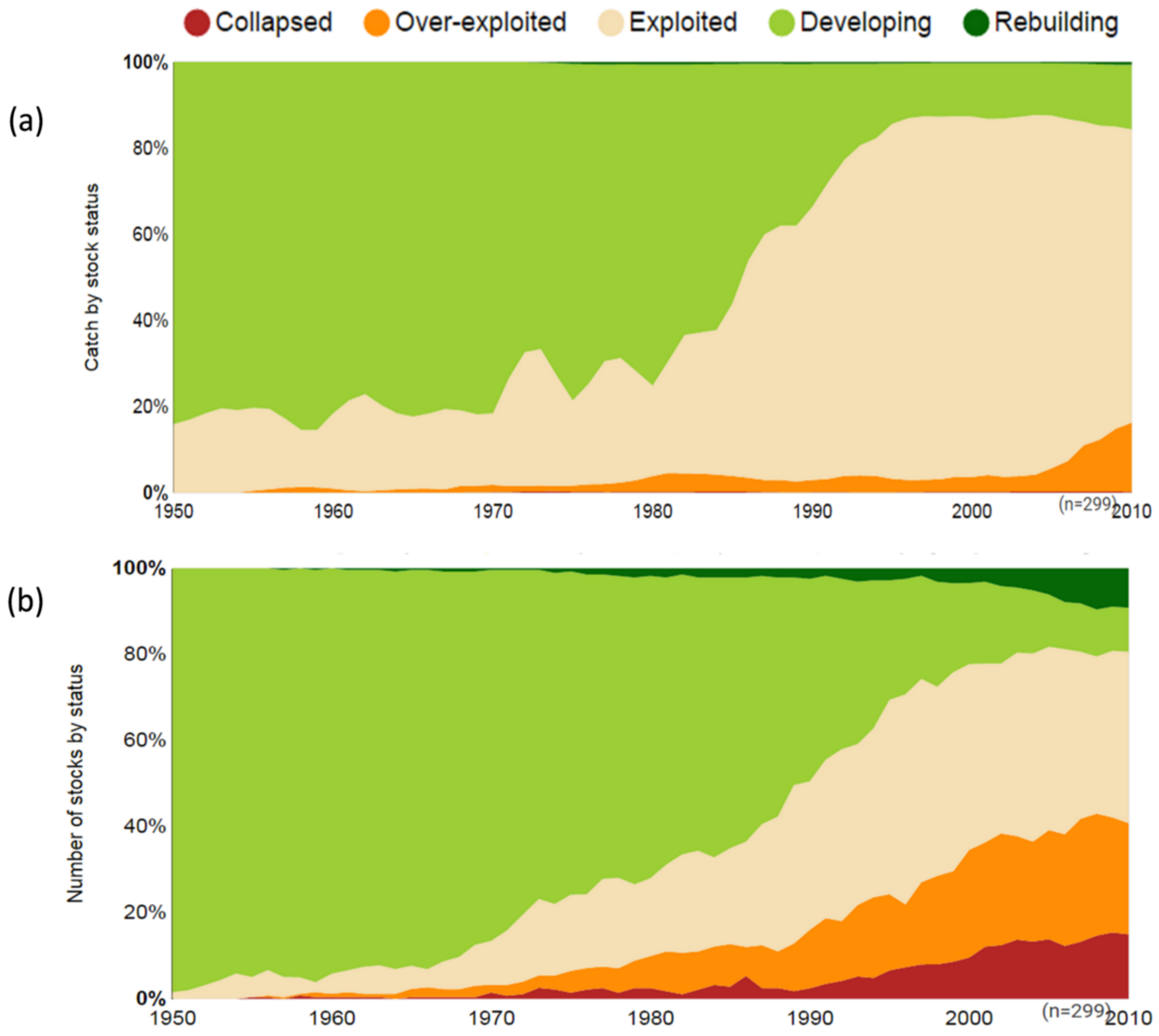

Figure 3. Stock–catch status plots for the South China Sea LME.

Notes: (a) The percentage of catches from stocks of a given status and (b) the percentage of stocks of a given status. The stock status plots assess the status of stocks by catch biomass (3-year running average values; panel (a)) and by the number of stocks (panel (b)) from 1950 to 2010. The stock–status categories are defined using the following criteria (all referring to the maximum catch [peak catch] or post-peak minimum in each series): developing (catches ≤ 50% of the peak and the year is pre-peak or the year of the peak is the final year of the time series); exploited (catches ≥ 50% of the peak catches); overexploited (catches between 50% and 10% of the peak and the year is post-peak); collapsed (catches < 10% of the peak and the year is post-peak); and rebuilding (catches between 10% and 50% of the peak and the year is after the post-peak minimum). The number of stocks (n) is defined as a time series of a given species, genus or family (higher and pooled groups have been excluded) for which the first and last reported landings are at least 10 years apart, for which there are at least 5 years of consecutive catches and for which the catch in a given area is at least 1000 tonnes. *Source*: Pauly and Zeller (2015), available from http://www.seaaroundus.org/data/#/lme/36/stock-status (cited 14 November 2015).

The SCS is one of the world's most contentious areas in relation to international waters, with significant territorial disputes among neighbouring countries (UNEP, 2005b). There have been significant territorial disputes between China and Vietnam over the sovereignty of the Paracel Islands (which have been occupied by China instead of Vietnam since 1974; Thao, 2001) and among China and Taiwan and their Southeast Asia neighbours over the sovereignty of the Spratly Islands and other offshore resources (UNEP, 2005b). A review of the disputes in the SCS was documented by Long (2009), particularly relating to access to fisheries.

The 1982 United Nations Convention on the Law of the Sea (UNCLOS), with the provision that all littoral countries can demand an EEZ of 200 nautical miles measured from the coastline, led to increased tensions in the SCS (Ablan and Garces, 2005; Han, 2007; Thao, 2001; UNEP, 2005b). The governments of the countries bordering the SCS publicly exhort their fishermen to fish in disputed waters (UNEP, 2006). Consequently, the establishment of EEZs has contributed to overexploitation and overcapacity of the fisheries in this region (Ablan and Garces, 2005; UNEP, 2005b). The governments have encouraged the development of the national fishing capacity and the use of advanced fishing technology to promote the development. They have provided subsidies to fisheries for social, economic and cultural reasons. An estimation of the fisheries subsidies of the countries bordering the SCS can be found in Sumaila and Pauly (2006). The governments have also encouraged fishing offshore and fishing agreements with other countries, which in several cases has created excess capacity (Ablan and Garces, 2005). All these factors have increased the fishing effort on fish stocks.

In addition, the SCS fisheries are generally considered to be open access as most countries on the margins of this sea region have very limited resources to monitor and control effectively the area bounded by their EEZs (Ablan and Garces, 2005). A transboundary diagnostic analysis conducted by Talaue-McManus (2000) identified loss of fisheries' productivity in the international waters of the SCS region as a key transboundary issue. Oceanic migratory species, such as tuna, billfish, sharks and other pelagic species, are overexploited, with potential transboundary effects (Sherman and Hempel, 2009; UNEP, 2005b). A regional management plan for the maintenance of transboundary fish stocks in the SCS region has been promoted. However, many transboundary issues remain unresolved due to the aftermath of regional conflicts, colonial heritage and international political affiliations (UNEP, 2005b). Therefore, the countries bordering the SCS have been facing problems regarding the socioeconomic impacts of unsustainable exploitation of fisheries and environmental deterioration, including the effect of subsidy policies (Ablan and Garces, 2005; Sherman and Hempel, 2009; UNEP, 2005b, 2006).

3. Marine capture fisheries and subsidies in Vietnam

3.1. Overview of marine capture fisheries in Vietnam

Vietnam's marine capture fisheries have started developing since the economic reforms of "Doi Moi" in 1986. However, after the U.S. lifted the embargo for Vietnam in 1994, its marine capture fisheries developed significantly, for exports as well, as the Vietnamese Government recognized the opportunities for Vietnam to invest in the fisheries sector for socioeconomic development. Subsidies were used to develop its marine capture fisheries, especially offshore fisheries.

Vietnam's coast has many bays and estuaries as well as diverse coastal and marine resources; thus, its EEZ contains an abundant number of species (FAO, 2005b). According to a recent evaluation, the potential of the marine fisheries' resources has been estimated to be 5.075 million tonnes, of which small pelagic fish account for 54% and demersal fish and oceanographic pelagic fish each occupy about 23% (Directorate of Fisheries, 2012a). The annual sustainable catch is 2.147 million tonnes, including 1.1 million tonnes of small pelagic species, 0.587 million tonnes of demersal fish and 0.462 tonnes of oceanographic pelagic fish. 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 nearly 4% to the gross domestic product (FAO, 2005a, 2005b; World Bank, 2005). The marine capture fisheries provide direct employment for 750,000 fishers, with annual average growth of about 50,000 people during the period 2001–2011 (Directorate of Fisheries, 2012a).

Vietnam’s marine fisheries are open access as participants are free to enter and the few regulations are almost unenforced (FAO, 2005a; UNEP et al., 2009). The number of mechanized fishing vessels has increased by about 5.2% per annum, from 71,495 units in 2001 to about 130,000 units in 2012 (Directorate of Fisheries, 2012a, 2012b). The average engine capacity of the vessels has increased from below 3.5 million HP in 2001 to over 7 million HP in 2012 – an average of 6.5% per year. Vessels with engine power of over 90 HP accounted for 1.4% in 1997 and around 8% in the years 2000–2002 (Directorate of Fisheries, 2012b; FAO, 2005a, 2005b). This increased to over 20% in the years 2011–2014 and reached about 31,235 units by 2014 (GSO, 2014). This indicates that Vietnam’s marine capture fisheries are considered to be small scale as a large amount of vessels are equipped with a small engine size (i.e., less than 90 HP) and these vessels operate mainly in coastal sea areas.

The Vietnamese fishing vessels are multi-gear. The most popular fishing gears are trawl, gillnet, longline/hand-line and purse seine. The structure of the vessels by fishing gear has changed over time. In 2001, the gillnet fleet accounted for the largest number of vessels, with 24.5%, followed by trawl (22.5%), longline/hand-line (19.7%) and purse seine (7.7%) (Directorate of Fisheries, 2012a). By 2010, this proportion had changed as follows: gillnet (accounting for 36.8%), trawl (17.6%), longline/hand-line (17.0%) and purse seine (4.8%).

Of the vessels equipped with engines smaller than 90 HP in 2010, the number of gillnet, longline/hand-line and trawl vessels accounted for the greatest amount, with 41.2%, 17.6% and 12.8%, respectively.

Vietnam's marine capture fishery production amounted to 1.481 million tonnes in 2001 and 2.511 million tonnes in 2012 – an increase of 4.9% per year (GSO, 2005, 2014). The fishing productivity declined from 19.9 tonnes/vessel/year and 0.42 tonnes/HP/year in 2001 to 17.3 tonnes/vessel/year and 0.34 tonnes/HP/year in 2010 (Directorate of Fisheries, 2012a). It should be noted that catch landings from inshore waters accounted for 70% of the total marine catch in 2001 and this figure decreased to below 50% in the years 2010–2014.

In recent years, Vietnam's coastal resources have been considered to be overexploited and biologically overfished (FAO, 2005b; UNEP et al., 2009; World Bank, 2005). This has led to a serious effect on the economic, ecological and social aspects of Vietnam's fisheries. The majority of coastal fishing communities are considered to be poor and their household income mainly depends on marine fishing (FAO, 2005a; Pomeroy et al., 2009). Most of them are regarded as having a low educational level. A total of 68% of fishers have not finished primary school; 20% have finished primary school and nearly 10% have finished secondary school; and fewer than 1% have a certificate or diploma from a vocational school or university (FAO, 2005b).

3.2. Offshore fisheries in Vietnam

Offshore fisheries have been strongly promoted by the Government since 1997, through the introduction of support programmes. This has encouraged the growth of underdeveloped offshore fisheries with the expansion of the fleets and an increase in the production (Directorate of Fisheries, 2012b; FAO, 2005b; UNEP et al., 2009). It should be noted that vessels with a capacity over 90 HP are classed as offshore fishing vessels and that offshore fishing grounds are defined in the Decree (2010) for Vietnam's fisheries context. The number of offshore vessels increased rapidly from 1,000 units in 1997 to 6,000 units in 2001 and 28,000 units in 2012 (Directorate of Fisheries, 2012b; FAO, 2005b; GSO, 2014). The proportion of offshore vessels in the total fishing vessels was about 25% in 2014 compared with 20% in 2012, 8% in 2001 and 1.4% in 1997. The engine capacity of the offshore fleet increased by 12.7% per year to reach almost 6 million HP by 2012 (GSO, 2005, 2014). The number of fishers participating directly in offshore fishing operations has increased over time, and was estimated to be 170,000 people in 2010 (Directorate of Fisheries, 2012a).

