LUND UNIVERSITY
School of Economics and Management

Securing future fishery production with TAC and ITQ

The case of Namibia

Master thesis in economics (15 credits)

January 2012

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Abstract

Overfishing is a severe threat to all of the world's fisheries. Uncontrolled effort levels and insufficient research about the state of the fish stocks has lead to a rapid decline in many fish stock populations. The most recent research reported that 32% of global marine resources are either overexploited or depleted and that 53% are fully exploited. Many countries put their hope to designing fisheries management systems (FMS) that enable the domestic fishing fleets to exploit their marine resources in a sustainable way and protect the stock populations. This paper investigates the effects implemented management systems have had on fishery production in three African countries. It also closer examines the FMS in Namibia and its effects on the costal environment and the economy.

Keywords: *Namibia, Total Allowable Catch, Quotas, Fisheries, Management, Property Rights, Namibianisation*

Acknowledgement

My gratitude goes to those who have helped me in the process of completing this thesis. My special thanks go to my supervisors Associate Professor Joakim Gullstrand from the School of Ecnomics and Managment at Lund University and Ph. D. Staffan Waldo at the AgriFood Economic Centre. I would also like to thank Mr. Willem Pronk, chairperson of the Pelagic Fishing Association of Namibia, for providing me with very insightful information about the pelagic fishing sector in Namibia. Warm thanks also go out to Mrs. Denise van Bergen and Mr. Pierre Rocher for guiding me in the right directions when trying to get in touch with local officials in Namibia. Last of all I would like to thank Annelie, Ramin, Michel, friends and family for their support during the last few months.

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Abbreviations

BCLME – Benguela Current Large Marine Ecosystem programme

DiD – Differences-in-Differences

EEZ – Exclusive Economic Zone

FAO – Food and Agricultural Organization of the United Nations

FIES – Fisheries and Aquaculture Information Statistics Service

FMS – Fisheries Management System

FPA – Fisheries Partnership Agreement

IQ – Individual Quotas

IFQ – Individual Fishing Quotas

ITQ – Individual Transferable Quotas

MCS – Monitoring, Control and Surveillance

MEY – Maximum Economic Yield

MFMR – Ministry of Fisheries and Marine Resources

MSY – Maximum Sustainable Yield

RFB – Regional Fishery Bodies

TAE – Total Allowable Effort

TAC – Total Allowable Catch

UNCLOS – United Nations Convention on the Law of the Sea

1. Introduction

Production of marine capture fisheries increased for most of the twentieth century and reached its peak in 1996 (FAO 2010). Since then production has declined slightly and there are few signs of future increases. The main reason why production is unlikely to increase anytime soon is because most of the marine resources worldwide are either harvested at their maximised yield or overexploited. Overfishing is causing a worldwide decline in fish stocks and is considered both a severe threat to the environment and to the supply of food. According to the Food and Agricultural Organization of the United Nations (FAO) 32% of the global marine resources were either overexploited (28%) or depleted (4%) in 2008 (FAO 2010). More than half of the global marine resources (53%) were fully exploited and only 15% of the fish stocks are considered being fished at a sustainable level. Today, the global production is making severe dents in marine food webs by targeting certain species and if current production levels are maintained, those actions could wipe out complete ecosystems.

1.1 Fisheries economics and developing countries

Fisheries have provided sources of food for the planet's population for hundreds of years. More recently they have also had an increasingly important economic role on the international market as fish and fishery products are traded worldwide to a larger extent than before. On the international market there is a wide range of different actors. The *European Union* is a large and powerful actor that has production in not only EU territorial waters but also in other countries' waters. This is made possible by signing Fisheries Partnership Agreements (FPA) with coastal nations rich in marine resources. During the last two or three decades many developing countries, with underdeveloped fishing fleets and fish processing industries, have found it worth signing FPAs in exchange for foreign currency (See Cullberg 2009, Hughes 2004 and Kaczynski & Fluharty 2001). Some researchers argue that this has been the wrong way to go for highly indebted and poor countries. Four of the most common arguments are as follows. Firstly, a country that lets some other country take over their production loses out on possibilities of creating employment for the local population as foreign vessels most definitely bring their own crews. Secondly, foreign fishing fleets with freezing capable vessels most of the times head straight for their home soil with the catch without landing it at a processing plant in the hosting country (Kaczynski & Fluharty 2001). The host country therefore loses out on value-added possibilities for products that could have been exported and sold on the international market. Thirdly, with little involvement in the fishing process, the host country has limited insight in the current state of the different fish stocks which could lead to depletion of the commercial species and environmental degradation (Jackson *et al.* 2001). Finally, fish and seafood are relatively inexpensive protein sources for the local populations in developing countries. A depletion of such resources could have the population being forced to turn to more expensive alternative protein sources (Alder & Sumaila 2004).

