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FACULTY OF BIOSCIENCES, FISHERIES AND ECONOMICS
NORWEGIAN COLLEGE OF FISHERY SCIENCE

Rent creation and distribution

-Theory and the Vietnamese small-scale purse seine fishery

Pham Thi Thanh Thuy

A dissertation for the degree of Philosophiae Doctor

April 2013

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Contents

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Summary

In Vietnam, as in many other countries, the fisheries sector plays an important role in securing food, providing livelihood, and promoting economic development. Vietnamese fisheries are characterized by open access, and the number of fishing vessels has increased tremendously over the past years while the harvest growth has slowed down. This seems to indicate that the fisheries have reached the limit on the growth, and that overfishing in near-shore waters may be imminent.

Overfishing has become an important issue for governments and organizations in all coastal states in recent years. Sustainability is now stated as an overriding policy objective. The concept of sustainable development makes clear that environmental, economic and social goals must be met simultaneously. Hence, in the management process, both environmental well-being and human well-being must be taken into consideration.

The central topic of this thesis is how and to what extent open-access fisheries may be consistent with or opposed to the goals of sustainable development. It is obvious that open-access fisheries may contradict the goal of environmental well-being. However, it is more unclear what an open-access regime does mean for the goal of human well-being. In the literature, it is generally assumed that the economic rent will disappear because of the common property problem. This thesis questions this assumption and takes a closer look at the processes of rent creation and distribution, and how these may affect environmental sustainability.

The main concerns of the three papers are the following: Paper 1 examines if rent can be generated and distributed in open-access fisheries by looking at the way fishermen formulate remuneration contracts. This issue is also discussed in paper 2, but in light of how the fishermen link with downstream markets when fish is traded internationally. Here, the effects of different market structures are highlighted. Both papers 2 and 3 deal with the linkage between the fishermen and the resources, which is an important issue from the point of view of environmental sustainability

The analytical framework applied in this thesis is presented in the model of the fishery system. This model emphasizes the relationship between the human system and the environment, and the complex interplay between the various components of the fishery system (resources, fishermen, community, market, and state). The theoretical models employed vary from general economic theories applicable to many different fields (principal-agent theory, expected utility theory, theories of market structures) to theories relating particularly to fisheries (the biological overfishing model, the backward bending supply curve in open-access fisheries. Various methodological techniques are also included (propensity score matching, autoregressive model, weight and constrained least square).

In all three papers, theoretical discussions and empirical findings are combined. The data is from Vietnam – mainly related to the inshore anchovy purse seine fishery. In addition, data from the offshore yellow fin tuna longline fishery is used in order to compare how different the results are between offshore and inshore fisheries.

This thesis shows that rent creation and distribution can be achieved in open-access fisheries, and that the existence of market power by middlemen to some extent can limit the overfishing problem. Hence, market power is not necessarily a failure. It also turns out that economic data might be applied to measure the problem of overfishing and the health situation of the resource if biological data is lacking. A more interdisciplinary approach, including behavior models and a holistic concept of the fishery system, could allow for an improvement of today's fisheries management. This thesis has particularly pointed out the importance of taking the fishermen's decision-making behavior into account. This is an issue which so far has not received much attention in the literature on fisheries management.

List of papers

Paper 1

Remuneration System and Economic Performance - Theory and the Vietnamese Small Scale Purse Seine Fisheries. *Marine Resource Economics Journal* 28(1): 19 –41.

Paper 2

Middlemen: Good for Resources and Fishermen? (Submitted)

Paper 3

The Backward-bending Supply Curve in Fisheries-Revisited. (Submitted)

Introduction

This thesis aims to provide more insight into whether and how rent creation and distribution take place in developing countries' open-access fisheries. Theoretical discussions and empirical investigations are integrated, based on data from Vietnam – mainly related to the inshore anchovy purse seine fishery. The thesis also discusses to what extent open-access fisheries contradict or may be in line with the principle of sustainable development. In total, the thesis consists of this introductory part and three papers. This introduction is structured as follows:

I start by giving a brief presentation of the fishery sector in Vietnam, and notably the purse seine fishery. As sustainable development is a major challenge in all open-access fisheries, the next section presents and discusses the concept of sustainability. In the subsequent section I outline the fishery system and the main characteristics of fisheries management in Vietnam. This is followed by an overview of previous research dealing with rent creation and distribution in open-access fisheries. Next, I explain the theoretical and methodological approaches which are applied throughout the thesis. After this, the three papers are summarized, and I explain how they are linked. In the concluding section, I highlight the main achievements of this thesis and point out some directions for future research. Table 1 gives an overview of the three papers that this thesis contains.

Table 1: Overview of the papers

Paper	Title	Authors	Published /submitted
1	Remuneration system and economic performance – Theory and the Vietnamese small-scale purse seine fisheries	Pham Thi Thanh Thuy Ola Flaaten Nguyen Thi Kim Anh	Published
2	Middlemen: Good for resources and fishermen?	Pham Thi Thanh Thuy Ola Flaaten	Submitted
3	The backward-bending supply curve in fisheries – Revisited.	Pham Thi Thanh Thuy Ola Flaaten	Submitted

The fishery sector in Vietnam

Vietnam has a coastline of 3,260 km and an Exclusive Economic Zone (EEZ) of about one million km^2 (FAO 2005). Its coast has diverse marine resources, with more than 2,100 species of fish, 75 species of shrimp, and 653 species of marine algae (Thao 2002). The Vietnamese fisheries are multi-gear, comprising both gill nets (19 percent), trawls (25 percent), longline and trolling (18 percent), seine nets (8 percent), and other fishing tackles (30 percent) (MOFI 2005).

With the abundance of marine resources and high economic value species, the fisheries sector plays an important role in securing food and promoting economic development in Vietnam. Every day, millions of people rely on fish as a direct source of nutrition. Fish is a central component in the traditional diet, and it accounts for 40 percent of the protein supply. The sector also contributes to human welfare by providing jobs for approximately 5 million people (MOFI 2010). The fisheries sector is of great importance for the national economy. It ranks as the fourth largest sector after garment and textile, crude oil,

and footwear. In 2008, the fisheries sector contributed to 5 percent of the country's GDP (AGROINFO 2009), up from 4 percent in 2006 (FAO 2009). In the period 2001–2011, export earnings increased by an average of 13 percent per year, i.e. 2.4 times, reaching 6 billion US dollars in 2011 (VASEP 2012). The Vietnamese fisheries have achieved a central position globally. In 2010, Vietnam was the twelfth largest country in capture production and the fourth largest in export value (FAO 2013).

The Vietnamese fisheries are characterized by open-access, that is, access to fisheries is unrestricted. Traditional modes of artisanal production and technologically backward capture still dominate (FAO 2009). The number of fishing vessels has increased tremendously over the past years. During the 1990s, the number of fishing vessels increased by an average of 2,300 per year. In 2009, there were about 1,300 thousand motorized fishing vessels, of which 70 percent had an engine with less than 45 horsepower and 90 percent a length of less than 20 meters. Of the motorized fishing vessels, 80 percent were operating in the near-shore areas which make up only 11 percent of the EEZ (MOFI 2010).