At present, the offshore fishing fleet consists of trawlers (up to 46.7% of the total number of offshore vessels), longline and hand-liners (14.0%), purse seiners (13.3%), gillnetters (10.0%) and others (16.0%) (Directorate of Fisheries, 2012a). The sea area of Vietnam is generally divided into four main regions, namely the Tonkin Gulf (northern), central, southeast and southwest. More than 60% of the offshore vessels operate in the central and southeastern regions.

The offshore capture fisheries' production was estimated to be about 0.456 million tonnes (up to 30.8% of the total capture fisheries' production) in 2001 and increased to 1.1 million tonnes (49.4%) in 2010 (Directorate of Fisheries, 2012a). There is no single accurate measure for assessing the productivity of the offshore fleet in Vietnam. The most commonly used measure is the catch per vessel and per HP for mechanized vessels, which is inaccurate, particularly during a period of rapid mechanization and an increase in vessels and power. Nevertheless, based on calculations self-authored from the limited available data, the catch per unit of effort changed from 75.9 tonnes/vessel/year and 0.28 tonnes/HP/year in 2001 to 41.6 tonnes/vessel/year and 0.24 tonnes/HP/year in 2010 (Directorate of Fisheries, 2012a; GSO, 2005, 2014). This is indicative of a decline in productivity in relation to a unit of effort.

It is generally known that poor enforcement of the law and legislation is commonly observed and that there is a poor response of fishers to regulations (FAO, 2005a; UNEP et al., 2009). Although the total allowable catch is set for different sea areas, there is no quota system and the management regime is regarded as being open access to offshore resources in Vietnam. In 2013, Vietnam's Prime Minister approved the master development plan for the fisheries sector to 2020 and the vision towards 2030 to create sustainable development for Vietnam's fisheries (Decision, 2013). According to this plan, the number of fishing vessels will be reduced to 110,000 units in 2020, of which the offshore fleet will account for 28,000 to 30,000 units. The total marine capture production is planned to be 2.2 million tonnes in 2020, of which the offshore production will be about 1.4 million tonnes.

Regarding the status of the offshore resources, one cannot say with certainty that there is biological overfishing in the Vietnamese offshore fisheries because of the absence of a robust and trustworthy maximum sustainable yield (MSY) estimate. Some signs indicate that the offshore fishing capacity and effort may be overinvested and that the offshore waters may be overexploited. At least, significant doubts have been raised concerning whether the offshore fish stocks are sufficient to support further expansion in the offshore capacity (DANIDA, 2010). First, the Vietnamese offshore fisheries are open-access fisheries that have been subsidized by government aid schemes. The growth in offshore fishing has, thus, been rapid in the aspects of both fishing capacity and production, and it is increasingly suspected that previously underfished offshore stocks have become overfished. Second, some signals suggestive of overfishing in offshore areas may be the increasing reports of offshore vessels fishing closer to shore and vessels straying into the waters of other territories. Boonstra and Bach Dang (2010) showed that more than half of the vessels with over 90 HP in the commune of Phuoc Hai in the southeast of Vietnam were found to be fishing in inshore areas. In addition, the reports of the UNEP (2005b, 2006) point out that the "common pool" nature of fishery resources, excessive fishing effort and fleet capacity (which cause overexploitation), poor recruitment of fish stocks and inappropriate subsidies result in overfishing in the SCS region. Such trends may be indicative of overfishing in areas of Vietnam's EEZs or of the stock approaching being biologically fully fished.

3.3. Government subsidies for offshore fisheries

The offshore fishing industry in Vietnam has been considered an underdeveloped industry. Therefore, fishing subsidies could be seen as a tool to implement an "infant-industry" strategy, in which government aid in the early stages results in rapid development of the industry. Temporary protection for such an infant industry is expected to help to modernize the fleet, acquire the fishing experience and skills needed to compete effectively with foreign vessels and overcome the short-term difficulties so that the industry may become self-sustaining (Schrank, 2003). In addition, the Government may have considered that offshore fisheries have long-term (strategic) potential, which it wishes to foster and protect for future socioeconomic growth and development. This is additionally promoted by several exemptions on subsidies, for which developing countries (e.g., Vietnam) would be authorized to apply in the context of the new World Trade Organization (WTO) rules for fisheries subsidies (UNEP, 2005a; UNEP et al., 2009; WTO, 2007).[1] An overview of the Government subsidies offered to the fisheries sector in Vietnam was presented by UNEP et al. (2009). The following provides more details of the key subsidies for Vietnamese offshore fisheries.

[1] That is, a list of subsidies could be directly linked to public policy objectives specific to developing countries, such as support for food security, subsistence and small-scale fishing, and emergency actions (UNEP, 2005a; WTO, 2007). In the Vietnamese case, these exemptions fall into the category Special and Differential Treatment for Developing Countries. The UNEP et al. (2009) found that Vietnam's subsidy policies on fuel and vessel building, upgrading and infrastructure have focused on solving short-term issues (and are not likely to remain in the long term). In the WTO negotiations on fisheries subsidies, policies on fuel, credits for vessel building, infrastructure, tax, and vessel renewal and upgrading are still being debated, and these require further consideration (UNEP et al., 2009).

From 1997 up to and including 2001, the Vietnamese Government ran a national target programme for offshore fishing development, which provided capital credit for the construction of (powerful) offshore vessels at government-subsidized interest rates. The subsidized interest was about 50% lower than that of commercial banks (UNEP et al., 2009). The cost of this programme from 1997 to 2001 was estimated to have been in the region of 1,300 billion Vietnamese dong (VND) (~94 million 2001 USD), with the construction of about 1,300 offshore vessels. The government programme aimed to achieve two broad policy objectives: first, to expand further the marine fish production for domestic consumption and for exporting; and second, to reduce the pressure on coastal resources (FAO, 2005b). Private capital may have been insufficient to permit vessel owners to make the indigenous offshore fishing industry efficiently competitive and to attain the two objectives above. It was thus expected that when this industry was built up to the point at which it was self-sufficient, the programme would be removed. However, the effectiveness of this programme was constrained. About 31% of the vessels produced under the programme operated at a loss (FAO, 2005b, p.5). A large number of the offshore vessels funded also performed poorly in economic terms and the repayment rates on the loans were very low. Even though the interest rate on loans was partially supported, the subsidized vessels experienced a high failure rate, and only about 10% of the 1,300 vessels funded met their scheduled repayments (World Bank, 2005, p.17). Ultimately, the 1997 subsidy programme was removed at the end of 2001.

In 2008, the Government introduced a fuel cost support subsidy due to the strong oil price increase in 2007 (Decision, 2008a, 2008b).[2] The UNEP et al. (2009) estimated the total cost of the fuel subsidy to have been in the region of 1,600 billion VND (~ 91 million 2008 USD). While funds were also provided for vessels below 90 HP, this subsidy was marketed

[2] Offshore vessels (90 HP or larger) were supported with 10 million VND per trip to a maximum of 3 trips per year. Vessels with an engine size from 40 HP to 90 HP could receive 6.5 million VND per trip, to a maximum of 4 trips per year, and others correspondingly 4 million VND per trip to a maximum of 5 trips per year.

as support for offshore fishing. During the time of high fuel prices, offshore vessel owners faced serious temporary difficulties and were in danger of ceasing operations. The 2008 support was thus seen as a temporary measure to help owners to overcome these difficulties (UNEP et al., 2009). However, this subsidy scheme was abolished after one year because the actual crude oil price decline during 2008 eliminated the arguments for further support.

In addition to the fuel cost subsidy, as regulated in Decision (2008a), in 2008 the government introduced support for building and buying new vessels as well as renewing machines for offshore fishing. There were two primary objectives of this support, namely (i) to support the building of new vessels with engines over 90 HP (70 million VND/year) and (ii) to support the renewal of machines to achieve more fuel-efficient vessels (10 million VND/year for vessels in the 40–90 HP range and 18 million VND/year for vessels over 90 HP) (Decision, 2008a). The policy time frame was 3 years (2008–2010). At present, a very low take-up rate of the subsidy has been reported.

The effects of the 2008 global economic crisis on the national economy in the following years, combined with increasingly difficult weather conditions and territorial disputes in the SCS, substantially influenced fishers' offshore fishing performance. In addition, the policy was expected to meet the two main offshore fisheries' goals in Vietnam's fisheries development strategy towards 2020: (i) to create employment and enhance the income and living standards of fishing communities as well as to contribute to poverty alleviation; and (ii) to reduce risk at sea and enhance the competitive capacity with foreign fishing vessels to contribute to the protection of the sovereignty of the territorial waters and the national security of Vietnam (Decision, 2010b).

In 2010, the Government of Vietnam introduced another subsidy programme for the offshore fishing industry (Circular, 2011; Decision, 2010a). This programme includes fuel cost support, insurance subsidies, loans at favourable interest rates and other subsidy schemes and has been operating since 2011. The fuel cost support subsidies are based on the engine size of the vessels and all vessels can be supported to a maximum of 4 trips per year.[3] This support appears as a quasi-lump sum subsidy per trip. The insurance subsidies cover 50% of the vessel insurance costs and 100% of the accident insurance costs for fishers. Other subsidy schemes include support for the purchase of long-range acoustic devices integrated with GPS and damage compensation.

The required conditions for receiving the fuel cost support and insurance subsidies are: (1) offshore vessels (i.e. vessels with engines of total capacity of 90 HP or more) had gone through registration and registry for regular operation in offshore sea areas, (2) vessel owners must provide confirmation that they regularly operate in offshore waters, which must be approved by the specified authorities located in offshore island areas, (3) submitting an updated log-book to the local fisheries management department for each fishing trip, and (4) the vessel owners need to submit a valid and complete dossier with the relevant documents to the local fisheries management department (Circular, 2011). For subsidized loans, the owners are required to fulfill additional conditions from the bank, such as providing collateral.

In 2014, the Government introduced a new subsidy programme for offshore fisheries (Decree, 2014), which replaced the 2010 subsidy programme. The implementation of this subsidy programme will exert an effect between August 2014 and December 2016. The new subsidy scheme includes subsidized loans and loan guarantees for vessel construction and modernization (for offshore vessels with engines of over 400 HP), subsidized loans and loan guarantees for expenditure on variable costs, insurance subsidies for vessels and crewmembers, favourable tax policies (including natural resources tax) and other support policies. As Vietnam is a party to the Trans-Pacific Partnership (TPP) Agreement that could

[3] Vessels with an engine size from 90 HP to 150 HP were supported with 18 million VND per trip, vessels with an engine size from 150 HP to 250 HP received 25 million VND per trip, vessels with an engine size from 250 HP to 400 HP received 45 million VND per trip and vessels with an engine size of 400 HP or larger were supported with 60 million VND per trip. For 2008, see footnote 2.

potentially come into effect by late 2018 or early 2019, according to Article 20.16 (Marine Capture Fisheries) of this Agreement, it shall seek to operate a fisheries management system that is designed to prevent overfishing and overcapacity and to promote the recovery of overfished stocks for all marine fisheries (TPP Agreement, 2015). The implementation of such a fisheries management system must include the control, reduction and eventual elimination of all subsidies that contribute to overfishing and overcapacity. Therefore, the Government subsidy programmes will be brought into conformity with the TPP Agreement no later than 5 years (included an extension of 2 additional years) from the date of entry into force of this Agreement for Vietnam (TPP Agreement, 2015).[4]

3.4. Offshore fisheries in Khanh Hoa province

The empirical analyses of this dissertation are applied to Khanh Hoa province's offshore gillnet and hand-line fisheries operating in the SCS. Khanh Hoa is a coastal province in Southern Central Vietnam (see Figure 4), with a total land area of about 5,200 km^2, a coastline of 520 km and more than 200 islands. Khanh Hoa's fishing vessels numbered nearly 10,000 unit in 2013, corresponding to a total engine capacity of about 0.5 million HP (DECAFIREP, 2013). The number of vessels and the total engine capacity increased by about 6.1% and 13.5% between 2001 and 2013, respectively. The production of this fleet increased by an average of 3.2% per year in the same period (GSO, 2005, 2014). The total capture landings of the province were about 82,300 tonnes in 2013. There are about 38,200 people working in the fishing sector in Khanh Hoa province, with average growth of 3.9% per annum in the period 2007–2012 (DARD, 2014).

[4] However, it is possible that inequalities and increasing disputes will appear among the countries bordering the SCS regarding the benefits from exploiting the SCS's resources as some of them are not part of the TPP, for example China, Thailand, the Philippines and Indonesia.