The decision on whether or not to allow other countries to utilise their marine resources by signing FPAs is a balancing act for the coastal nation's government. On the one hand, the government can decide to exploit their resources heavily during a short amount of time to earn large amounts of foreign currency today. On the other hand, a more restricted use of the resources leads to higher income over time. The underdeveloped fishery sectors make it hard for poorer nations to fully exploit the resources and benefit for its actual value. Building the infrastructure needed takes time and it is understandable that other domestic issues like public health and education might be prioritised. However, research shows that developing countries could enjoy much higher incomes if the infrastructure was in place and they took care of the production themselves. Kaczynski and Fluharty (2001) estimated that the license fee revenues received by Guinea-Bissau from the EU were approximately US$ 8,250,000 in 1996 whereas the end value of the fishery products fished by the union was estimated to US$ 110,424,000. Hughes (2004) acknowledges that even though some countries have signed more beneficial deals, the average compensation only accounts for thirty to forty percent of the actual catch value.

Although smaller nations may have less negotiation power than bigger actors like the EU, USA and China, recent trends show that the poorer coastal states have improved their situation on the market and countries like Morocco and Argentina even have abstained from renewing their agreements (Hughes 2004). Suggestions that regional coastal states should create joint initiatives to improve their investment climate can also be seen frequently in the literature (see Kaczynski & Fluharty 2001, Hughes 2004 and Porter 1998).

This paper adds to the ongoing debate on at what terms developing countries could consider contracting other countries to run the country's marine resource production instead of doing it themselves. It investigates the effects a fisheries management system (FMS) has on production in three neighbouring African countries; Angola, Namibia and South Africa. Furthermore, the paper also examines the successfully developed FMS in Namibia and highlight positive and negative aspects of the system.

Namibia has since its independence in 1990 developed a well working FMS that regulates the amount of fish extracted each year from the country's exclusive economic zone (EEZ) (Payne *et al.* 2001). The FMS determines an annual Total Allowable Catch (TAC) for each species included in the system in order to prevent further depletion of fish stocks. Each TAC is later divided into individual quotas (IQs) that are issued to a number of connoisseurs engaged in the fishing industry. Since implementation, the system shows great potential in restoring some of the severely exploited resources Namibia inherited their former colonisers. Though many other countries are trying to manage fish stock population in a similar manner, only a few (Norway, Iceland and New Zealand) have set up systems as advanced as the Namibian (Lange 2004). In these cases the FMSs rely on fisheries asset accounts that record stock sizes and changes in stocks of the species determining TAC levels. However, apart from a successfully implemented FMS, Namibia lacks other similarities with big fishing nations like Norway, Iceland and New Zealand. Compared to the developed and rich fishing nations, Namibia is a very poor nation located on the most underdeveloped continent in the world. Despite its differences, the success story of the FMS in Namibia makes it unique in this situation[1]. Namibia is one of very few countries that have succeeded in capturing substantial economic rent from the implementation of a quota fees system (Armstrong *et al.* 2004). Despite the success in Namibia, many other African coastal states have yet to introduce similar systems. More commonly, African nations let others utilise the resources in their waters by selling fishing rights to the European Union, the United States and Asian countries in exchange for foreign currency (see Alder & Sumaila 2004 and Kaczynski & Fluharty 2001).

Along with biological goals the Namibian government (at the time of the introduction of the FMS) also developed guidelines for how the system should benefit the Namibian people and especially social groups previously excluded from participation (Iyambo 2000). The Namibianisation policy was implemented to adjust the uneven distribution of Namibian involvement in the fisheries that was the case prior to independence (Armstrong *et al.* 2004). With the policy the government intended to increase Namibian employment and ownership and boost investments in fishing sector infrastructure.