Even though Vietnam, with its open-access fisheries regime, stands out as one of the countries with the highest harvest growth in the world, it is clear that the growth has slowed down in recent years (Flaaten 2013). From 1985 to 2005, the harvest continuously increased, from 571 thousand tonnes to 1,995 thousand tonnes, but the increase from 2000 to 2005 was more modest – of 334 thousand tonnes (GSO 2008). Catch per horsepower (hp) thus has decreased from 1.11 tonnes/hp in 1985 to 0.34 tonnes/hp in 2005. This seems to indicate that the fisheries have reached the limit on the growth, and that overfishing in near-shore waters may be imminent (FAO 2004, 2005).

As is well known from the literature, overfishing has serious economic, social and environmental consequences. The economic surpluses from the fishing activities are reduced and may even disappear in some cases (Flaaten 2011; Long 2003). Thousands of people may be forced to leave the fisheries. When total catch go down, a race may also develop among the vessels as each of them try to secure their individual catch to be able to remain in the fisheries. This may include new investments being made in the hope of increasing catches.

However, this process only tends to reinforce the problems. It becomes harder for the small-scale fishing vessels to make a living. Resources are put under increasing pressure. When commercially valuable species are overexploited, other species and habitats that share the same ecosystems are easily affected. Many vessels unintentionally kill untargeted marine life, including juvenile fish, corals and other bottom-feeding organisms, sharks, whales, sea turtles, and birds. Killing these species can have large and undesired effects on the marine ecosystems.

The purse seine fishery in Khanh Hoa province, Vietnam

In Vietnam, the purse seine fishery was initially introduced in the North in 1959 and then in the South in 1975. Nowadays, this fishery is dominant in 29 out of 64 provinces in Vietnam. The purse seine fishery plays an important role in creating economic values and generating jobs for thousands of people. In 2005, the number of vessels in this fishery was 6,413.

The province of Khanh Hoa is located in the south central Vietnam (see figure 1). Its land area is approximately 5,260 km^2, with a coastline of more than 520 km. There are about 31,500 people working in the fishing sector in this province. They live in fishing villages along the coast. Approximately 30 percent of them are involved in inshore purse seine fisheries (GSO 2009).

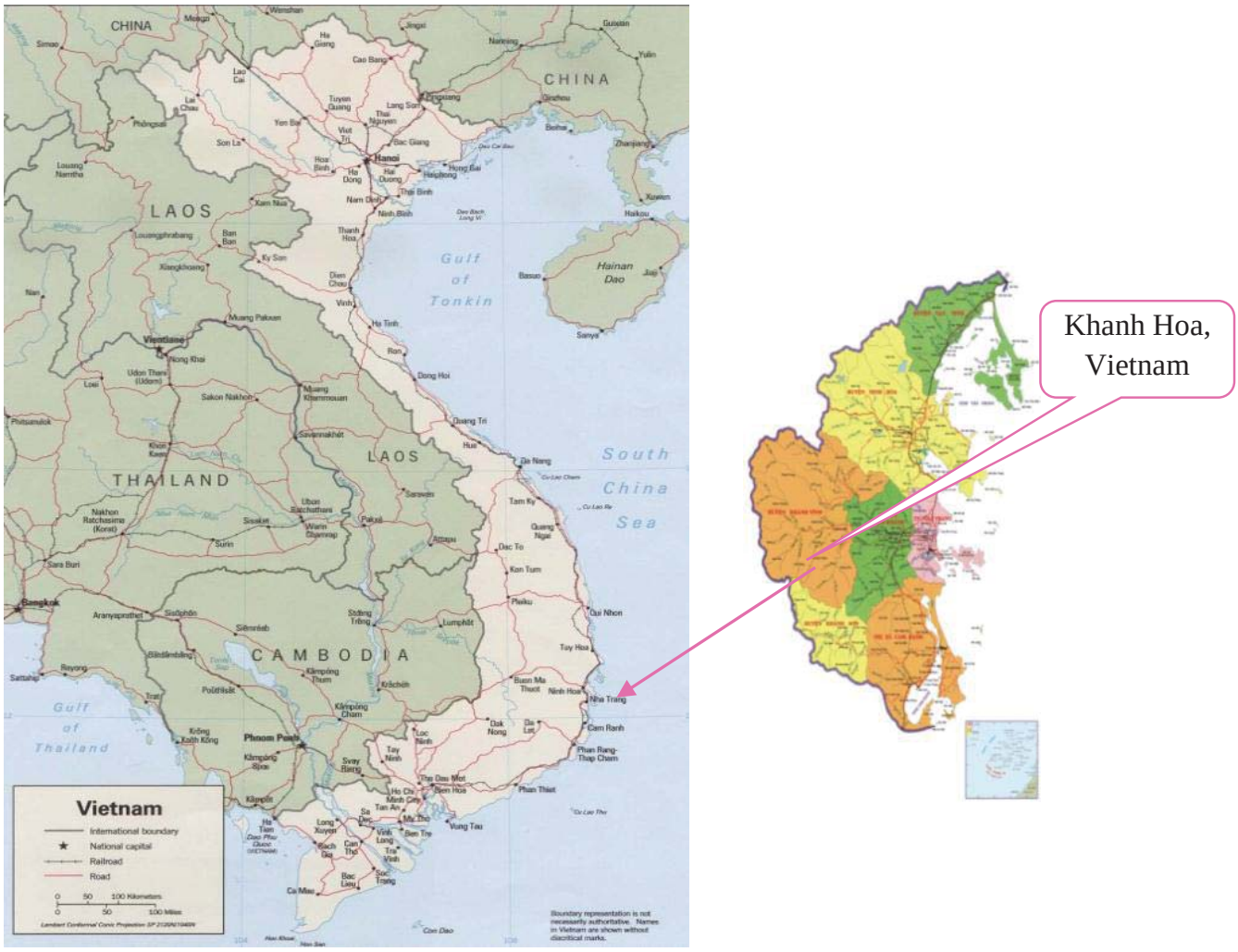


Figure 1: Khanh Hoa province, Vietnam

The purse seine fishery in Khanh Hoa has the general characteristics of traditional small-scale purse seine fisheries. The fishery basically implies filtering water to catch fish. The purse seine functions as a wall of net that is set in the water surrounding an area, and it is then hauled at either side of the vessel. Today, this practice is supplemented with additional features such as the use of lighting and echo-sounder to attract and search for fish. The target species of purse seiners are seasonal pelagic fish, mainly anchovy (*Stolephorus spp.*), but also other species like mackerel (*Scomberomorus spp.*), skipjack tuna (*Katsuwonus pelamis.*), and scad (*Decaterus spp.*). Of these, anchovy yields the highest revenue. The average annual operating time is about eight months. The high season starts in February and

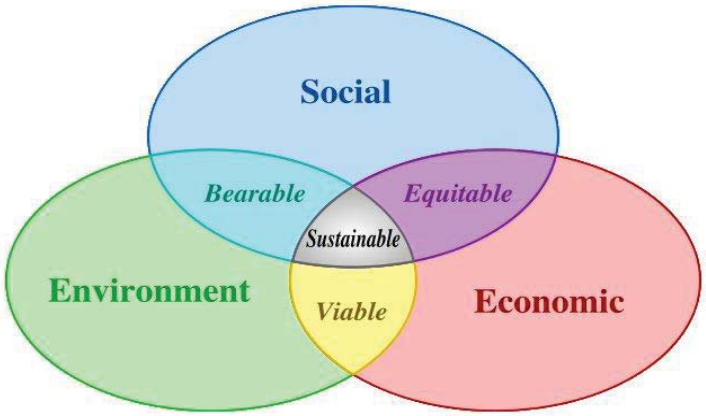
runs until September or October. The remaining months are the low season. The fishing grounds are in waters with a depth of less than 50 meters.