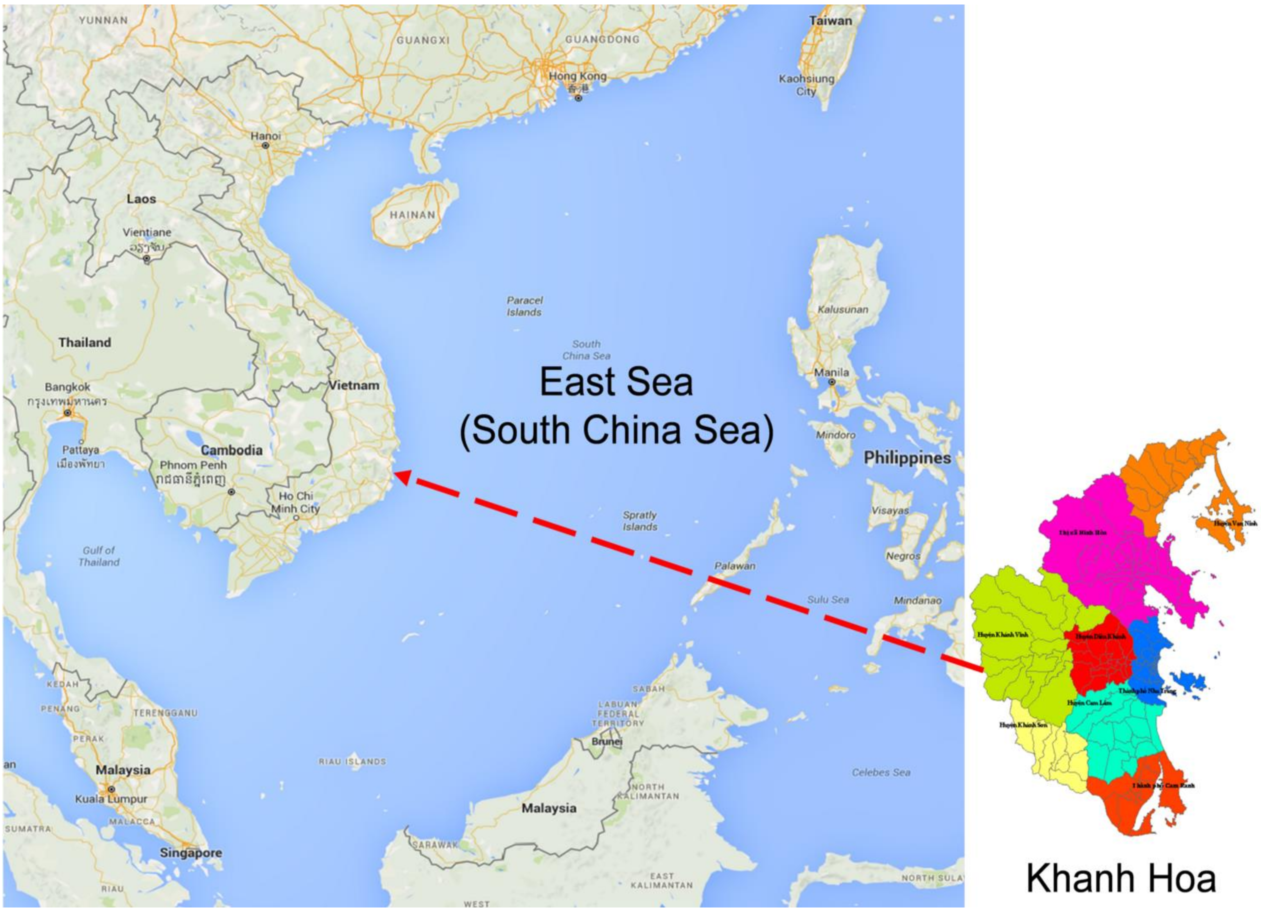

Figure 4. Khanh Hoa province, Vietnam.

Out of the total fishing vessels in 2013, Khanh Hoa's offshore fleet consisted of barely more than 1,000 units – accounting for about 10% of the total vessels (DECAFIREP, 2013). The major offshore fishing gears are gillnet, longline/hand-line, trawl, set net and lift net. The gillnet and hand-line vessels make up about 25% and 15% of these offshore vessels (Figure 5), with an average capacity of 303 HP/unit and 283 HP/unit, respectively. These vessels are mainly found in the provincial capital, Nha Trang. Their number has increased over the years; vessels with an engine power over 400 HP increased significantly in the period 2009–2013 (Figure 5). The offshore fishery in Khanh Hoa has been open access since its inception and a minor resource tax was abolished in 2008. In addition, the offshore vessels have been subsidized by the Government support programmes since 1997.

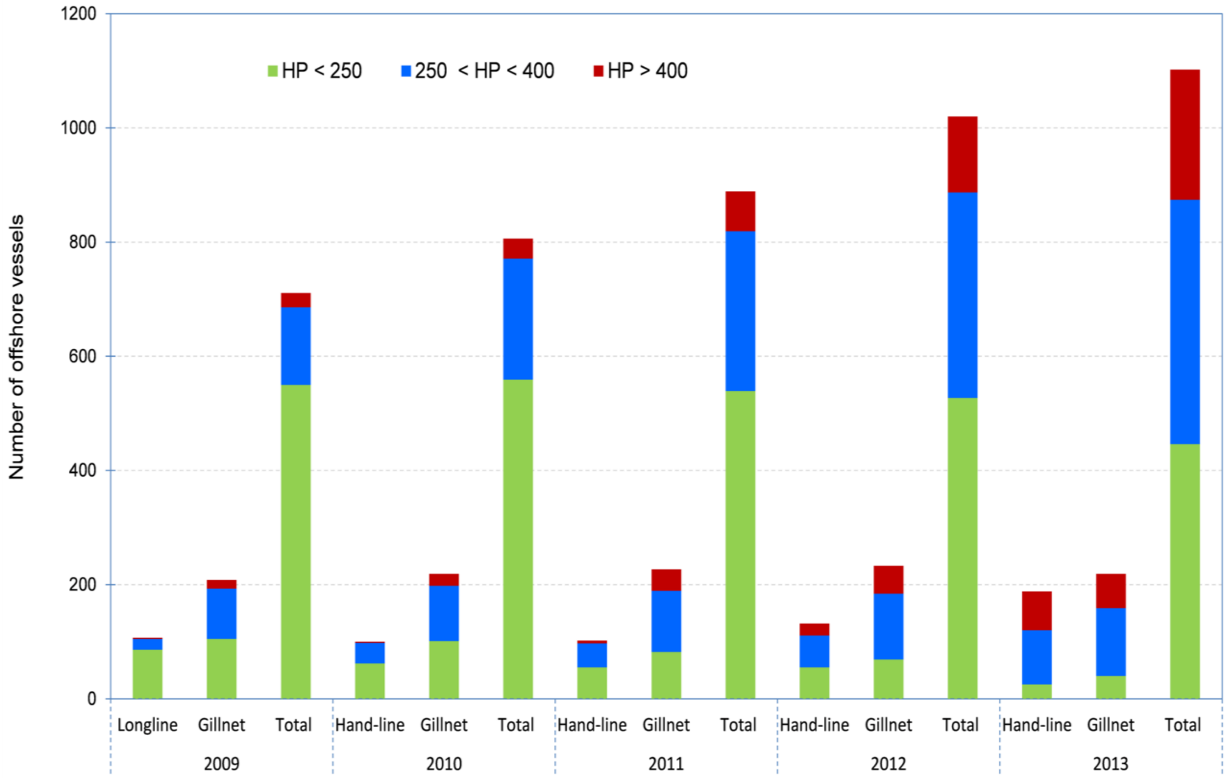

Figure 5. The distribution of offshore vessels in Khanh Hoa province.
Source: DECAFIREP (2013)

The offshore fishing takes place all year round, from October to September of the following year, and is divided into two fishing seasons: the northeast monsoon (from October to March) and the southwest monsoon (from April to September). Offshore vessels often stay onshore for repairs and maintenance from either August to September or September to October. The target fish species of the gillnetters and hand-liners are migratory pelagic species (e.g., tuna species). The main target species in the gillnet fishery include striped tuna (*Sarda orientalis*), skipjack tuna (*Katsuwonus pelamis*) and mackerel species, such as the Indo-Pacific king mackerel (*Scomberomorus guttatus*), wahoo (*Acanthocybium solandri*) and narrow-barred Spanish mackerel (*Scomberomorus commerson*), as well as some other species caught as incidental bycatches. For the hand-line fishery, yellowfin tuna (*Thunnus albacares*) and bigeye tuna (*Thunnus obesus*) are the main target species caught, while a small amount of other species are referred to as bycatches. The fishing activities of the hand-line vessels are conducted with light. Lamps are located along both sides of the vessel to attract squid, which are in turn used as bait. The hand-line gear uses a single hooked line attached to a bamboo pole to catch the fish. Gillnets consist of many individual net walls tied together to form a large net wall that hangs vertically in the water. Floats line the top of the net, while weights line the bottom of the net. When fish swim into the net, they are gilled, entangled or enmeshed by their gills.

The actual fishing grounds depend on the direction of movement and the aggregation of these species. The fishing grounds are the offshore waters of the central sea region (11º30'N–14º00'N, 109º30'E–114º00'E) and the waters of the southeastern and southwestern areas, as well as high-sea waters (6º00'N–11º30'N, 105º00'E–114º00'N). In the northeast monsoon, tuna species are often found in the offshore sea areas of the central provinces from Phu Yen to Vung Tau and the central SCS (10º30'N–14º00'N, 110º00'E–114º00'E). The offshore vessels move to the southeastern waters and southwest of the Spratly Archipelago (6º00'N–10º30'N, 105º00'E–114º00'E) in the southwest monsoon. Tuna is also fished in the territorial waters of the provinces from Phu Yen to Binh Thuan, located at a distance of about 50 to 100 nautical miles from the shore in this second season.

4. Subsidy and sustainable development perspective

4.1. Definition of subsidy

According to Article 1 of the WTO Agreement on Subsidies and Countervailing Measures (WTO, 1999), a subsidy is defined as a financial contribution of a government that confers a benefit to firms or individuals. A financial contribution can involve a direct or potentially direct transfer of funds to the firm or individual (e.g., grants, loans, loan guarantees, equity infusions), foregone government revenue (e.g., tax waivers or exemption), government provision of goods and services other than infrastructure (at less than market prices) and government support of prices and incomes (WTO, 1999, p.231). This definition of a subsidy is considered to be legally agreed internationally. In the *Transition to Responsible Fisheries* study conducted by the Organisation for Economic Co-operation and Development (OECD), a government financial transfer is defined as "the monetary value of government interventions associated with fisheries policies" (OECD, 2000, p.129). Another study by the OECD (2006, pp.19–25) showed that the OECD definition of a government financial transfer covers subsidies as defined under the WTO as well as transfers related to management, research and enforcement, fisheries access agreements and fisheries-specific infrastructure. The definition of government financial transfers used in the document by the OECD (2000) includes market price support. The OECD (2006) study also showed that a broader definition of subsidy by the Food and Agriculture Organization (FAO) expert consultations includes the lack of government intervention to internalize externalities, untaxed resource rents and negative subsidies.

It is generally well known that there have been political debates about using alternative definitions of support to the fisheries sector. In this dissertation, the terms "subsidy", "government financial transfer", "support" and "transfer" are used interchangeably. The subsidies used in this dissertation modify the returns received and the costs incurred by the sector participants, so their profits are modified. This modification motivates them to alter their behaviour in fishing. This dissertation does not attempt to discuss subsidies involving either an increase in the market prices of fish caught or a reduction in the market prices of inputs employed in fishing operations.

4.2. Subsidies from a sustainable development perspective

Since the report by Brundtland et al. (1987) introduced the concept of sustainable development, fisheries economists and researchers have highly quoted this concept in assessing the effects of policy decisions (OECD, 2006). Brundtland et al. (1987, p.54) stated that "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The concept is enshrined in the concern that policies should address the economic, environmental and social dimensions of sustainable development. The fisheries sector is considered as a prime illustration of this concept in analysing the effects of policy interventions (OECD, 2006).

Effort has been devoted to analysing the effects of subsidies on economic and environmental sustainability (Flaaten and Wallis, 2001; Heymans et al., 2011; Munro and Sumaila, 2002; Sumaila et al., 2008). It is also known in the fisheries economics literature that there is a strong connection between fisheries management, sustainable development and the way in which subsidies serve to meet the sustainability goals (Clark et al., 2005; von Moltke, 2011). Such a study focuses greatly on the economic and environmental dimensions of sustainable development.

Based on the sustainable development concept, the OECD (2006) emphasized the linkages and interactions between the three dimensions of sustainability, as illustrated in Figure 6. As a subsidy policy is often referred to as an economic policy tool designed to change the prices faced by agents in the fisheries sector or to change the relative wealth of the participants, the implementation of such a policy will influence the economic dimension first. The economic effects will then flow through to the effects on the environmental and social dimensions, which will in turn generate dynamic feedback effects amongst the three dimensions. The interaction between the economic and the environmental dimension includes the effects on the fish stocks and ecosystem. Depending on the effectiveness of the management measures in place, the status of the resource stocks affects the economic dimension in return. The interactions between the economic and the social dimension include, on one side, the impacts of the subsidy policies on the distribution of benefits and income, on the skills, incentives and structures in the labour market and on the individual and community resilience. On the other side, subsidy programmes can affect the provision of human inputs into the fisheries sector in the form of labour, skills, knowledge and creativity. Policy intervention may lead to impacts of social norms, attitudes and institutions on the functioning of markets as well as on the need for the enforcement of regulations. The interactions between the environmental and the social dimension are dependent on the impacts of subsidies on the economic dimension (for example, from the economic to the environmental to the social dimension and from the economic to the social to the environmental dimension) (OECD, 2006).