The aim of this thesis is twofold. Presented first is a general discussion that highlights possible economic gains from a well-defined and carefully constructed FMS. The Namibian case study views economic, environmental and institutional aspects other developing countries may consider during their policy processes designing management systems. Secondly, the question whether or not total allowable catch limits or quota allocations actually have positive effects on production will be investigated by using panel data from the three countries. A number of regressions will be conducted by using a Diff-in-Diff model to distinguish the importance of TAC and quotas.

The basic results of this paper are dichotomised. They indicate that regulating policies with TAC limits can have a positive effect on production. However, the quotas imposed seem to be of less importance which is inconsistent with earlier research arguing that the implementation of quota systems makes production and processing of fishery products more efficient (Brady & Waldo 2008).

[1] A success achieved by the development of a lucrative business environment, the employment of a large number of Namibians while managing fish stock levels and making sure production levels could be maintained or even increase in the future.

The paper is structured as follows: Section 2 presents the historic background of fisheries management systems. It gives a brief review of the Namibian fishing industry prior and past independence as well as the biological background. It also gives a literature review of some of research made on the topic. Section 3 explains the theories behind FMS and gives examples of how they work in Namibia. Section 4 describes the collection of data and the descriptive figures. Section 5 explains the empirical assessment and section 6 analyses the results. The final part of the paper contains a concluding discussion.

2. Background and literature review

Fisheries were for hundreds of years used as open-access resources and were seen as resources lacking a system of rules governing their use (Harris 2002, p.77). Today, most countries' territorial waters are protected by the Exclusive Economic Zones (EEZ), stretching out 200 nautical miles from the coastal lines. The introductions of the EEZs in 1982 during the third *United Nations Convention on the Law of the Sea* (UNCLOS) gave each country sole right of its marine resources and left only the less desirable nonterritorial waters treated as open-access[2]. The new territorial zones protect the country from the exploitation of other nations by a legislative framework that prohibits foreign vessels from operating within the zones. The EEZs have enabled nations to better control how much fish are extracted from their waters and simplify their work with managing their natural resource.