As the open-access regime applies to all fisheries in Vietnam, the purse seine fishery is no exception. Therefore, the purse seine fishery is facing several of the challenges typically associated with open-access fisheries. There are risks of dwindling economic surpluses, loss of jobs for thousands of people, and overexploitation of the resources. To avoid such economic, social and environmental consequences, thorough management systems appear to be necessary.

Sustainable development

In recent years, overexploitation of marine resources has become an important issue for governments and organizations in all coastal states. In Vietnam, as in most other countries, sustainability is now

stated as an overriding policy objective. The concept of sustainable development was adopted by the World Commission on Environment and Development (WCED) in 1987 and soon become a highly quoted concept. Sustainable development is simply defined as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (WCED 1987: 8). A key message in the Commission's report is that the issue of sustainability not only has an environmental dimension, but that it also has a social and economic dimension. The three dimensions must complement and support each other, as illustrated in figure 2.



Source : Wikipedia

Figure 2: Scopes of sustainable development, introduced by WECD (1987)

The concept of sustainable development introduced by WECD (1987) can be considered a general framework for fisheries sustainable development. The concept makes clear that while the environment must be protected and conserved, this cannot be achieved without promoting a viable, bearable and equitable economic and social development. Overexploitation of marine resources tends to be associated with social inequality and economic losses. Hence, in the management process, both environmental well-being and human well-being must be taken into consideration. Environmental well-being and human well-being should be seen as two sides of the same coin.

In my own research, a central topic is how and to what extent open-access fisheries may be consistent with or opposed to the goals of sustainable development. ‘The tragedy of the common’ is a concept that is frequently referred to in the literature on natural resource management. The concept was introduced by Hardin (1968) and describes how actors operating individually and rationally in their own self-interest can deplete a shared resource, even though they all know that the depletion of the shared resource runs counter to their

long-term interests as a group. Open-access fisheries appear to be an example of this. It is obvious that open-access fisheries may contradict the goal of environmental well-being. An open-access regime encourages overfishing as fishermen tend to catch as much fish as they can without regard to the preservation of the fish stock. If alternative employment opportunities are restricted, fishing will continue despite the depletion of the resource.

However, it is more unclear what an open-access regime does mean for the goal of human well-being. In the literature, it is generally assumed that the resource rent will disappear because of the common property problem (Gordon 1954; Munro and Scott 1985). According to Gordon (1954), open-access fisheries will end up with both biological overfishing and economic overfishing. But only a few studies actually deal with rent creation and distribution in open-access fisheries (Copes 1972, Coglan and Pascoe 1999, Flaaten 2011), and they suggest that the relationships are less clear cut. Hence, the processes of rent creation and distribution, and how these may affect environmental sustainability, are issues that merit further investigation. To analyze this more in detail, it is necessary to consider the fishery system as well as the different kinds of economic rent that are involved.

The fishery system

What does a fishery system look like? A fishery system may be perceived as a system consisting of two main parts: the human system and the environment, and the interactions between them. This is depicted graphically in figure 3. In this section I will deal with each of the main components and how they are linked together.

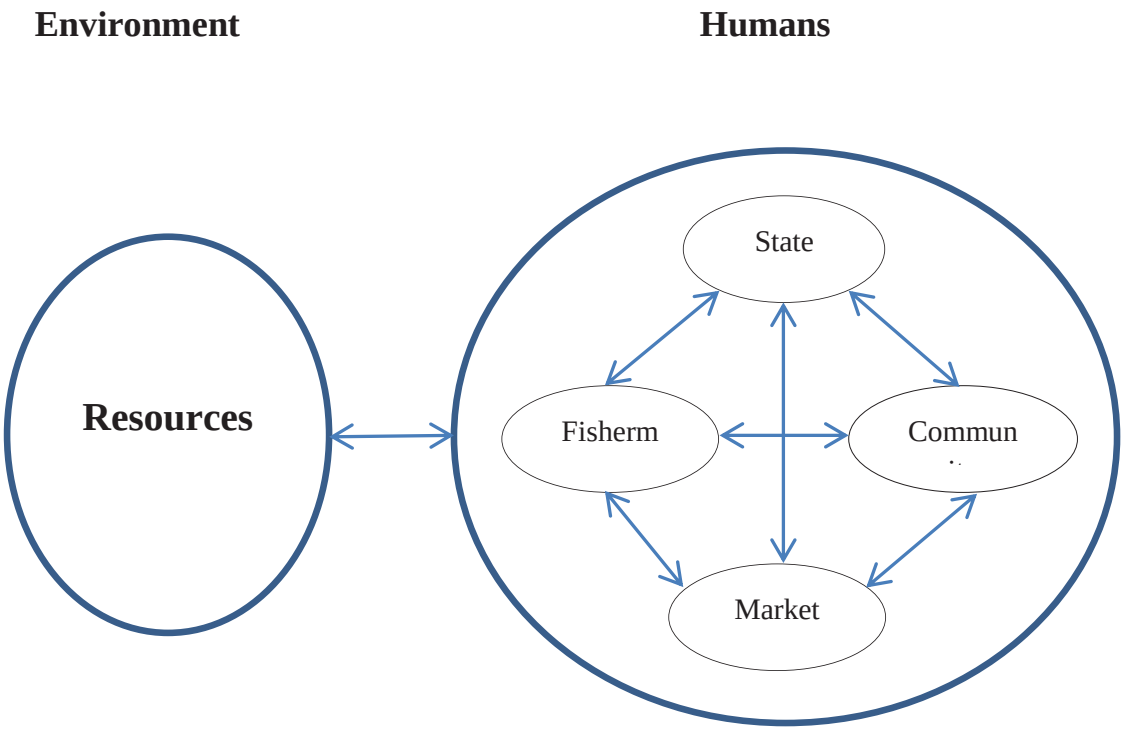


Figure 3: A simplified model of a fishery system

The environment

The environment is made up of all the physical and biological factors that enable human existence. In this context, I focus on the marine resources that are essential for satisfying human needs. The marine ecosystems are complex and dynamic. They are normally characterized by high biodiversity, and they evolve and fluctuate more or less independently of human activities and influences. However, fish stocks that are perceived as valuable from an economic point of view can be heavily exploited. Resource extraction involves any activity that withdraws resources from nature, and fishing and marine harvesting may have substantial effects not only on single stocks but on the overall ecosystems of which these species are a part.