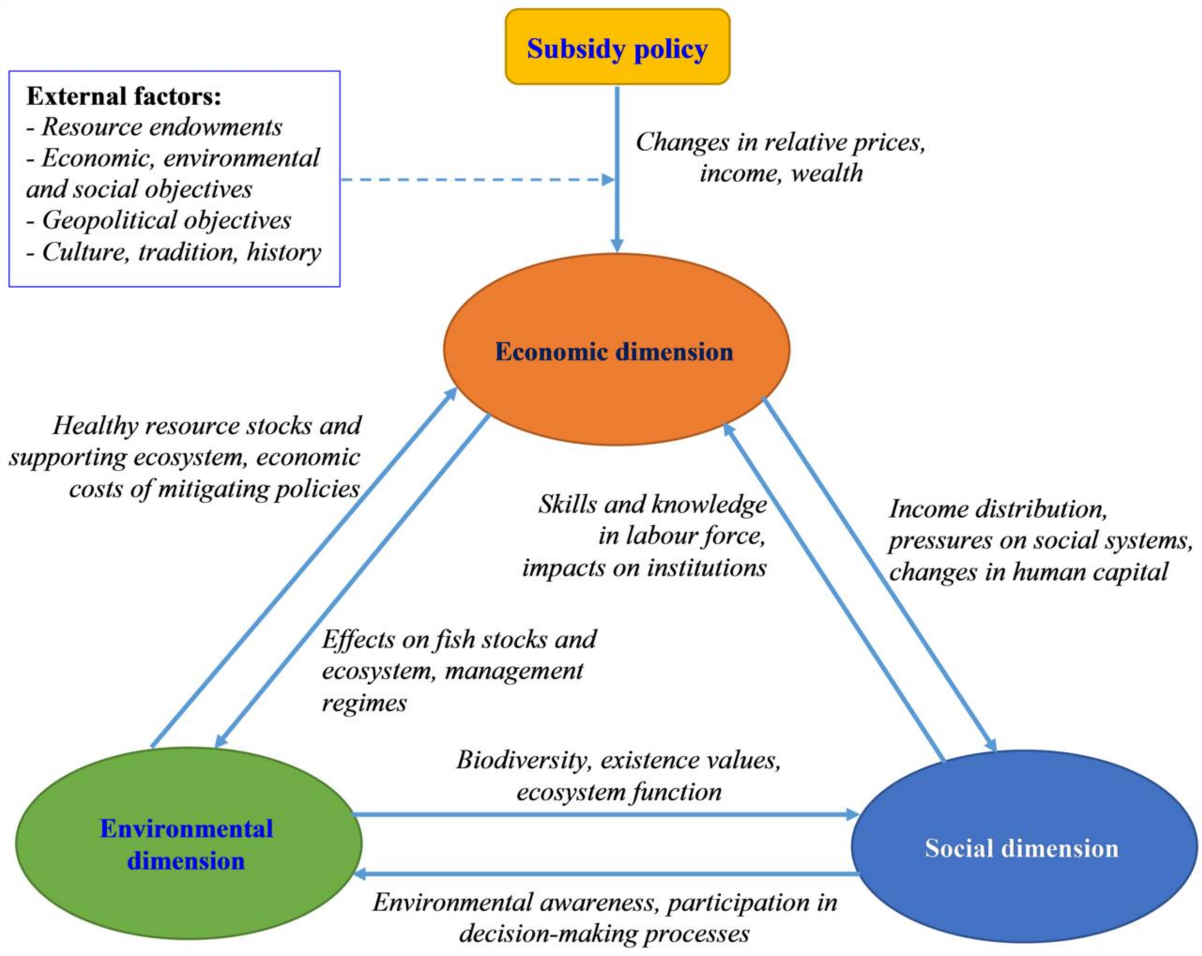

Figure 6. Interaction between the economic, environmental and social dimensions of sustainable development.

Source: Adapted from the OECD (2006).

The linkages between the dimensions also involve unavoidable conflicts or trade-offs in the short term. Therefore, sustainable development stresses the long-term compatibility of the economic, environmental and social dimensions of human well-being. It is at the interfaces between the three dimensions that the concept of sustainable development is most relevant to policy (OECD, 2006).

The OECD (2006) study argued that sustainable development is probably obtained in a well-managed fishery. However, it is well known in the fisheries economics literature that subsidies in open-access fisheries do not achieve the goals of sustainable development (OECD, 2006; Schrank, 2003; Sumaila, 2013; von Moltke, 2011). It is obvious that capacity-enhancing subsidies under open-access schemes have negative effects on economic and environmental sustainability. In open-access fisheries, subsidies that improve the profitability will lead to overcapitalization and overexploitation (Munro and Sumaila, 2002). Overexploitation of resource stocks tends to be associated with economic losses and reductions of the well-being of the individuals and human communities reliant on the fishery. Therefore, this dissertation considers the extent to which the Government subsidy programmes affect the investigated fisheries under the open-access condition in relation to the aspects mentioned previously. It should also be noted that subsidy programmes are likely to be social and political policy tools of the Government and to play a central role in other social/political objectives. For example, subsidy programmes are linked to the need to maintain employment in the fishery, prevent the collapse of fishing communities, develop infant fishing industries, develop and support regional communities, maintain cultural and heritage values and so on.

5. Theory of fisheries economics

This dissertation integrates the theoretical frameworks of bioeconomics and vessel economics of fisheries and empirical investigations to examine the research problems. In particular, these theoretical frameworks act as bases for the empirical applications of the first three papers. First, these aim to illustrate in terms of theoretical analysis whether any net benefits exist for an open-access fishery. In the presence of subsidies, the bioeconomic theory can explain the effects of subsidy policies and the interactions between the economic and environmental dimensions. The vessel economics theory describes the impacts of subsidies at the individual vessel level, that is, the effects on the distribution of benefits and income of individuals (the interactions between the economic and the social dimension).

5.1. Bioeconomic model and the impacts of subsidies

The traditional economic model of Gordon (1954) is extended to illustrate the existence of intra-marginal rent for an open-access fishery with heterogeneous vessels (Copes, 1972; Flaaten, 2016) and the static effects of subsidies on the fishery. Given competitive vessels with heterogeneous cost structures, the industry marginal cost is an increasing function of the fishing effort (Copes, 1972; Flaaten, 2016). Thus, the industry long-term total cost curve (*TC*) and total revenue curve (*TR*), with a constant price of the catch, are as shown in Figure 7a. The open-access bioeconomic equilibrium point is where the industry average revenue of effort equals the industry marginal cost of effort, $AR = MC$ (Figure 7b).

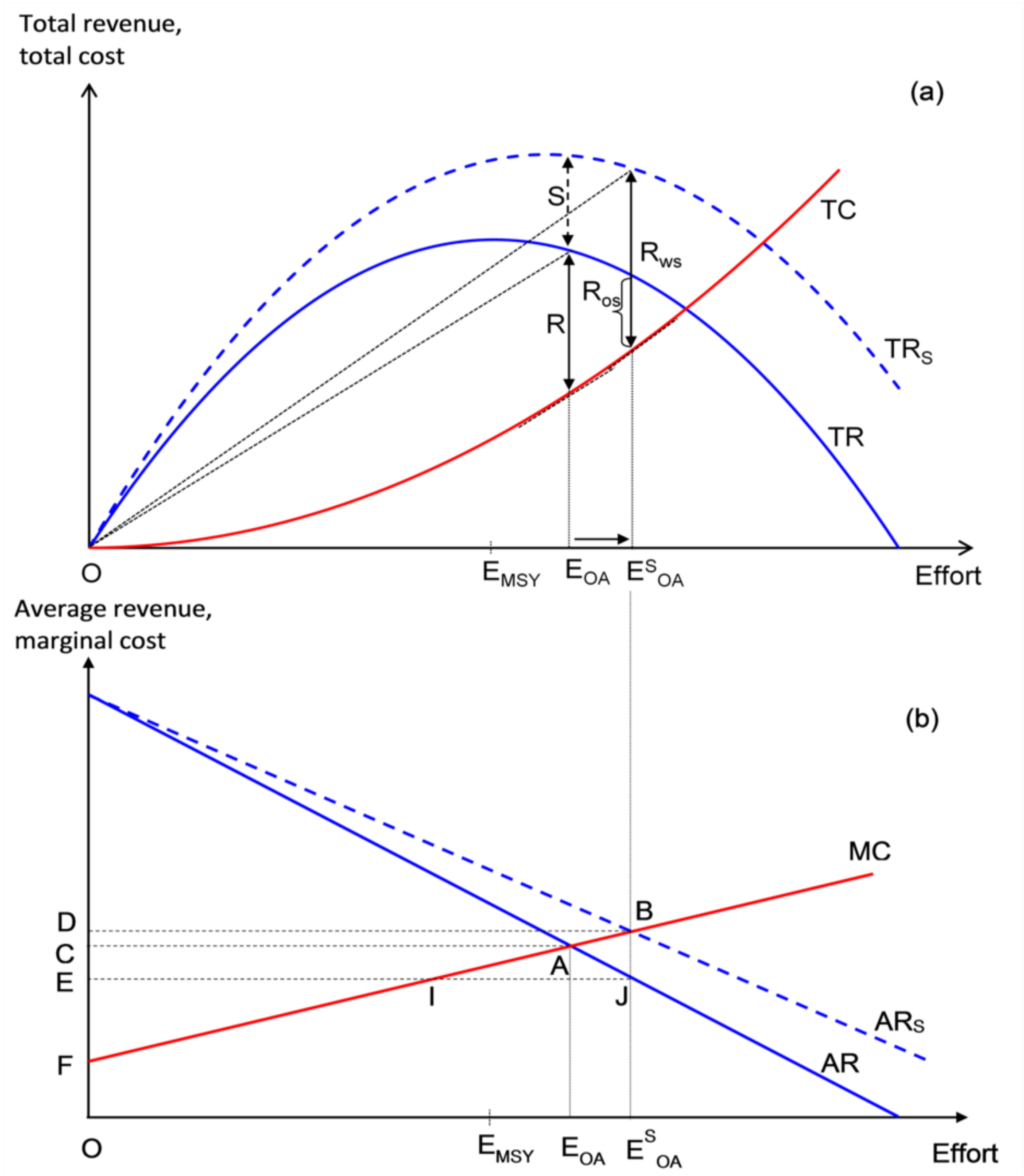

Figure 7. Intra-marginal rent and impacts of revenue-enhancing lump sum subsidies under open access in the case of heterogeneous vessels.

It is assumed that commercial fishers are profit-seekers. In an unregulated open-access fishery, the existence of any positive economic profit will attract new entrants to the industry, resulting in a reduction of the industry average revenue of effort until it equals the industry marginal cost of effort (Flaaten, 2016; Gordon, 1954). Thus, there will be open-access equilibrium of the effort level, E_{OA} (Figure 7). With this equilibrium effort, there is a welfare economic, also called a social surplus, for the fishery, which is called the intra-marginal rent (Figure 7, the line segment *R* (panel a) or the area ACF (panel b)). The potential return to the resource (resource rent) is dissipated in this situation because of the excessive level of effort being applied to the stock (Flaaten, 2016; Gordon, 1954), but the intra-marginal rent is generated from the most cost-efficient vessels earning above-normal profits.[5] Therefore, profits that are above normal for an average vessel would indicate the existence of intra-marginal rent for the open-access fishery with a heterogeneous fleet.

The government subsidies' effects on vessel profits, which are examined in the case study of Vietnam, can be divided into revenue-enhancing and cost-reducing subsidies (Flaaten and Wallis, 2001; Westlund, 2004). For the sake of theoretical illustration, the effect of revenue-enhancing subsidies is discussed in this section. The Government's income support appears as quasi-lump sum subsidies per trip on a per vessel basis and is based on vessel engine sizes. We thus assume that the total government financial transfers (S_{sub}) are defined as an increasing function of the fishing effort (E), for example linear $S_{sub} = sE$, where s is the average subsidy per unit of effort. These subsidies increase the total revenue received at each level of vessel effort, resulting in a shift of the total revenue curve from TR to TR_S (Figure 7a). This may have the short-term effect of creating an economic surplus for the existing fishers (signified by the line segment *S*) in an open-access fishery (Flaaten and Wallis, 2001), which then attracts new entrants to the fishery. Accordingly, the long-term effect of revenue-enhancing lump sum subsidies is that a new equilibrium effort (E^S_{OA}) in this case shifts further away from the level of the maximum sustainable yield (MSY) effort

[5] The economic profits from exploiting natural resources consist of two components: resource rent and intra-marginal rent. *Resource rent* is referred to as the return to the owner of the fisheries resource (Gordon, 1954) and represents the value of the input generated by the fish stock in the production process (Coglan and Pascoe, 1999). *Intra-marginal rent* is generated by the factors of production owned by the fishers through more efficient vessels and practice (Coglan and Pascoe, 1999; Copes, 1972). Normal profits in this context are referred to as zero economic profits. Vessels earning normal profits are called marginal vessels.