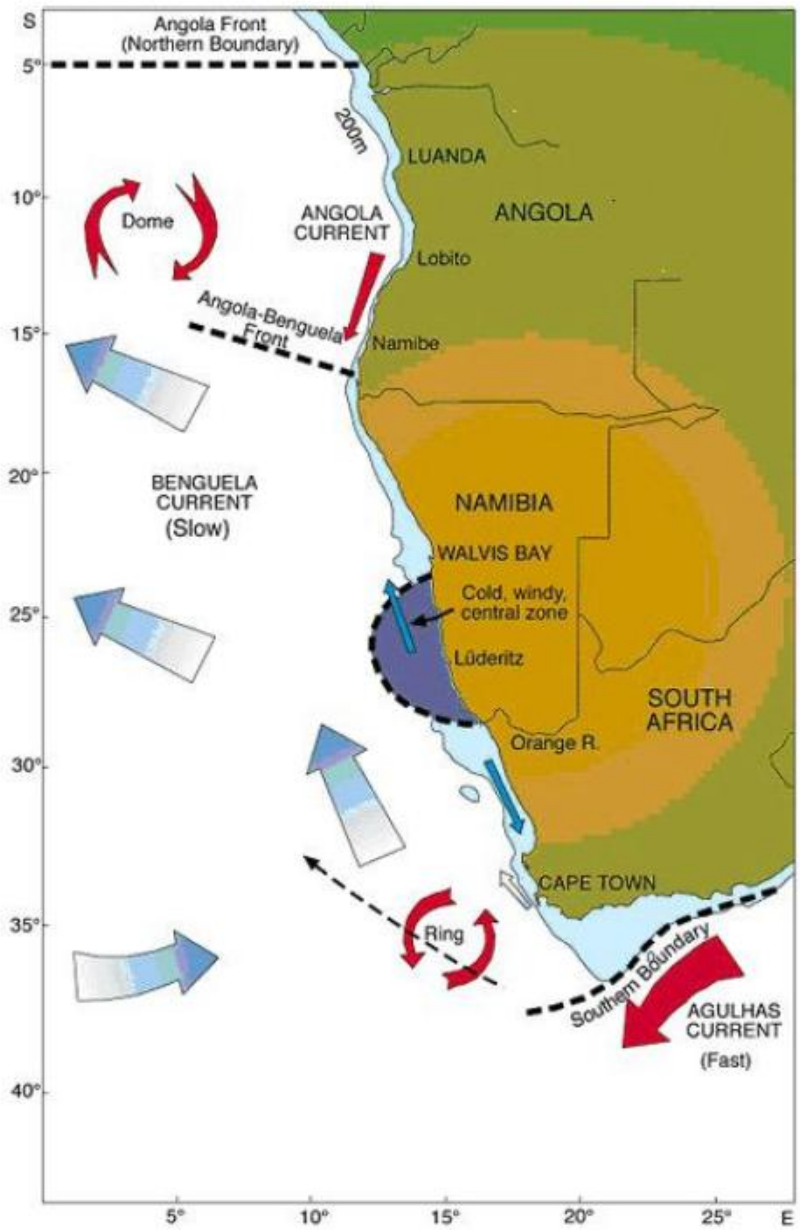
Managing the resources of a fishery is nothing new per se. History reveals examples such as the 12th century Maori people's law strictly prohibiting taking more than one could eat, or the eighteen-century Norwegian law limiting fishing during certain periods of the year (see MoF 2009 and MFCA 2007) However, for hundreds of years the oceans across the globe and the marine resources within them were available for everyone. The development of new technologies and fast improvements of fishing gears during the last century increased marine resources production and would have exceeded beyond the peak level of 1996 if the resources were not limited. The decline in production quickly became a huge concern for the major fishing nations of the world as effort levels of fishing did not slow down with the decreased production. Maintained, high effort levels and decreasing fish stocks can lead to severe depletion. The most well known example is the Northern Cod fishery in eastern Canada (Hutchings & Myers 1994). The Atlantic cod *Gardus morhua* was fished for centuries in waters outside Newfoundland. The development of technologically advanced catch methods and unsustainably high effort levels eventually led to a

[2] However, over the years many nations have wished to extend their territorial zone beyond the EEZ to include also the continental shelf in order to claim sole rights to the natural resources in those areas (Prows 2006).

collapse of the cod stock in the region. Since the Canadian government declared the moratorium on the Northern Cod fishery in 1992 the stock has yet to recover (Shelton *et al.* 2005).

2.1 The Benguela Current

The highly productive waters along the coastal line of Namibia have been popular fishing grounds on a commercial level for over a century. The marine life on the continental shelf of Namibia is affected by the nutrient-rich water of the Benguela current. The Benguela current is a nutrient-rich upwelling bordering to the Angola current in the north and the Agulhas current in the south (Payne *et al.* 2001). Both the Angola current and the Agulhas current are warm water currents flowing, from north to south and south to north respectively, towards the equator. When the Benguela current deflect away from the coast it creates an upwelling generating the highly productive marine ecosystem. The different characteristics of the three currents create different conditions for their ecosystems. Diversity is for example lower in Namibian waters than further south along the west coast of South Africa (van Zyl 2001). However, many of the biological features are consistent over the whole geographical area, *id est* the ecosystems are similar and hold both endemic and migratory species. The Benguela current system features a number of upwelling cells, where the intensity of the cells depend on winds and pressure fields, topographic features and the orientation of the coast (Skogen 2004). The food web along the coast is represented by seals as the top predators and hake, squid, snoek and chub mackerel as the piscivorous species. Horse mackerel, round herring, saury, sardine and anchovy represent the main pelagic prey and lightfish, lanternfish and goby represent the main demersal preys (Sumaila & Steinshamn 2004). This study compares Namibian fish production with production in its two neighbouring countries, Angola and South Africa. The biological conditions are considered similar in all three countries since the Benguela current not only covers the entire Namibian coast but also the southern and western part of the South African coast and part of the Angolan coast. The two boarding currents, the Angola and the Agulhas current, are also considered highly productive waters and contribute to production in Angola and South Africa respectively.