Today, there is much debate internationally about marine resource extraction. This is partly due to increasing scarcity of resources, and partly due to the fact that fisheries and exportation of marine resources constitute an important element in the economy of many

countries. It is recognized that the physical and biological environment puts basic constraints on the growth and development of the human subsystem. The human subsystem, in turn, is actively modifying its physical and biological environment. In order to sustain the structure and function of the marine ecosystems, a balance is needed between the human societies and their environment. This may be achieved because the self-organizing ability and homeostasis of the ecosystems is paralleled by the self-organizing ability and homeostasis of the human subsystem**.**

The human system

In figure 3, the human system comprises four components: the fishermen, the market, the community and the state. The *fishermen* are the actors harvesting the sea. As they are directly interacting with the resources, they make up the core of the relevant human system. There are variations among fishermen in demographic, social, and economic aspects such as age, educational level, social status, and economic wealth. Fishermen also vary in their motivation and risk preferences. For instance, some fishermen are risk-averse while others are risk-seeking. For many fishermen, fishing is their only income generating activity. They are therefore motivated to put more efforts into fishing. Different motivations and risk preferences lead to different fishing strategies. For instance, a risk-seeker would tend to be a profit maximizer, whereas a risk-averse harvester may prefer to be a fixed satisfier, i.e., would like to have a fixed income.

Fishermen are unable to go fishing without knowledge, skills and technology. These resources thus are important to the success of fishing, and they shape the behavior of the fishermen. The fishermen will observe and balance factors relating to the biological nature of the fish being harvested, the economic nature of the technologies, and the social considerations underlying the fishery. For instance, great yields in previous years encourage fishermen to invest in new technologies; new technologies tend to make the vessel owners more risk-seeking, and this again can be decisive for the type of remuneration contract they prefer.

Fishing can be done for own consumption, but as this thesis focuses on commercial fisheries, the *market* is included as a significant component of the human system. The function of the market is to bring fish from the fishermen to the end consumers. The market also introduces competition. The fishermen and other stakeholders are stimulated to act more rationally in economic terms. The existence of markets can therefore help reduce waste and post-harvest losses; maximize the value added through appropriate processing; develop distribution and marketing systems, and integrate the fishery into overall development efforts. That is, an important function of the market is to ensure that the limited quantities of fish available are used as efficiently as possible to meet social and economic ends.

The theory of supply and demand is a cornerstone in economic analyses of fish markets (Cunningham et al. 1985). The 'benchmark' system is typically one that is perfectly competitive. However, markets for fish are rarely perfect. It is important to be aware of possible market imperfections. A common market imperfection arises in the fishing industry due to the role of middlemen – not only as fish buyers but also as financiers, lending money to harvesters, who agree to sell fish to the middlemen in return. The middlemen may exert selling power for capital and equipment, and buying power for fish. This means that subsequent market interactions are not based solely on supply and demand, but rather on links between these individuals.

Usually, *community* refers to a group of people living in a common geographical location. In Vietnam, as in many other counties, the fishermen mostly live in fishing villages and communities along the coast. Each community has its characteristics in terms of demography, infrastructure, economic base, patterns of organization, institutional structure, etc., and they are also linked to other communities in certain ways. The communities are shaping the opportunity situation of the fishermen and other stakeholders. The geographical location and the social networks are important for access to resources, circulation of information, and ability to coordinate operations. In the communities, there are social norms and obligations that are sanctioned both formally and informally. Characteristics of the communities are therefore guiding and regulating behavior.

Nevertheless, there are differences both between and within communities. Urban and rural areas usually differ in many respects. The social rules and control mechanisms can be more or less strict, and some individuals have greater latitude and are more willing to take risks than others. This can, for instance, influence the type of remuneration system that prevails.

The *state* determines the framework conditions and the regulations that apply to the fisheries sector. The state can govern by legal, economic, organizational or pedagogic means. Even though the state does not generate direct fishery outputs, it can make a difference by ensuring that such productive benefits are obtained. In most fisheries, a primary role of the state is to control exploitation. This is done in various ways – by controlling access, efforts, or output. Today, the sustainability agenda has made states aware of the need to prevent fish stocks from being depleted and destroyed. States also see the necessity of balancing between conflicting biological, social and economic goals, and that present-day's needs must be balanced against the need to maintain the fisheries resources at suitable levels for future use. The state can perform its functions by planning and policy development, surveillance and control, enforcement of regulations, and fisheries research and monitoring.

Basically, there are three main approaches to the regulation of open-access fisheries. The first rests on command and control from above. That is, the state puts restrictions in terms of catch control, efforts control including gear and vessels restrictions, and technical control including time and area closure. The second approach is based on the idea of co-management. That is, the fishermen and the local communities should be actively engaged in the design and implementation of regulations in order to ensure legitimacy and compliance. Co-management implies that power is shared between the authorities and the communities of resource users. The third approach is to work through economic incentives in order to adjust the decision making behavior of the fishermen and to organize the value chains so that rent creation can be increased while preventing overfishing. This means integrating insights from psychology as well as modern economic theory.

Management of Vietnamese fisheries

In Vietnam, fisheries management has largely been based on a command and control approach. However, in practice, it is hard to carry out restrictions and obtain compliance in a country in which four million people are dependent on fisheries. Fishing licenses are imposed, but many fishermen appear to ignore them. According to MOFI (2010), there are around 4,000 unregistered vessels in Vietnam. The minimum mesh size restrictions seem to be inefficient in many fisheries. Almost all vessels are seriously violating the minimum mesh size regulation (Long et al. 2008). Under the Government Decree No. 68/1998/ND-CP, dated 3 September 1998, an ordinance of natural resources tax was imposed. The taxation was officially based on the catch landed, but in effect, it was determined by the engine power of the vessels. This is due to the difficulties of controlling the catches landed by thousands of vessels in hundreds of fishing ports. Therefore, it can be concluded that catch control has not been applied, and attempts at efforts control and technical control hardly seem to work in Vietnam.

The co-management approach has been advocated by several authors such as Pomeroy (1995), Pomeroy et al. (2001, 2003), and Armitage et al. (2008). The co-management literature rightly point out that at local level there are institutions and rules that define who has the right to fish where. Areas are divided between different users and types of gear, and there are informal sanctions that are applied if rules are broken. However, these local regimes are under pressure as the economy is modernizing. They do not make up a coherent framework for overall fisheries management, and they play no significant role in the management systems put in place by the government. The benefits of this approach are therefore still highly debatable.