(E_{MSY}). This leads to a negative impact on the fish stocks. The stock size at the E^S_{OA} level is lower than that at the E_{OA} level (see more in Flaaten and Wallis, 2001).

At the new equilibrium effort E^S_{OA}, the business economic surplus (with subsidies) for the open-access fishery is indicated by the segment R_{ws} (panel a) or the area BDF (panel b), of which the actual economic surplus (without subsidies) accruing from fishing operations is signified by the segment R_{os}. The value of R_{os} corresponds to the difference between the areas IEF and IJB in Figure 7b. It is clear that $R_{os} < R$. In other words, the welfare economic surplus for the fishery when the government's subsidy action takes place is smaller than the surplus without this action. This welfare economic surplus may be positive, zero or negative, depending on the magnitude of the subsidies and the increasing level of effort and hence on the decreasing size of the resource stock. When the subsidy value is high, the social surplus for the fishery is likely to be dissipated. Intra-marginal vessels still exist due to the different cost structures of the vessels.

The effects of cost-reducing subsidies can easily be derived from the use of a similar model to the revenue-enhancing subsidies. The industry cost curve *TC(E)* and the industry marginal cost curve *MC(E)* shift downward as an effect of a cost subsidy. The industry effects are similar to that which has been described above. The same applies to a subsidy per unit of landed fish – the *TR(E)* and *AR(E)* curves shift upward, increasing the equilibrium effort and reducing the stock level and the intra-marginal rent.

5.2. Economic behaviour of fishing firms and the impacts of subsidies

This subsection briefly describes the effects of revenue-enhancing lump sum subsidies on the vessel behaviour and on the distribution of benefits in an open-access fishery. Given that the industry is competitive and that individual vessels are not able to influence the market price of fish, all the vessels face the same marginal revenue (equivalent to the industry average revenue) at a given point in time (Coglan and Pascoe, 1999).[6] For the objective of profit maximization, an individual vessel's profit is maximized at the level of effort at which its marginal cost (*mc*) equals its marginal revenue (*mr*).

Figure 8b shows that, in the absence of subsidies, the open-access equilibrium effort level of the industry is at the E_{OA} level (the intersection of the *MC* curve with the *AR* curve). During any time period (e.g., one year), some vessels are likely to earn economic profits (intra-marginal rent) while others make economic losses (extra-marginal rent) (Coglan and Pascoe, 1999). In Figure 8a, vessel 1 is earning economic profits (showed by the shaded area) with its profit-maximizing effort e_1^{OA}, where $mr^{OA} = mc_1$, and vessel *i* is making normal profits with its fishing effort e_i^{OA}, whereas vessel *j* is experiencing an economic loss. The vessels making economic losses after capital costs (i.e., vessel *j*) may operate in the short term if their marginal revenue of effort is more than the minimum average variable cost of effort, but in the long term, they will be forced to exit the fishery.

The total subsidies are, as assumed, an increasing linear function of the fishing effort. The introduction of this subsidy policy will shift the fishery's average revenue curve from *AR* to AR_S in Figure 8b, given a constant price of fish. The new open-access equilibrium is at the point at which the level of effort is E^S_{OA} and the fishery's average revenue, including the effort subsidy, is AR_{ws}. At this level of effort, the actual average revenue from fishing operations (excluding the subsidies), AR_{os}, is equal to the AR_{ws} level minus the average subsidy per unit of effort, *s*.

[6] For the sake of illustration of the existence of intra-marginal vessels, the fishing vessels are assumed to be heterogeneous in cost structures rather than in fishing effort in this subsection.

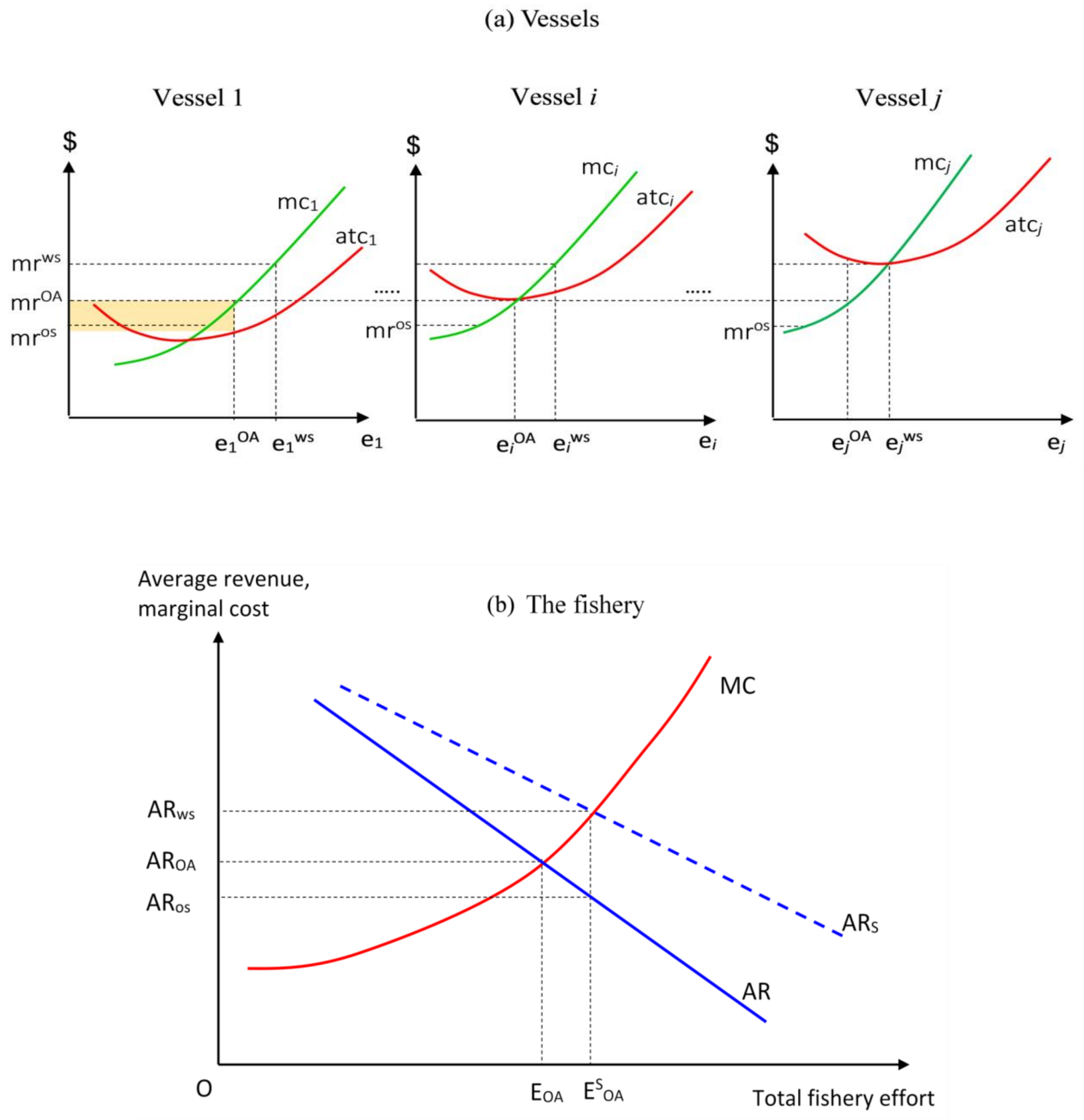

Figure 8. Heterogeneous fishing fleet in an open-access fishery with revenue-enhancing lump sum subsidies.

Notes: *mc* is the marginal cost of the individual's effort curves, and *atc* is the average total cost of the individual's effort curves.

When the fishery's average revenue increases from AR_{OA} to AR_{ws} (Figure 8b), vessels will increase their individual fishing effort to maximize their profits. As illustrated in Figure 8a, by receiving the subsidies, vessel 1 and vessel *i* increase their individual effort to the level e_1^{ws} and the level e_i^{ws} to maximize their profits, respectively. Vessel *j* is producing the effort level e_j^{ws} (where $mr^{ws} = mc_j$) to obtain normal profits. Some formerly unprofitable vessels thus become profitable and the total effort expands. Even though the marginal revenue of effort is lower than the minimum average variable cost of the individual vessel effort, fishers may still operate in the short term, as long as they have a positive operating cash flow, including the subsidies. Similarly, even if vessels' revenue (without the subsidies) is not able to cover all their costs, they may continue to operate in the long term, as long as they have positive economic profits including the subsidies. However, the rent generation and distribution and the effects of subsidies on the distribution of benefits and income differ among individual vessels. This is due to the different cost structures of fishing firms. Vessel 1, with a lower cost structure, may receive more benefits than the others.

The impacts of cost-reducing subsidies on vessel behaviour and equilibrium can be described in a similar way to those for revenue-enhancing effort subsidies. Because of the effect of an effort cost subsidy, the average cost of effort will be reduced. Since the Government's cost support is based on vessel engine sizes, the cost structure obviously differs among vessels, resulting in a heterogeneous distribution of benefits and income.

6. Methodology

The dissertation uses economic performance indicators to evaluate vessel profitability and to examine whether intra-marginal rent exists in the investigated fleets. The economic performance of fisheries can be assessed from economic surveys of the vessels participating in the fishery (Coglan and Pascoe, 1999). From a fisheries management perspective with heterogeneous vessels, the level of economic rent (i.e., intra-marginal rent) accruing in an open-access fishery can be estimated from the economic profits of the vessels surveyed.

The economic performance definitions used in this dissertation (Papers 1, 2 and 3) correspond in principle to those used in business economic analysis in general and in previous profitability analyses of fishing vessels in industrialized countries (EC, 2004; Flaaten et al., 1995; Le Floc'h et al., 2008; Pascoe et al., 1996; Whitmarsh et al., 2000). The operating cash flow or gross cash flow is the main performance indicator, and it equals the concept of earnings before interest, taxes and depreciation (EBITDA). A positive operating cash flow indicates that the revenue exceeds the vessel owner's operational and labour costs (Pascoe et al., 1996; Whitmarsh et al., 2000) and that intra-marginal rent may exist in the short term for the owners (Copes, 1972). Meanwhile, rent (i.e., intra-marginal rent) is an economic performance indicator that measures the efficiency of a producer from the society's perspective. It is referred to as the economic rent to society of employing the owner's capital in the fishing activity after subtracting all the expenses, including the opportunity cost of this capital (Whitmarsh et al., 2000). Since the revenue generated by the industry exceeds the real cost of the factors of production, the resultant positive rent implies that the fishery is efficient and profitable for society (Whitmarsh et al., 2000). If the rent is negative while the operating cash flow is positive, vessel owners may be commercially viable in the short term but not operating optimally, based upon a long-term analysis of the efficient allocation of the society's resources (Pascoe et al., 1996; Whitmarsh et al., 2000).

To analyse the effect of fisheries subsidies on the profits of vessels, Papers 1 and 2 follow the costs and earnings analysis principles presented by Westlund (2004, pp.45–49). The subsidy values and earnings and costs survey data are organized into a format allowing the calculation of a profit and loss account with subsidies (representing the actual situation) and one in which the subsidies are removed. Therefore, these first two papers focus on an assessment that constitutes a snapshot of the current situation. According to the classification of Westlund (2004), the Vietnamese fuel cost subsidies can be classified as direct financial transfers, while loans on favourable terms and insurance schemes for vessel and fishers are referred to as services and indirect financial transfers. To analyse their impact on the profits, it is important to know in precisely which way they influence the financial situation of the vessels and to provide information on which revenues and costs are affected (Westlund, 2004). Therefore, the subsidies influencing the profits are divided into revenue-enhancing and cost-reducing subsidies.

For Paper 1, the economic performance indicators are calculated for two cases: one including and one excluding the 2008 fuel subsidies, based on the 2008 costs and earnings data of offshore gillnet vessels. The 2008 Government fuel cost support appears as quasi-lump sum subsidies per trip, payable directly to fishers for a limited number of trips per year. Fishers have to accept the market fuel price in their fishing operations; in reality, the fuel cost support is income support for fishers, although it may resemble an effort subsidy. Hence, this subsidy item is added to the gross revenue instead of subtracting it from the costs in this paper (as discussed above).

To compare the economic efficiency of individual vessels, the fishing effort of the vessels is standardized. Standardized fishing effort indicators for the vessels are estimated using the production function approach. Adapting the definition of relative fishing power by Beverton and Holt (1957), the relative standardized fishing effort of each vessel is determined. Therefore, the ratio of the cost to the relative standardized effort reflects the cost efficiency and economic efficiency of the vessel. The relationship between cost efficiency and the relative standardized effort of each vessel is graphed using a Salter diagram, with the relative standardized effort along the horizontal axis and the average cost per unit of relative standardized effort on the vertical axis. For each vessel, the relative standardized fishing effort is measured by the width of the bar, whereas the height of the bar measures the cost per unit of effort. All the vessels are arranged from left to right according to their cost-efficiency levels, from the most cost-efficient to the least cost-efficient.