Source: UNEP

Figure 2-1: The Benguela Current

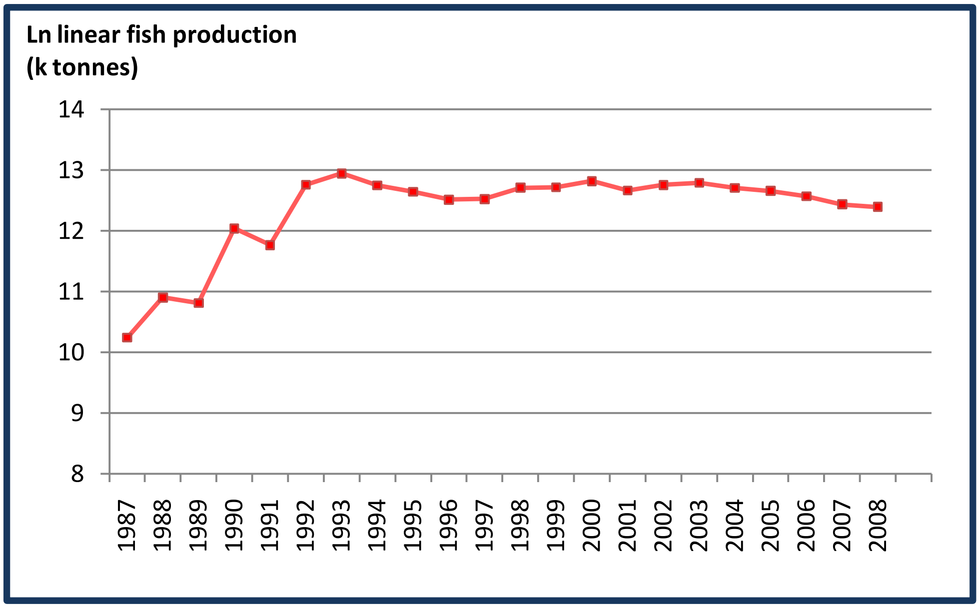
2.2 The Namibian fisheries management system

Prior to the Namibian independence in 1990 the coastal waters were heavily dominated by foreign fleets. The uncontrolled fishing that took place was mainly operated by Spanish and Soviet vessels, but also Portuguese, South African, Romanian, Polish and Bulgarian vessels contributed to a severe reduction of all major fish stocks (Nichols 2004). The South African occupation regime also controlled all of Namibia's inshore marine resources leaving Namibia with depleted fish at the time of its independence (Iyambo 2000). Shortly after independence the newly elected government quickly founded the Ministry of Fisheries and Marine Resources (MFMR), a governmental fisheries administration organisation. The policy framework that was created shortly after emphasized sustainable utilization of the fisheries as well as four main strategies that were to ensure a long lasting contribution to the country's economy (Nichols 2004). The four strategies were (1) rebuilding fish stocks through the use of up to date research facilities and methods, monitoring territorial waters and conservative fishing effort levels; (2) building a domestic processing industry; (3) Namibianisation, a policy saying that the government would make sure ownerships of companies, vessels, and new jobs were passed on to Namibian citizens; (4) empowerment, making sure the all social groups are represented in the industry, especially the previously disadvantaged.

Since then fish stocks have stabilised and by maintaining and carefully execute conservative managing policies the government is hoping to restore much higher levels, last seen in the 1960's (Lange 2003). The directorate of operations of the MFMR showed successful work with monitoring, control and surveillance (MCS) and the system has gained a solid reputation as being one of only a few well functioning MCS systems in Africa (Bergh & Davies 2004). Twenty three on-shore processing plants were built between 1990 and 2003, employing about 8000 people of whom nearly all were Namibians (Nichols 2004). Onboard the fishing vessels there were about 5600 people employed in 2003, of which 68 per cent were Namibians, adding up to a total of 13 500 people working in the sector.