The same applies to the third approach. It has not been seriously considered in Vietnamese fisheries management, even though the basic philosophy is quite simple. The idea behind this approach is that all parties in the fisheries will respond, provided that the right market signals are in place. In other words, we don't have to change human nature to

save the seas; we just have to change the human incentives. A look at the varying fisheries management approaches around the world shows that the industry behaves in very different ways under different sets of rules. For example, if overfishing occurs as a consequence of open-access fisheries, then a key to solve the problem can be to take fishermen's behavior into account, giving the industry more rather than less rights and responsibilities, and developing financial rewards for stewardship of the shared resource. I think this is an approach with great potential. It could be well worth testing it out in Vietnamese fisheries. Implementing such measures may be challenging, but without new and fresh initiatives it can become hard to realize further rent as well as a consumer surplus from the open-access fisheries. That's why the main topic of this thesis is rent creation and distribution in light of the problem of overfishing in open-access fisheries.

Rent creation and distribution

A key measure of human well-being often mentioned in fisheries economics is economic rent. Economic rent is generally defined as the difference between revenues and input opportunity costs. Economic rent can be generated both by saving on input costs and by earning additional revenues. Economic rent consists of two components: resource rent and intra-marginal rent. Resource rent is the industry earnings in excess of all costs. Intra-marginal rent accrues to those vessels that are more cost efficient than the marginal one. In other words, intra-marginal rent exists whenever vessels in reality are heterogeneous in terms of capital and labor so that some of the vessels are more efficient than the others (Coglan and Pascoe 1999; Copes 1972; Flaaten 2011).

Under open-access fisheries, consumer surplus and intra-marginal rent may exist (Copes 1972; Flaaten 2011). Consumer surplus is usually not included in the concept of rent, but still it may be an important component of people's welfare. Thus in the context of this thesis consumer surplus is considered important and therefore included as an additional type of rent. If the middlemen are regarded as the consumers, then the consumer surplus is the difference between the amount middlemen could have been willing to pay and the amount

they actually pay to the fishermen. A consumer surplus arises when the middlemen purchase harvest for a price that is lower than the highest price they would be willing to pay. Such a discrepancy may occur because in the long run it is likely that the unit costs of harvest will go down due to technological improvements, while the consumers are willing to pay higher prices due to increasing demand (both per capita and by an increasing number of people). Studying actual consumer markets and behavior is outside the scope of this thesis.

The issue of rent creation and distribution in open-access fisheries has not received much scholarly attention. Instead, since the seminal paper by Gordon (1954), it has generally been assumed that the economic rent will dissipate as an inevitable consequence of open-access fisheries (Hannesson 1981; Homans and Wilen 2005). The rent dissipation will normally be caused by either a build-up of excessive inputs, which raises the costs on the production side, or more inferior product types, which leads to lower revenues on the market side – or by a combination of both factors. The analysis of this process is now standard material in any textbook in fisheries economics. There are only few studies that have addressed the possibility of a positive rent in open-access fisheries (Copes 1972; Duy et al. 2012; Flaaten 2011; Long et al. 2008; Ngoc et al. 2009). Among these, Flaaten (2011) discusses the theoretical aspects, while Duy et al. (2012) follow this up by providing empirical evidence for cost efficiency and rent creation among the vessels.

This thesis also shares the view that rent creation and distribution is possible in open-access fisheries. In fact, when Gordon (1954) claimed that the economic rent would dissipate, this was based on certain assumptions. First, he assumed that the vessels are homogeneous and hence the unit cost of effort is the same for all vessels. Second, he assumed that the demand for fish is perfectly elastic, i.e., any increase in the price, no matter how small, will cause demand for fish to drop to zero. These assumptions are unrealistic. As mentioned above, the vessels are different in terms of capital and labor, which means that the unit costs of effort are normally different, and there are always consumers who are willing to pay a higher or lower price for fish, which means that demand cannot be perfectly elastic or inelastic. Instead, it is relatively elastic or inelastic or unit elastic.

Rent is very important for the harvesting sector around the world because this sector is known to be among the poorest in the economy. Therefore, how to make money to purchase goods and services, and how to choose the right remuneration contracts that can contribute to rent creation and distribution, are important questions to study. The last question is not easy to answer since the fishing industry is characterized by great uncertainty and incomplete information. It is unreasonable to expect that vessel owners and crew members will be able to foresee all risks and to take them into consideration at the time they enter into contracts. The issue of how contracts are formed and which contracts that account for risk uncertainty and provide work incentives is thus of great interest to economists and policy makers.

In Vietnam, there have been no studies of the fishermen's decisions when it comes to type of remuneration, and no studies of how rent creation and distribution may vary among different types of remuneration contracts. Internationally, however, several authors have discussed these issues. The first was Sutinen (1979), who has been followed by, among others, Flaaten (1981), Azabou et al. (1989), Platteau and Nugent (1992), Bergland (1995), and Quang and Leung (2009). They all point out that risk sharing play an important role in explaining the fundamental principle of formulating share contracts. A share contract is a type of contract where the remaining income is shared between the crew and the vessel owner after variable costs have been deducted from revenue. Nevertheless, share contracts can be hard to negotiate successfully. In contrast, fixed-wage contracts are easy to deal with (Platteau and Nugent 1992). None of the studies have investigated the incentive aspects of crew members that lead to flat-wage contract decisions (i.e., each crew member receives an equal share of total sales in addition to a fixed wage, but this part is small compared with the fixed amount).

At a theoretical level, the authors demonstrate that share contracts are beneficial for rent creation and distribution. For instance, Quang and Leung (2009) showed a positive correlation between a vessel's rent and the use of share contracts. In their empirical illustration, they documented that vessels with share contracts experienced significantly higher revenues than those with flat-wage contracts, but they did not study the rents of the

vessels. Hence, the empirical section did not prove justification for their theoretical arguments. Moreover, their analysis was based on the restrictive assumption that all vessels are homogeneous. In fact, the vessels have different characteristics and therefore some vessels might have a better and some a worse economic performance than the average.

Rent appears only if fish is traded. Thus, I have been searching for opportunities of rent creation and distribution through commercial markets. Generally speaking, there are three main markets: first stage markets, intermediary markets, and final stage markets. Associated with these markets are the agents: producers, middlemen, and consumers. The role of middlemen has been noticed and studied for years. In Vietnam, Van (2008) described the middlemen as an indispensable intermediary in generating rents for all stakeholders in the supply chain. In the international fisheries management literature, the role of middlemen has been explored and debated for decades. Some studies point out that middlemen as purely exploitative (Masters 2007, 2008), contributing to a loss of welfare (Brander and Taylor 1997; Bulte and Barrier 2005; Chichilnisky 1993, 1994), and to a depletion of the resources (Brander and Taylor 1997; Bulte and Barrier 2005; Chichilnisky 1993, 1994). Others have an opposite view and consider that middlemen play a beneficial role and can foster an efficient use of a free access resource (Clark and Munro 1980; Crutchfield and Pontecorve 1969; Schworm 1983). However, very few of these studies elaborate on the effects of different market structures (WTO 2010).