To apply this method properly, the fish stock level is assumed to be constant in the short term, so the catch per unit of effort (CPUE) is referred to independently from the vessel's standardized effort. In addition, the fish price is considered to be the same for all vessels; the average revenue of a vessel's standardized effort is thus similar among fishing vessels and equals the average revenue of the effort of the fishery. Hence, 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.

In Paper 2, the economic performance indicators are used to evaluate vessel profitability. The effects of the government subsidies are analysed by a static comparison of the economic performance of vessels, including and excluding subsidies. Thus, the paper presents the costs and earnings findings, with and without subsidies, based on 2011 and 2012 data of two offshore fleets: gillnet and hand-line vessels. The 2010 government fuel cost subsidies also appear as quasi-lump sum subsidies per trip, payable directly to fishers for a limited number of trips per year. Similarly to Paper 1, Paper 2 refers to this subsidy item as a revenue-enhancing subsidy. Support for vessel insurance costs and accident insurance costs for fishers and loans at subsidized interest rates are defined as cost-reducing subsidies. These two insurance cost items are components of the fixed operating costs. The interest payment on loans is estimated using the subsidized interest rate for the subsidy case and the commercial interest rate for the non-subsidy case.

For Paper 3, the average treatment effects based on the propensity score-matching method are used to evaluate the vessel profitability when the Government's subsidy action takes place and that without this action (i.e., counterfactual profitability). This method, developed by Rosenbaum and Rubin (1983), is applied to analyse the effects of the 2010 subsidy programme on the profitability of offshore gillnet vessels in two operating years, 2011 and 2012. In this paper, vessels that received at least one of the subsidy types as those that participated in the 2010 subsidy programme are called subsidized vessels; hence, these vessels received a treatment. Vessels that did not receive any support types from the Government are considered to be non-participants in the programme and are referred to as non-subsidized vessels; thus, they belong to the control group. The method involves three stages. In the first stage, the propensity scores are estimated using a probit model in which the predicted probability of a vessel being subsidized is a function of variables. In the second stage, the vessels from the subsidized group are matched with those in the non-subsidized group based on their propensity scores. The sample is then tested to determine whether the subsidized and the non-subsidized vessels have the same characteristics. This means that the propensity scores estimated from the probit model need to satisfy the balancing property. In the final step, the treatment effects of the 2010 subsidy programme are obtained by comparing the means of the economic performance indicators across the two groups.

The research objective of Paper 4 is to analyse three technical efficiency estimation methods with different fish stock proxy measures when using the stochastic production frontier (SPF) approach. The methods are applied to offshore gillnet and hand-line fisheries, based on 2011 and 2012 data. Because information on stock abundance is lacking, the three methods of fish stock proxy measures investigated in this paper are as follows:

- Method 1: An index of stock abundance is derived based on changes in the average level of CPUE over time and this index is directly incorporated into the production frontiers as an explanatory variable. Using this method, an implicit assumption is made about the unitary elasticity of fish stock and effort.
- Method 2: Instead of applying the CPUE index as an explanatory variable per se, it is used to adjust the output measure to allow the effects of stock change on output

to be incorporated into the analysis. The assumption tested is constant returns to effort.

- Method 3: The dependent variable (catch) is adjusted using a composite stock effect index, which is referred to as the technical change component of the Malmquist index (see Appendix). Data envelopment analysis (DEA) is used in configurations such that the within-period variations in efficiency are independent of the underlying stock and the between-period differences in efficiency are, thereby, assumed to be directly proportional to the changes in stock abundance. This method is developed by Pascoe and Herrero (2004). To estimate the composite stock effect index, three steps of analysis with two output-oriented DEA models are proposed. The first DEA model with different outputs is used to estimate the TE of each vessel in each period. After that, the efficient levels of output of each vessel in each period are projected so that all the vessels are located on the frontier of each period. In the final step, the second DEA model is used to estimate the stock index by calculating the shift in the frontiers between the two periods, comparing the projected efficient output levels in period $t \neq s$ (e.g. year 2) with those in period s (e.g. year 1).

7. Data

This dissertation uses primary data of the surveyed samples of two offshore fleets in Khanh Hoa province of Vietnam – gillnet and hand-line – for three fishing year seasons – 2008/2009, 2011/2012 and 2012/2013 (termed the 2008, 2011 and 2012 seasons, respectively). Following Long et al. (2008), the questionnaire was adjusted and the data of each fishery were collected with the same questionnaire for these year-seasons. While the data on the gillnet fishery were collected in three years, 2008, 2011 and 2012, the hand-line fishery was surveyed for two years, 2011 and 2012. As mentioned previously, Paper 1 uses the 2008 data on the gillnet vessels, while Papers 2 and 4 apply the 2011 and 2012 data on both fisheries and the data of the three fishing year-seasons in the gillnet fishery are used in Paper 3.

The data consist of detailed information on various aspects of the two offshore fisheries, such as vessels' technical and operational characteristics, costs and earnings data, catch information (only for 2011 and 2012) and demographic data and crewmembers' income. These data were collected through direct face-to-face interviews with fishing households, which were represented by the vessel owner and/or his wife. The 2008 data were obtained from 58 fishing households (25.8% of the population) involved in offshore gillnet fisheries. The data for 2011 and 2012 constituted a balanced panel of 57 gillnetters and 39 hand-liners, which comprised about 22.1% and 25.5% of the gillnet and hand-line population, respectively. These surveyed samples are representative samples of Khanh Hoa's offshore gillnet and hand-line population based on the samples' representativeness test.

While the surveys for 2008 were administered between August and November 2009, for 2011 and 2012 they were undertaken between September 2013 and February 2014. 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 fishing vessels, despite the stated need to do so. Some independent research papers have been published in recent years for the Khanh Hoa fisheries (Khanh Ngoc et al., 2009; Long et al., 2008; Thuy et al., 2013) and for the Da Nang fisheries (Pham et al., 2014). These papers use the survey data (recall data) for their costs and earnings analysis and provide reasonably consistent results. Because in general it is difficult for fishermen, and their wives, to memorize and provide information on the different fishing trips carried out in the operation years, the average trip data of the costs and earnings each year were requested in the questionnaire, as in the quoted studies. A few observations of missing and obviously unreliable information in the questionnaires were corrected by revisiting the fishing households, almost without exception producing a good final result. Hence, the data set is considered to be reliable for analyses of various aspects of the Khanh Hoa offshore fleets, including costs and earnings.

In addition to the information on the offshore fisheries investigated, price data are collected from traders who buy fish directly from fishers. The dissertation also uses secondary data from published studies and organizational reports. These data provide helpful information for empirical discussions as well as comparison.

8. Research results: a summary of the papers

Paper 1 investigates the economic efficiency and performance of vessels in the open-access gillnet fishery and 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. Even so, the economic analysis demonstrates that some vessels made good earnings. These are the intra-marginal vessels in the heterogeneous fleet. 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. Hence, it is important to note that even in open-access fisheries many vessels may create net benefits to society, as demonstrated in this paper.

Paper 1 demonstrates that the introduction of the 2008 fuel cost support had a positive effect on the profitability of the surveyed gillnet vessels. It also reveals that the engine HP effect, the amount of gear and the days of operation are the factors that produce the best indicators of vessel efficiency. The relative standardized effort was developed and estimated for the surveyed vessels. In addition, the paper discusses the distributional impacts of the 2008 fuel subsidies. The most economically efficient vessels are mainly, but not only, those with high relative standardized effort. These vessels earned most of the intra-marginal rent generated. The 2008 subsidies generated relatively more benefits for small-scale vessels than for large-scale ones. Furthermore, the results demonstrate that, on an annual basis, the average crew income is almost the same as that for the workers with higher educational levels or technical/vocational training working in the most profitable registered enterprises in Khanh Hoa; on a monthly basis, it is even more. The large-scale vessels created a greater annual income for crewmembers.

Paper 2, based on the surveys of offshore gillnetters and hand-liners in the years 2011 and 2012, illustrates that the offshore fisheries could be profitable for the vessel owners in the short term, without being socially optimal in the long term. The empirical results indicate that the Government's intervention by the use of subsidies led to a reduction in the actual surpluses of the two fisheries compared with no intervention. The crewmembers earned their opportunity cost of labour or above in the working years. Some vessels achieved good earnings in these two years of the profitability analysis even when excluding the subsidies, probably due to the introduction of cost-saving practices. Like Paper 1, this paper confirms that, even in open-access fisheries, some vessels in the heterogeneous fleets may create net benefits to society.

This paper demonstrates that the 2010 Government subsidy schemes had positive effects on the profitability of the investigated vessels, with the quasi-lump sum fuel cost support having the greatest effect. Unlike the effect of the 2008 subsidy programme in Paper 1, the 2010 subsidy schemes produced relatively more benefits for large vessels than for small ones. The largest vessels (i.e., engines with a high HP) received relatively more support than the smaller ones and earned most of the super-profit as well as the intra-marginal rent generated. However, the higher subsidies for larger vessels did not help all of them to achieve a higher level of economic performance. This paper also discusses several arguments for the Vietnamese subsidy programme. The subsidies may come from infant-industry arguments, strategic rent-shifting incentives of neighbouring countries, social and geopolitical objectives and SCS border security reasons.

Paper 3, evaluating the average treatment effects of the 2010 Government subsidy programme, also provides quantitative evidence that the 2010 subsidies had a positive effect on the vessel profitability. These arrangements resulted in increased operating cash flow, profit, rent, operating cash flow margin and profit margin. The increased profitability of the vessels is a result of both the revenue-enhancing and the cost-reducing subsidy schemes, that is, positive effects of the fuel cost support on the gross revenue, negative effects of insurance subsidies on the fixed operating costs and negative effects of capital cost subsidies on the interest payment on loans. However, Paper 3 does not show a rosy prospect for the investigated gillnet vessels. The empirical results demonstrate that the profits were eroded over the two years of the analysis. The average treatment effects on the vessel profitability decreased from 2011 to 2012, while the 2010 support schemes were unchanged over the two years. The counterfactual profitability pointed to a decrease in 2012. In addition, the average catches of the surveyed vessels declined when comparing 2012 with 2011.

Furthermore, the effects of the 2010 subsidy programme on the distribution of benefits and income of vessels and crewmembers are explored in this paper. The subsidies had positive impacts on the operating cash flow of large vessels (i.e., engines of over 400 HP) but negative effects on their intra-marginal rent, while they had positive effects on the rent of the small vessels (i.e., engines of less than 400 HP). In addition, it is interesting that the Government subsidy programme seems to have generated benefits for the vessel owners rather than for the crewmembers. Statistically insignificant effects of the subsidies on the average income per fisher are found in the empirical analysis. The income of crewmembers is based on the sharing rules of the actual fishing income; therefore, in the short run, the sharing rules are not affected by the subsidy arrangements. This paper also infers that the argument that subsidies prevent unemployment and the collapse of fishing communities in developing countries, as discussed in paper 2, is partially convincing only in the short term. The intention to increase the track records of the bordering countries through the use of subsidies, for a better future bargaining advantage, may be futile. If future track-record-based management systems are applied to the SCS's EEZs, this will probably lead to the fuelling of an international fishing war among neighbouring countries. International negotiations and dispute settlement based on international law should be used to agree on an internationally recognized delineation of the SCS to avoid encouraging the presence of countries' own vessels in these areas with the use of subsidies and therefore reduce the pressure on the offshore resources.

Paper 4 follows the SPF approach to estimate the production frontiers and technical efficiency for offshore gillnet and hand-line vessels based on the 2011 and 2012 catch and effort data. Due to the lack of stock estimates, three efficiency estimation models with three different stock proxy measures are proposed for each fishery. Based on the consistency conditions of the efficiency estimates, the results show that the CPUE measures provide the same estimates of efficiency scores as the DEA measures. The CPUE measures are not subject to a distortion in the estimates of technical efficiency as the average characteristics of the vessels in the two years are similar. Based on tests of the assumption of unitary elasticity for effort, the results demonstrate that the use of the DEA index provides a more robust estimate of production frontiers and elasticities when information on the stock abundance is lacking. This approach is free from production-related assumptions in its derivation. Hence, it cannot be subject to a distortion in the measures of production elasticities.

Both the CPUE and the DEA stock proxy measures indicate a decrease in the stock abundances from 2011 to 2012. This also indicates that the fish resources in Vietnam's offshore waters are most likely to be biologically overfished. Under the open-access scheme for the investigated fisheries, the subsidy programmes have motivated the fishers to engage in more intensive use of the existing vessels and the expansion of fishing effort and capacity through investment, possibly resulting in overfishing. Furthermore, Paper 4 reports that the average TE scores were about 0.63 for gillnetters and 0.79 for hand-liners in the three models. These results may indicate that there is short-term potential for catch expansion for both fleets without additional inputs. However, this potential probably disappears in the long term because of the effects of the catch on the already-overfished open-access stocks.

9. Conclusions

This dissertation focuses on analysing the business and welfare economic performance and on evaluating the economic effects of the Government's subsidy programmes for Vietnam's offshore fisheries operating in the SCS. It integrates the theoretical frameworks of bioeconomics and vessel economics of fisheries and empirical investigations to examine the research problems. It approaches a sustainable development perspective for assessing the effects of the Government subsidies. Hence, although the key focus of the research is on the economic effects of subsidies, the ecological and social dimensions are taken into account. The empirical analyses are applied to the offshore gillnet and hand-line fisheries in the Khanh Hoa province. The first result shows that open-access fisheries can create net benefits (i.e., intra-marginal rent) for society, which are derived from the cost saving of the efficient vessels. Thuy (2013) reported the same finding that rent creation can be achieved in an open-access regime.

Regarding the effects on the economic dimension, the subsidy programmes had positive effects on vessel profitability in the years of the analysis (Papers 1, 2 and 3). However, the profits were eroded over the years (Papers 2 and 3). There has been a decrease in counterfactual profitability as well as the average treatment effects on vessel profitability. It is also indicated that the Government's intervention with the use of subsidies led to a reduction of the actual surpluses of the investigated offshore fisheries compared with the situation with no intervention. Therefore, the offshore fisheries could be profitable for the vessel owners in the short term without being socially optimal in the long term.

Concerning the ecological dimension, the estimate of the fish stock proxy indices shows that the fish resources in Vietnam's offshore waters are most likely to be biologically overfished. The previously published studies and organizational reports, as presented in this dissertation, provide similar findings on the status of fisheries' resources. The Government's support for the fisheries managed by the open-access regime may have added to this problem.

For the social dimension, the dissertation addressed the aspect of human well-being, particularly within the area of income and rent distribution. For the 2008 year-season, the most economically efficient vessels are mainly those with a high level of relative standardised effort, but not without exception. The majority of these vessels earned intra-marginal rent, while the smallest vessels were the most dependent on the Government's 2008 quasi-lump sum fuel subsidy scheme. For the 2010 subsidy programme, the larger vessels (i.e., a higher engine) received relatively more support than the smaller ones and earned most of the super-profit as well as the intra-marginal rent generated. The 2010 subsidy schemes brought about relatively more benefits for large vessels than for small ones; the opposite applies to the 2008 arrangements. However, the bigger subsidies for larger vessels did not help all of them to achieve a higher level of economic performance. The average treatment effect of the subsidies on the rent of the largest vessels (i.e., engines over 400 HP) was negative (i.e., in 2012). In addition, the majority of the large-scale vessels provided a greater annual income for crewmembers, although insignificant effects of the subsidy arrangements on the income for crewmembers were found. Furthermore, the Government subsidy programmes generated more benefits for the vessel owners than for the crewmembers. In fact, this is to be expected in a free labour market in which labour in fisheries earns opportunity costs, adjusted for risk, long working days, working away from home and other factors. This could affect the behaviour of crewmembers towards other forms of remuneration contracts or alternatives in the future if maintaining such a subsidy programme.

It is clear that the Government subsidy intervention had a negative impact on the sustainable development of the offshore fisheries. The design of subsidy programmes such as the 2010 schemes aimed to provide incentives for fishermen to invest in large-scale offshore vessels with more powerful engines. Under the open-access scheme, which allows new effort to enter the fishery, the policy goal of improving the income and profitability of the offshore fisheries by the use of subsidies can be achieved only in the short term. In the long term, the environmental deterioration (i.e., a smaller stock size) will counter the effect of the subsidies on economic and social sustainability.

This research offers policy recommendations. Firstly, it is important to note that both the efficient utilization of the input resources associated with fishery production and the effective management of marine resources are fundamental issues that should be addressed for the fisheries in Vietnam's EEZs as well as in the SCS. To achieve the goals of sustainable development, it would be wise for Vietnam to seek to operate a fisheries management system that is designed to prevent overfishing and overcapacity and to promote the recovery of overfished stocks for offshore fisheries. It is also important for Vietnam to enhance its offshore fishing programmes to reduce the pressure on already-overfished coastal resources through support that does not contribute to overfishing and overcapacity. This support may include training fishermen to adopt new technology, providing information about the fish stock, forecasting weather and rescue and life-saving activities in high seas as well as transfers related to management, research and enforcement.

However, international negotiations and existing dispute settlements based on international law should be used first to reach an internationally recognized delineation of the SCS to avoid encouraging the presence of countries' own vessels in this area by the use of subsidies. The second is to promote the establishment of an effectively cooperative fishing regime in the SCS region, where the bordering countries share the common benefits from fisheries resources (see Long, 2009 for an overview and concepts). The calls for sharing the total allowable catch among the involved countries should be considered (see Armstrong and Flaaten, 1991; Munro, 1979 for discussions). These can contribute to reducing the pressure on Vietnam's offshore resources and to maintaining the transboundary fish stocks and therefore can approach the sustainable development of the offshore fisheries.

Finally, the dissertation contributes to the further development of the methods for comparing the economic performance and efficiency of vessels by the standardization of fishing effort and the estimation of a Salter diagram (Paper 1). To the best of my knowledge, this method for comparing vessel efficiency has not been published previously. The dissertation extends the traditional economic model of Gordon to illustrate the existence of intra-marginal rent for an open-access fishery with heterogeneous vessels and to model the static effects of revenue-enhancing lump sum subsidies on the fishery and individual vessels (Papers 2 and 3). It provides the first contribution to the literature regarding the treatment effect evaluation of a subsidy programme on a Southeast Asian fishery (Paper 3). It also uses different fish stock measures to estimate the technical efficiency of vessels due to the lack of stock estimates, which have been ignored in the previously published studies on Vietnam's fisheries (Paper 4). In future, the subsidy polices should be reviewed and assessed at national levels. This should be performed for all bordering countries fishing in the SCS. A proper analysis framework for assessing the effects of fisheries subsidies, including consistent methodologies, should be developed for the SCS fisheries. This review and assessment should address the economic, environmental and social outcomes, potential trade-offs and cost-effectiveness, as well as taking into account the size of the impacts and the probabilities associated with the potential outcomes.

Appendix

Given the production possibility set P_s in a base time period s (i.e., year 1) as the reference technology, the output distance function of a decision-making unit (DMU) in time period s is defined as $D_O^s(x_s, y_s) = min\{\delta: (x_s, y_s/\delta) \in P_s\}$, where x_s is the set of inputs used in period s, y_s is the set of outputs produced in period s and δ is the value of the distance function for a vessel using the input levels x_s to produce the outputs y_s. The Malmquist (output-oriented) index of productivity change between period s and period t, which was defined by Caves et al. (1982), can be written as $M_O^s = M_O^s(x_s, y_s, x_t, y_t) = D_O^s(x_t, y_t)/D_O^s(x_s, y_s)$, where $D_O^s(x_t, y_t)$ represents the distance from the period t observation to the period s technology.

The M_O^s index will be affected by changes in efficiency among the periods and technical change (Färe et al., 1994). By making each DMU "efficient" in each time period through the appropriate radial expansion of their output levels, an equivalent set of efficient DMUs can be derived from the observed data by $y_s^* = y_s/D_O^s(x_s, y_s)$ and $y_t^* = y_t/D_O^t(x_t, y_t)$, where y_s^* and y_t^* are the efficient levels of output given the level of inputs and the technology employed in periods s and t, respectively. Consequently, the differences in efficiency are removed and all the "efficient" DMUs will sit on the frontier relating to each period. As a result, the index, reducing to $M_O^{*s} = D_O^s(x_t, y_t^*)/D_O^s(x_s, y_s^*) = D_O^s(x_t, y_t^*)$, will represent the technical change, which is assumed to reflect the changes in stock abundance in the case of fisheries (Pascoe and Herrero, 2004). In this case, M_O^{*s} may be named "biotechnical change".

References

ABLAN, M. C. & GARCES, L. 2005. Exclusive Economic Zones and the Management of Fisheries in the South China Sea. *In*: EBBIN, S., HÅKON HOEL, A. & SYDNES, A. (eds.). *A Sea Change: The Exclusive Economic Zone and Governance Institutions for Living Marine Resources*. Springer Netherlands, pp. 136–149.

ARMSTRONG, C. & FLAATEN, O. 1991. The Optimal Management of a Transboundary Fish Resource: The Arcto-Norwegian Cod Stock. *In*: ARNASON, R. & BJØRNDAL, T. (eds.). *Essays on the Economics of Migratory Fish Stocks*. Series: Studies in Contemporary Economics. Springer Berlin Heidelberg, pp. 137–151.

BEVERTON, R. & HOLT, S. 1957. On the Dynamics of Exploited Fish Populations. Fisheries Investigation Series 2, Volume 19, UK Ministry of Agriculture. *Fisheries, and Food, London, UK.*

BOONSTRA, W. J. & BACH DANG, N. 2010. A History of Breaking Laws—Social Dynamics of Non-compliance in Vietnamese Marine Fisheries. *Marine Policy*, 34(6), pp. 1261–1267.

BRUNDTLAND, G., KHALID, M., AGNELLI, S., AL-ATHEL, S., CHIDZERO, B., FADIKA, L., HAUFF, V., LANG, I., SHIJUN, M., MORINO DE BOTERO, M., SINGH, M., OKITA, S. & OTHERS, A. 1987. *Our Common Future ('Brundtland report'). The United Nations World Commission on Environment and Development (WCED)*. Oxford University Press, USA.

CAVES, D. W., CHRISTENSEN, L. R. & DIEWERT, W. E. 1982. The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity. *Econometrica: Journal of the Econometric Society*, 50(6), pp. 1393–1414.

CIRCULAR 2011. Guiding the Implementation of Decision 48/2010/QĐ-TTg of Vietnam's Prime Minister on July 13, 2010 on Some Policies Encouraging and Supporting for

Fishing, Aquaculture and Fisheries Service on Offshore Sea Areas. *Joint Circular 11/2011/TTLT-BNN-BQP-BTC of the Ministry of Agriculture and Rural Development, the Ministry of Defence and the Ministry of Finance on March 14, 2011*. Hanoi, Vietnam.

CLARK, C. 1990. *Mathematical Bioeconomics: the Optimal Management of Renewable Resources*. 2nd ed. New York: Wiley.

CLARK, C. W., MUNRO, G. R. & SUMAILA, U. R. 2005. Subsidies, Buybacks, and Sustainable Fisheries. *Journal of Environmental Economics and Management*, 50(1), pp. 47–58.

COGLAN, L. & PASCOE, S. 1999. Separating Resource Rents from Intra-marginal Rents in Fisheries' Economic Survey Data. *Agricultural and Resource Economics Review*, 28, pp. 219–228.

COPES, P. 1972. Factor Rents, Sole Ownership and the Optimum Level of Fisheries Exploitation. *The Manchester School of Social and Economic Studies*, 40, pp. 145–163.

DANIDA. 2010. *The Fisheries Sector in Vietnam: A Strategic Economic Analysis*. DANIDA Report 12/2010. Hanoi: The Royal Embassy of Denmark in Vietnam (DANIDA).

DARD. 2014. *Social-economic Report 2014 (in Vietnamese)*. Khanh Hoa's Department of Agriculture and Rural Development (DARD), Khanh Hoa, Vietnam.

DECAFIREP. 2013. *The Annual Reports of the Number of Vessels and Engine Power Registered in the Period 2001–2013 (in Vietnamese)*. DECAFIREP Annual Reports 2001–2013. Khanh Hoa's Department of Capture Fisheries and Resources Protection (DECAFIREP), Khanh Hoa, Vietnam.

DECISION 2008a. Some Policy Supporting for Ethnic Minority People, Poor People and Fishermen (in Vietnamese). *Decision 289/QD-TTg of Vietnam's Prime Minister on March 18, 2008*. Hanoi, Vietnam.

DECISION 2008b. Repairing and Supplementing Decision 289/QD-TTg by Vietnam's Prime Minister on March 18, 2008 (in Vietnamese). *Decision 965/QD-TTg of Vietnam's Prime Minister on July 21, 2008*. Hanoi, Vietnam.

DECISION 2010a. Some Policies Encouraging and Supporting for Fishing, Aquaculture and Fisheries Service on Offshore Sea Areas (in Vietnamese). *Decision 48/2010/QĐ-TTg of Vietnam's Prime Minister on July 13, 2010*. Hanoi, Vietnam.

DECISION 2010b. Vietnam's Fisheries Development Strategy towards 2020. *Decision 1690/QD-TTg of Vietnam's Prime Minister on September 16, 2010*. Hanoi, Vietnam.