While the issue of rent creation and distribution has not been paid much attention in studies of Vietnamese fisheries, the problem of overfishing as a consequence of open-access fisheries has been frequently discussed. In all these studies it is emphasized that overfishing is a huge problem in waters with a depth of less than 50 meters, something which has resulted in a severe depletion of the coastal fish stocks (Pomeroy et al. 2009; Pomeroy 2010; Thuoc 2001). However, this conclusion rests on a fairly thin basis. First, the authors evaluate overfishing by comparing with the estimated maximum sustainable yields (MSY). They disregard that these numbers vary depending on the sources (Chung et al. 2001; RIMF 2001). Second, the calculation of MSYs does not take the species composition into account. Some species have short lifespans and high reproduction rates, which means that the stock

can recover fairly quickly. Third, it must be stressed that all kinds of statistics are rather weak in Vietnam (Zwieten et al. 2002).

The aim of this thesis is to fill the gaps mentioned above. It aims to shed light on how and to what extent open-access fisheries are consistent with or opposed to the principle of sustainable development. Is it possible to maintain sustainable resource exploitation while ensuring rent creation and distribution? The issues of rent creation and distribution, and the problem of overfishing, are therefore highlighted. The policy implications for management are also discussed in order to clarify relevant measures that can be taken to ensure more sustainable open-access fisheries.

Theoretical approach

The general analytical framework applied in this thesis is summarized in the model of the fishery system, depicted in figure 3. This model emphasizes the interaction between the human system and the environment and the complex interplay between the various components of what is called the fishery system. As indicated in figure 2, sustainable development has an environmental dimension as well as an economic and a social dimension. Environmental well-being and human well-being must be met simultaneously.

While this thesis concentrates on the *fishermen*, the other components of the fishery system are also taken into account, albeit differently in the three papers. In the first paper, both personal aspects (demographic characteristics, economic motivations, risk preferences) and *community* aspects (social norms, peer effects) are considered in the discussion of factors that influence the choice of remuneration system. In the second and third papers, which emphasize the fishermen's economic motivation, the links between the fishermen and the *market*, and the fishermen and the *resources*, are given special attention. The effects of different market structures are also dealt with. Finally, the role of the *state* is discussed in all three papers in terms of policy implications; that is, what the state can do in order to achieve the goals of sustainable development and to avoid the possible failures due to open-access fisheries.

This thesis is based on the assumption that fishermen act rationally under given constraints. Economic behavior is considered at both individual and industry levels. The theoretical models employed vary from general economic theories applicable to many different fields (e.g., principal-agent theory, expected utility theory, theories of market structures) to theories relating particularly to fisheries (e.g., the biological overfishing model, the backward bending supply curve in open-access fisheries). Principal–agent theory concerns the difficulties for one actor (the principal) who hires another actor (the agent) to act on his or her behalf, but cannot ensure that the agent performs the tasks as the principal would like. The two parties can have different interests, and it can be very costly or difficult for the principal to monitor the decisions and the performance of the agent (asymmetric information). Expected utility theory deals with decision-making amongst various possible choices. The theory states that the decision-maker chooses between risky or uncertain prospects by comparing their expected utility values. The choice will be a function of the payouts, the probability of occurrence, risk aversion, and the utility derived when people have different preferences or assets. The market structure is largely determined by the number of sellers and buyers in the market for identical goods or services. A basic distinction is made between perfect and imperfect competition. Perfect competition requires many sellers and buyers, free flow of information, and no barriers to entry or exit, while imperfect competition occurs when any of these assumptions are not met.

In fisheries economics, Gordon (1954) was the first to formulate the theory of the open-access regime. This theory was then combined with the theory of the yield curve by biologist M. Schaefer (1957) into the Gordon-Schaefer model, which is a cornerstone in bioeconomics. The Gordon-Schaefer model points out that in open-access fisheries, effort tends to reach equilibrium at the level where the economic rent disappears. The model has been extensively used to compute the maximum sustainable yield in fisheries, and it occupies a prominent position in all discussions about economic and biological overfishing. The model is based on the assumptions of logistic biological growth, constant harvest price, constant unit cost of effort, and harvest linear in stock biomass and fishing effort. By the year 1970, Copes relaxed the assumption of constant harvest price and demonstrated that the

equilibrium supply curve in the Gordon-Schaefer model is backward bending, possibly giving rise to catastrophic results. In the short run, the supply curve in fishery is increasing, but in the long run, it is constrained by the limits on the growth of the resource. As fishing efforts are increased, the harvest will eventually start to decline as a consequence of over-exploitation. Even if the price is rising, supply will diminish. Nevertheless, economic rent might still be achieved under some circumstances (Copes 1972).

Table 1 summarizes what the three papers encompass in terms of components of the fishery system and theoretical models. As each paper analyzes open-access fisheries in light of the goal of sustainable develop, table 2 also indicates which dimensions of sustainable development that open-access fisheries may be consistent with or opposed to.

Table 2: Summary of the analytical aspects of the papers

Paper	**Component of the fishery system**	**Theoretical model**	**Dimension of sustainability**
1	Fishermen Community State	Principal-agent theory Expected utility theory	Economic sustainability Social sustainability
2	Fishermen Market Resource State	Theory of backward-bending supply curve in open-access fishery Market structures	Economic sustainability Social sustainability Environment sustainability
3	Fishermen Market Resource State	Theory of backward-bending supply curve in open-access fishery Biological overfishing model	Environment sustainability

Methodology

The thesis uses different empirical methods to illustrate and test the findings of the theoretical models. A summary of the methods and data is provided in table 3.

Table 3: Summary of the empirical models and data of the papers

Paper	Empirical model	Data
1	Propensity score matching	Anchovy purse seine fishery for 2005, 2008
2	Autoregressive model	Anchovy purse seine fishery for 2005, 2008, 2011
		Yellow fin tuna longline fishery for 2008−2012
3	Weight and constrained regression	Anchovy purse seine fishery for 2005, 2008, 2011

The propensity score matching method employed in paper 1 is developed by Rosenbaum and Rubin (1983). Its basic concept is to estimate the average treatment effect to determine whether a causal relationship exists between contract types and economic performance. It involves three stages. In the first stage, I estimate a probit model for the factors associated with the probability of belonging to the share-contracted vessels, and the propensity score is estimated. In the second stage, the vessels from the share group are matched with those in the flat-wage group based on their propensity scores. The sample is then tested to determine whether the share and the matched flat-wage contracted vessels share the same characteristics. The balancing requirement is satisfied if all of the underlying characteristics in both groups are sufficiently similar. In the final step, the effect of share contracts is obtained by comparing the means of the economic performance variables across the two groups.

The aim of the autoregressive method in paper 2 is to evaluate the casual effect of the world market price on the ex-vessel price of yellow fin tuna in Vietnam. An advantage of this method is to describe time-varying processes in nature. It works well if the output variable depends not only on other variables but also on its own previous value. The data for yellow fin tuna represents a time series, thus the ex-vessel price of the current month may depend not only on the world market price but also on the ex-vessel price of the previous months.