DECISION 2013. Approving the Master Development Plan for the Fisheries Sector to 2020 and Vision toward 2030 (in Vietnamese). *Decision 1445/QD-TTg of Vietnam's Prime Minister on August 16, 2013*. Hanoi, Vietnam.

DECREE 2010. On Management of Aquatic Resource Exploitation by Vietnamese Organizations and Individuals in Sea Areas. *Decree no. 33/2010/ND-CP of Vietnam's Prime Minister on March 31, 2010*. Hanoi, Vietnam.

DECREE 2014. On Some Fisheries Development Policies. *Decree no. 67/2014/ND-CP of Vietnam's Prime Minister on July 7, 2014*. Hanoi, Vietnam.

DIRECTORATE OF FISHERIES. 2012a. *The Master Development Plan for the Fisheries Sector to 2020 and Vision toward 2030 (in Vietnamese)*. Summary Report 7/2012. Hanoi, Vietnam: Directorate of Fisheries. http://tongcucthuysan.gov.vn/.

DIRECTORATE OF FISHERIES. 2012b. *The Stages in the Development of Vietnam Fisheries Sector*. Hanoi, Vietnam: Directorate of Fisheries. Available at:

http://tongcucthuysan.gov.vn/introduction/about-directorate-of-fisheries/history-of-fisheries-development/ (accessed 26 October 2015).

EC. 2004. *Economic Performance of Selected European Fishing Fleets*. Concerted Action on Economic Assessment of European Fisheries (Q5CA-2001-01502). Annual Report 2004. European Commission, December 2004.

FAO. 2005a. *Fisheries and Aquaculture Country Profiles—Vietnam*. Rome: Food and Agricultural Organization of the United Nations (FAO). Available at http://www.fao.org/fishery/facp/VNM/en (accessed 25 November 2015).

FAO. 2005b. *Report of the Conference on the National Strategy for Marine Fisheries Management and Development in Viet Nam*. FAO/FishCode Review No. 16. 1728-4392. Food and Agriculture Organization of the United Nations, Rome, Italy: FAO.

FLAATEN, O. 2016. *Fisheries Economics and Management*. 1st ed. Copenhagen, Denmark: Bookboon. Available at: http://bookboon.com/dk/fisheries-economics-and-management-ebook.

FLAATEN, O., HEEN, K. & SALVANES, K. G. 1995. The Invisible Resource Rent in Limited Entry and Quota Managed Fisheries—the Case of Norwegian Purse Seine Fisheries. *Marine Resource Economics*, 10, pp. 341–356.

FLAATEN, O. & WALLIS, P. 2001. *Government Financial Transfers to Fishing Industries in OECD Countries*. OECD Working Paper 1917911. The Organisation for Economic Co-operation and Development, Paris.: Available at: http://www.oecd.org/greengrowth/fisheries/1917911.pdf (accessed 6 October 2013).

FÄRE, R., GROSSKOPF, S. & LOVELL, C. A. K. 1994. *Production Frontiers*. Cambridge: Cambridge University Press.

GORDON, H. S. 1954. The Economic Theory of a Common Property Resource: the Fishery. *Journal of Political Economy*, 62, pp. 124–142.

GSO. 2005. *Statistical Yearbook of Vietnam 2005*. Hanoi, Vietnam: Statistical Publishing House, General Statistics Office (GSO).

GSO. 2014. *Statistical Yearbook of Vietnam 2014*. Hanoi, Vietnam: Statistical Publishing House, General Statistics Office (GSO).

HAN, M. P. H. 2007. Fisheries Development in Vietnam: A Case Study in the Exclusive Economic Zone. *Ocean & coastal management*, 50(9), pp. 699–712.

HARDIN, G. 1968. The Tragedy of the Commons. *Science*, 162(3859), pp. 1243–1248.

HEYMANS, J. J., MACKINSON, S., SUMAILA, U. R., DYCK, A. & LITTLE, A. 2011. The Impact of Subsidies on the Ecological Sustainability and Future Profits from North Sea Fisheries. *PLoS One*, 6(5), p. e20239.

KHANH NGOC, T. Q., FLAATEN, O. & KIM ANH, N. 2009. Efficiency of Fishing Vessels Affected by a Marine Protected Area—The Case of Small-Scale Trawlers and the Marine Protected Area in Nha Trang Bay, Vietnam. *In*: DAHL, E., MOKSNESS, E. & STØTTRUP, J. (eds.). *Integrated Coastal Zone Management*. UK: Wiley-Blackwell, pp. 189–206.

LE FLOC'H, P., DAURÈS, F., BRIGAUDEAU, C. & BIHEL, J. 2008. A Comparison of Economic Performance in the Fisheries Sector: A Short- and Long-term Perspective. *Marine Policy*, 32(3), pp. 421–431.

LONG, L. K. 2009. *The Potential for Cooperation in Shared Fisheries: Theory and Application to Vietnam's Fisheries Strategy in the South China Sea*. PhD dissertation. Tromsø, Norway: University of Tromø.

LONG, L. K., FLAATEN, O. & KIM ANH, N. T. 2008. Economic Performance of Open-access Offshore Fisheries—The Case of Vietnamese Longliners in the South China Sea. *Fisheries Research*, 93(3), pp. 296–304.

MUNRO, G. & SUMAILA, U. R. 2002. The Impact of Subsidies upon Fisheries Management and Sustainability: the Case of the North Atlantic. *Fish and Fisheries,* 3(4), pp. 233–250.

MUNRO, G. R. 1979. The Optimal Management of Transboundary Renewable Resources. *Canadian Journal of Economics*, 12(3), pp. 355–376.

OECD. 2000. *Transition to Responsible Fisheries*. Paris: The Organization for Economic Co-operation and Development (OECD) Publishing.

OECD. 2006. *Financial Support to Fisheries: Implications for Sustainable Development*. Paris: The Organization for Economic Co-operation and Development (OECD) Publishing.

PASCOE, S. & HERRERO, I. 2004. Estimation of a Composite Fish Stock Index using Data Envelopment Analysis. *Fisheries Research*, 69(1), pp. 91–105.

PASCOE, S., ROBINSON, C. & COGLAN, L. 1996. *Economic and Financial Performance of the UK English Channel Fleet*. CEMARE research report No. 44. Centre for the Economics and Management of Aquatic Resources, University of Portsmouth, United Kingdom.

PAULY, D. & CHRISTENSEN, V. 1993. Stratified Models of Large Marine Ecosystems: A General Approach and an Application to the South China Sea. pp. 148–174. *In*: SHERMAN, K., ALEXANDER, L. M. & GOLD, B. D. (eds.). *Large Marine Ecosystems: Stress, Mitigation, and Sustainability*. Washington, DC: American Association for the Advancement of Science (AAAS) Press.

PAULY, D. & ZELLER, D. 2015. Sea Around Us Concepts, Design and Data (www.seaaroundus.org).

PHAM, T. D. T., HUANG, H.-W. & CHUANG, C.-T. 2014. Finding a Balance between Economic Performance and Capacity Efficiency for Sustainable Fisheries: Case of the Da Nang Gillnet Fishery, Vietnam. *Marine Policy*, 44, pp. 287–294.

POMEROY, R., KIM ANH, N. T. & THONG, H. X. 2009. Small-scale Marine Fisheries Policy in Vietnam. *Marine Policy*, 33(2), pp. 419–428.

ROSENBAUM, P. R. & RUBIN, D. B. 1983. The Central Role of the Propensity Score in Observational Studies for Causal Effects. *Biometrika*, 70(1), pp. 41–55.

SCHRANK, W. 2003. *Introducing Fisheries Subsidies*. Series: FAO Fisheries Technical Paper. No. 473. Rome, Italy: Food and Agriculture Organization of the United Nations.

SEAFDEC. 2012. *The Southeast Asian State of Fisheries and Aquaculture 2012*. Bangkok, Thailand: Southeast Asian Fisheries Development Center (SEAFDEC), 130 p.

SEAFDEC. 2013. *Fishery Statistical Bulletin of Southeast Asia 2013*. Bangkok, Thailand: Southeast Asian Fisheries Development Center (SEAFDEC).

SHERMAN, K. & HEMPEL, G. 2009. *The UNEP Large Marine Ecosystem Report: A Perspective on Changing Conditions in LMEs of the World's Regional Seas*. Series: UNEP Regional Seas Reports and Studies No. 182. Nairobi, Kenya: United Nations Environment Programme, 852 p.

SUMAILA, U. R. 2013. How to Make Progress in Disciplining Overfishing Subsidies. *ICES Journal of Marine Science: Journal du Conseil*, 70(2), pp. 251–258.

SUMAILA, U. R. & PAULY, D. 2006. *Catching More Bait: A Bottom-up Re-estimation of Global Fisheries Subsidies (2nd version)*. Fisheries Centre Research Reports 14(6). Vancouver, Canada: Fisheries Centre, the University of British Columbia.

SUMAILA, U. R., TEH, L., WATSON, R., TYEDMERS, P. & PAULY, D. 2008. Fuel Price Increase, Subsidies, Overcapacity, and Resource Sustainability. *ICES Journal of Marine Science: Journal du Conseil*, 65(6), pp. 832–840.

TALAUE-MCMANUS, L. 2000. *Transboundary Diagnostic Analysis for the South China Sea*. EAS/RCU Technical Report Series No. 14. Bangkok, Thailand: United Nations Environment Programme.

THAO, N. H. 2001. Vietnam and the Code of Conduct for the South China Sea. *Ocean Development & International Law*, 32(2), pp. 105–130.

THUY, P. T. T. 2013. *Rent Creation and Distribution—Theory and the Vietnamese Small Scale Purse Seine Fishery*. PhD dissertation. Tromsø, Norway: University of Tromsø.

THUY, P. T. T., FLAATEN, O. & KIM ANH, N. T. 2013. Remuneration Systems and Economic Performance: Theory and Vietnamese Small-scale Purse Seine Fisheries. *Marine Resource Economics*, 28(1), pp. 19–41.

TPP AGREEMENT. 2015. *Text of the Trans-Pacific Partnership (TPP) Agreement*. Released by TPP Parties on 5 November 2015. Available at: http://tpp.mfat.govt.nz/text (accessed 6 November 2015).

UNEP. 2005a. *Reflecting Sustainable Development and Special and Differential Treatment for Developing Countries in the Context of New WTO Fisheries Subsidies Rules*. An Issue and Options Paper. The United Nations Environment Programme (UNEP), Geneva, November 2005: Available at: http://www.unep.ch/etb/events/pdf/SCtr.pdf (accessed 13 April 2014).

UNEP. 2005b. *Wilkinson, C., DeVantier, L., Talaue-McManus, L., Lawrence, D. and D. Souter. South China Sea, GIWA Regional Assessment 54*. Kalmar, Sweden: University of Kalmar.

UNEP. 2006. *Challenges to International Waters—Regional Assessments in a Global Perspective*. Nairobi, Kenya: United Nations Environment Programme (UNEP).

UNEP, VIFEP & WWF. 2009. *Fisheries Subsidies, Supply Chain and Certification in Vietnam*. Final Summary Report Vietnam. Hanoi, September 2009: Report produced by the United Nations Environment Programme (UNEP) Division of Technology, Industry and Economics (DTIE), Vietnam Institute of Fisheries and Economic Planning (VIFEP), World Wildlife Fund for Nature (WWF).

VON MOLTKE, A. 2011. *Fisheries Subsidies, Sustainable Development and the WTO*. Oxford: Earthscan.

WESTLUND, L. 2004. *Guide for Identifying, Assessing and Reporting on Subsidies in the Fisheries Sector*. Series: FAO Fisheries Technical Paper. No. 438, vol. 438. Rome, Italy: Food and Agriculture Organization of the United Nations.

WHITMARSH, D., JAMES, C., PICKERING, H. & NEILAND, A. 2000. The Profitability of Marine Commercial Fisheries: A Review of Economic Information Needs with Particular Reference to the UK. *Marine Policy*, 24(3), pp. 257–263.

WORLD BANK. 2005. *Vietnam Fisheries and Aquaculture Sector Study*. Final Report No. 31695. World Bank, Washington, DC: World Bank. Available at: http://documents.worldbank.org/curated/en/2005/02/5716520/fisheries-aquaculture-sector-study-final-report-fisheries-aquaculture-sector-study (accessed 6 January 2014).

WTO. 1999. Agreement on Subsidies and Countervailing Measures, April 15, 1994, Marrakesh Agreement Establishing the World Trade Organization (WTO), Annex 1A. *In*: *The Legal Texts: the Results of the Uruguay Round of Multilateral Trade Negotiations*. Cambridge: Cambridge University Press, pp. 231–274.

WTO 2007. Draft Consolidated Chair Texts of the AD and SCM Agreements. *Chairperson's Texts 2007 (TN/RL/W/213)*. Doha development agenda, World Trade Organization, Doha, November 30: Doha development agenda, Chairperson's Texts 2007. Available at: http://www.wto.org/english/tratop_e/rulesneg_e/rules_chair_text_nov07_e.htm (accessed 13 April 2014).