In paper 3, weighted, constrained least square is applied with both linear and non-linear estimates. Weights are measured by frequencies of the observed prices. Observed prices with large frequencies shall influence the estimated supply curve more than prices with smaller frequencies. Zero intercept is constrained to regress. The regression with zero intercept is an operation which has been much discussed, and there is still controversy and confusion. But in some cases, it is unavoidable if transformations of the least square model are needed to correct violations of the Gauss–Markov assumptions, i.e., the errors of the models have expectation zero and are uncorrelated and have equal variances.

All three papers include data from the inshore anchovy purse seine fishery in the Khanh Hoa province, Vietnam. Paper 2 also uses data from the offshore yellow fin tuna longline fishery to compare how different the results are between offshore and inshore fisheries. As discuss above, the inshore anchovy purse seine fishery is dominant in Vietnam. It has contributed greatly to economic development and is providing food and livelihood for thousands of people. Therefore, using the anchovy purse seine fishery as the empirical reference is definitely significant for fisheries management in Vietnam.

The primary data regarding purse seine fishery consists of an unbalanced panel of 221 fishing households in Khanh Hoa province in three years: 2005, 2008, and 2011. Through the stratified sampling method and the use of a questionnaire and direct interviews with vessel owners and crew members, 57 forms were collected in 2005, 101 in 2008 and 63 in 2011. Data was collected both in rural and urban areas. The rural areas were represented by the Ba Ngoi and Cam Loi communes and Binh Ba-Binh Hung and Vung Ngan islands,

while the urban areas were represented by the Vinh Truong and Vinh Nguyen communes. We gathered information on various aspects of the purse seine fisheries such as fishing grounds, operating time, catches, vessel characteristics, fishing gear, costs, revenues, and income for crew members. We also obtained details of taxes and fees from the relevant local government authorities (communes). Likewise, suppliers of fishing equipment were interviewed to substantiate the answers that had been collected from the fishermen.

While the primary data on the anchovy purse seine fishery includes various aspects of the economic performance of the harvesting sector, the data on the yellow fin tuna longline fishery is limited to market prices on the world market and the ex-vessel market. The data is reported by a dominant processing company in Vietnam exporting yellow fin tuna. The data represents a time series which runs from January 2008 to September 2012.

Applying primary data from the anchovy purse seine fishery as well as the yellow fin tuna fishery has several advantages. The data provides original and unbiased information which could not have been retrieved from secondary data sources. Official data in Vietnam is normally characterized by low categorical resolution and non-transparent aggregation of data into mere administrative spaces (Zwieten et al. 2002). By means of our own primary data, we could control the quality and tailor the selection of data to the purpose of the study.

Nonetheless, the primary data on the anchovy purse seine fishery might have some weaknesses. First, the reliability of the data depends to a great extent on the answers of fishermen who have a limited educational background and very simple bookkeeping systems. Second, the data stems from unbalanced panels and do not represent a time series. This limits to some extent the opportunities for making analyzes. For example, in paper 1, it would have been very interesting to make an economic comparison between share contracted and flat-wage contracted vessels in rural and urban areas, respectively. However, there are few flat-wage contracted vessels observed in urban areas, thus the analysis here between different types of remuneration contracts is carried out without taking the differences between urban and rural areas into account. In paper 3, it would have been relevant to have balanced panel data to see how the vessel owners change their behavior over years to adapt

to changes in the fish stock and the market. Nevertheless, this seems unrealistic, because the vessels might be upgraded, demolished or sold due to various economic and social circumstances. The statement that the anchovy stock might be rebuilding in paper 3, would also have been more convincing if time series data was available. Third, the lack of biological information regarding the fish stock implies that the data presented in this thesis only concerns the economic side. Hence, in paper 2, the impact of middlemen on the fish stock under conditions of international trade could not be examined. The paper therefore mainly discusses this issue on a theoretical level. In practice, obtaining reliable and adequate biological data on specific species is almost impossible in tropical and developing countries like Vietnam, as biological surveys are normally costly and take years to acquire.

Summary of the papers

Paper 1 shows that rent creation and distribution can occur in open-access fisheries. This is done by evidencing that both share contracts and flat-wage contracts are able to create and distribute rent for vessel owners and crew members. The former contracts are shown to be more prominent than the latter in these aspects though. This is due to higher cost savings in share contracts. Paper 1 also investigates why flat-wage contracts still prevail in fisheries even though they create less rent for the fishermen than share contracts do. This aspect has not been greatly explored in the literature. It turns out that the choice of remuneration contracts is related to the possibility of avoiding fraudulent reporting by vessel owners, alternative jobs and income opportunities, as well as risk preferences.

The existence of rent creation and distribution in open-access fisheries is once again stated in paper 2. However, unlike paper 1, this paper focuses on the linkage between fishermen and downstream markets. The role of middlemen who exert market power on the supply chain is highlighted. In addition, the paper reveals that if middlemen have no market power, open-access fisheries can attract more fishermen and result in increasing efforts being put into fishing, which leads to an overexploitation of the resource. However, this problem can be avoided if either monopsonistic middleman or oligopsonistic middlemen take over the

intermediary functions. This challenges the idea that the presence of oligopsonists or monopsonists always represents a market failure. It turns out that interventions by the state is necessary only if the market power among the middlemen is so great that it leads to over-conservation of the resource, or competition among middlemen is so high that it creates overexploitation equilibrium of the resource. The two case studies of inshore and offshore fisheries, respectively, support the theoretical findings of the paper.

Paper 3 examines whether open-access fisheries actually create an overfishing problem. To provide an answer, the paper attempts to understand how fishermen react to market fluctuations in terms of fishing effort. This is done by analyzing the real backward-bending supply curve, based on data from the inshore anchovy purse seine fishery. Different proposed backward bending supply functions are employed for the analysis. The results show that the stock to some extent has been exposed to biological overexploitation, but it seems to have been rebuilding in recent years. This implies that overfishing is an imminent threat in open-access fisheries. However, market mechanisms could mitigate the problem. The paper also opens a new avenue for management in using available, cheaply collected fisheries data on harvests, prices and costs to evaluate the biological trend of the fish stock, if biological surveys are lacking, which is often the case due to the cost of establishing expensive research capacities and time series.

Conclusion

This thesis demonstrates that open-access fisheries may be both consistent with and opposed to the goals of sustainable development. For the goals to be met there must be rent creation and distribution, and no overfishing. Hence, the main topic of the thesis has been to analyze under which conditions environmental, economic, and social sustainability can be achieved simultaneously. Rents of open-access fisheries are found as intra-marginal rent and consumer surplus. Intra-marginal rent is derived from the cost saving of the efficient vessels. Consumer surplus exists when the middlemen purchase harvest for a price that is lower than the highest price they would be willing to pay.

In the literature, the overfishing problem has usually been emphasized. It has been stressed that a free-access regime tends to imply that too many vessels will be competing for a limited resource. But while the problems of open-access fisheries have attracted a lot of attention, this thesis has tried to shed light on some of the positive sides of an open-access regime and questioned existing solutions for mitigating the problems. It is obvious that right management is important in an open-access regime. However, what this thesis has shown is that rent creation and distribution can be achieved, and that the existence of market power by middlemen to some extent can limit the overfishing problem. Hence, market power is not necessarily a failure. It also turns out that economic data might be applied to measure the problem of overfishing and the health situation of the resource if biological data is lacking. A more interdisciplinary approach, including behavior models and a holistic concept of the fishery system, could allow for an improvement of today's fisheries management. This thesis has particularly pointed out the importance of taking the fishermen's decision-making behavior into account. This is an issue which so far has not been very much dealt with in the literature on fisheries management.

Management does not come for free (Wallis and Flaaten 2000). Costs normally incur in three ways: First, there are costs associated with doing research to inform fisheries management decision makers (called research services). Second, there are costs relating to the creation and implementation of the management system (management services). Third, there are costs resulting from the enforcement of fisheries management rules (enforcement services). The question that needs to be raised is what is the best solution: to maintain an open-access regime and then pay a small cost for management to mitigate conflicts, or to shift the fisheries from an open-access regime to the optimal one, which potentially could have maximized the resource rent, but at huge costs. In some cases it might be that the open-access regime is the most favorable solution, given that the management costs are taken into consideration. This thesis indicates that open-access fisheries still work, especially for developing countries heavily dependent on fisheries.

The thesis also point out directions for future research. The issue of rent creation and distribution in open-access fisheries has not received much scholarly attention, and it

important to explore solutions that can help create a larger rent and a more equal distribution in open-access fisheries. The existence of consumer surplus is proved theoretically when middlemen are considered the final consumer. However, in the real world there are many stakeholders, and their interaction is a topic that deserves more thorough investigation. Overfishing is a well-known problem of open-access fisheries, but this thesis, by the case of purse seine fishery, indicates that the stock is about to be rebuilt. This reveals that overfishing might not be a serious problem for some species and in some types of fisheries. Hence, the overfishing issue needs to be re-examined comprehensively in the future.

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Paper 1

Paper 2

Paper 3

Appendix A

The MSY produced price and corresponding harvest are derived by taking the derivatives of the harvest with respect to the price and assigning it into zero:

Model 1

$dH/dp = ae^{-b(p_{MSY}-p_o)}(1 - bp_{MSY} - bp_o) = 0 => p_{MSY} = 1/b + p_o$ and $H_{MSY} = a/be$

Model 2 – Based on Gordon-Schaefer model

$dH/dp = rK\, p_o/{p_{MSY}}^2\,(-1 + 2\, p_o/p_{MSY}) = 0 \Rightarrow p_{MSY} = 2p_o \; and \; H_{MSY} = rK/4$

Model 3 – Based on Ricker model

$dH/dp = 0 \leftrightarrow e^{r(1-p_o/p_{MSY})}(1 - r\, p_o/p_{MSY}) = 1 \Rightarrow H_{MSY} = K\, p_o/p_{MSY}\,(1/(1 - r\, p_o/p_{MSY}) - 1)$

To determine p_{MSY}, we apply the Newton's method, also known as the Newton-Raphson method. It is implemented as follows:

Given a function f defined over X_t, and its derivative f ', approximation of X_{t+1} will be:

$$X_{t+1} = X_t - f(X_t)/f'(X_t)$$

A challenge when applying non-linear regression for this model is to find out good initial values for α, β, γ. Bad initial values might end up with under- or overestimated results. In order to get initial values for α, β, γ, we need to know p_o, r, K. We determine minimum price, p_o, by letting it equal to the minimum affordable price that the owner of the most cost efficient vessel is willing to sell. This means that it is exactly p_o in model 1 ($p_0 = 2.78$). Regarding the intrinsic growth rate, *r*, we borrow the lowest one among the growth rates that Thi et al.(2007) reported for different anchovy species ($r = 0.53$). With respect to the value of carrying capacity, this is the most difficult one since we have no explicit information. We therefore pick up the value of the current biomass for anchovy that Thi et al. (2007) reported ($B \approx 120\,000$). This figure is evaluated slightly higher than the MSY level for anchovy purse seine fisheries in the study. Hence, we can extrapolate the initial carrying capacity ($K = 240\,000$).

Model 4 – Based on Gompertz-Fox model

$\frac{dH}{dp} = rK\, p_o/{p_{MSY}}^2\,[ln\, p_o/p_{MSY} + 1] = 0 => p_{MSY} = ep_o$ and $H_{MSY} = rK/e$

Appendix B

ANNUAL SURVEY ON PURSE SEINE FISHING VESSELS IN NHA TRANG CITY, VIETNAM

I. General information:

1. Data of the year…….Period of data from month……..to……month .....
2. Time of survey: Date.....month.....year.... .....
3. Main fishery …… Other .....
4. Name of interviewer.....
5. Phone number of interviewer

II. Vessel characteristics

1. Register Number .....
2. Name of Vessel Owner .....
3. Address ……. ……..Phone number: … .....
4. Hull length (m)……..... ……
5. Year of building……if vessel owner does not know, please tick here…….....
6. Engine (HP)…….....

III. Information about labor

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

IV. Information about harvested quantity and price, operating time

	Main season	Other season
1. Number of trips		
2. Quantity of harvested species per trip a. Main species 1 (kg) b. Main species 2 (kg) c. Main species 3 (kg) d. Main species 4 (kg) f. Others (kg)		
3. Average annual price a. Main species 1 b. Main species 2 c. Main species 3 d. Main species 4 f. Others		

V. Capital Items

	Year of purchase	Physical units	Monetary units			Condition at time of purchase (old or new)	Estimated lifespan
			Purchase price (1000 VND or gold)	Current estimated price	Estimated price if buy a new one with the same size and technical standard		
1. Hull							
2. Engine							
3. Auxiliary engine (generator)							
4. Mechanic equipment		-	-			-	-
a. Winch							
b. Normal lighting system (batteries and lamps)							
c. Special lighting system for fishing							
d. Other mechanic equipment							
4. Electronic equipment		-	-			-	-
a. GPS							
b. Compass							
c. Short-range radio							
d. Long-range radio							
5. Gear		-	-			-	-
a. Fishing net							
b. Long-lining							
c. Hooks							
d. Subgear							
6. Freezing equipment							

VI. Annual Repair and Maintenance

	Costs (1000VND)

1. Hull	
2. Engine	
3. Fishing gear	
4. Others	
5. Total	

VII. Improvement/Investment

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

VIII. Insurance and Tax

	Costs (1000 VND)
1. Insurance	
2. Resource tax	
3. Business tax	
4. Other	

IX. Loan

	Debt at the end of year (1000 VND)	Interest payment	
		Total per year (1000 VND)	% per month
1. Bank			
2. Private loan			
3. Government project loan			

X. Average operating costs/trip

	Main season		Other season	
	Quantity	Value (1000 VND)	Quantity	Value (1000 VND)
1. Fuel				
a. Oil (diesel) (liter)				
b. Lubricant (unit)				
2. Ice				
3. Bait				
4. Food				
5. Minor repair and maintenance				
6. Other costs				
Total (from 1-6)				

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