2.3 Literature review

The development of a well working FMS in Namibia has inspired the scientific world and there is a variety of research available discussing the implications the FMS has had on the country and the marine environment (See for example *Namibia's Fisheries: ecological, economic and social aspects*, Eburon Academic Publishers 2004). Glenn-Marie Lange (2004) investigates the fisheries' contribution to the economy after a decade of independence. She argues that extending and taking control of the EEZ at independence has had a significant impact on Namibia's national wealth. Bringing the fisheries under national control contributed to an increase in wealth between 1980 and 1998 which Namibia otherwise would not have experienced. As the value of natural capital is quite volatile, changes in natural conditions and on international markets make fisheries contribution to the Namibian economy unpredictable. After independence, fisheries contribution to GDP showed a steady increase from 4% in 1991 to 10% in 1998 (Arnason 2002). Out of the 10%, harvesting accounted for about 4% and processing accounted for the rest. More recently the fisheries sector contribution hovers around 6% which, with its N$ 2490 million, still is quite remarkable (MFMR 2006). However, Lange (2004) also highlights the less impressive decrease in per capita national wealth since the 1980's. Figure 2-2 shows that the fisheries production in Namibia has decreased slightly since 1993 which leads to the assumption that the increase in contribution to GDP have been gained from an efficient management regime of the nation's fisheries. The fisheries sector in Namibia has since independence consistently been the second largest export sector. Fish and fishery products to a valued of N$ 2106 million were exported in 1999 which was six times greater than at independence (MFMR 2003 and van Zyl 2001). Over the next seven years exports increased to a valued of N$ 3883 million making the sector the second fastest growing sector behind tourism (MFMR 2006).



Source: FAO

Figure 2-2: Ln linear fish production (k tonnes) in Namibia

Mareike Meyn (2005) emphasises that many African countries fail to manage their resources efficiently and therefore does not become more integrated in the global value-added chain. She finds that when many countries export mainly unprocessed fish, Namibia can be seen as an exception. She further argues that Namibia has not increased the manufacturing activities it envisioned. A more all-embracing product development and better marketing could, according to the author, make the products less exchangeable on the international market and hence increase the bargaining power of retailers. According to Meyn, a move towards a more retail orientated manufacturing would increase employment and enable producers to create own brands and become more involved in marketing and distribution.

Lange (2004) also investigates the variation in fish stock sizes during the period 1990 to 2000. The results of environmental accounting for three major commercial fish stocks in Namibia show that only hake had a positive change during the period. Both horse mackerel and sardine fell below their 1990 levels. Lange emphasises how difficult it is for a government to master the balance of pressure from the industry and the danger of further collapse that comes with it. A large amount on inter-annual variation in stock makes it even more difficult to manage the fisheries and the zero TAC of sardines in 2002 proves that environmental accounting is no easy task. During the first decade of the 21st century there has been great variation in the major fisheries. Sardines are still in a precarious state and the TAC was set to a low 10 000 tonnes for 2007 (MFMR 2007). The improved status of hake enabled Namibia to enjoy increasing catch sizes for five years before returning to late 1990's numbers. In 2007 the opening stock was well below its 1990's level.

Lange (2004) admits that Namibia in a short period of time has succeeded in establishing a sustainable fisheries management system that is relatively well enforced. The system has increased the economic contribution to the Namibian economy while avoiding subsidisation. However, Lange also finds it unlikely that the country will be able to restore their marine resources to previous highs anytime soon. Dr. van Zyl (2001) means that restoring the stocks to previous levels is a long-term process but is highly affected by biological fluctuations in stock sizes. He argues that the harvest levels, that are set to help stock sizes return to their maximum sustainable yield (MSY), are set without a proper idea of what those MSY stock sizes should be.

Williems and Pauly (2002) show a more widespread concern towards the fisheries science community in the region. They argue that there has been a lack of attention to earlier states of the resources in West Africa, affecting the information of which fisheries scientists base the TACs on. The problem, they argue, is that fisheries scientists accept the stocks size and species composition at the beginning of their career as a baseline to evaluate changes. Instead, they should acknowledge the exploitation patterns and trends when formulating management advice. Dr. van Zyl (2001) acknowledges that further development in research and management is necessary, especially research on transboundary effects on fisheries for which scientific co-operations amongst neighbouring countries will be needed. However, he also praises Namibia's achievements in training marine fisheries scientists and highlights the fact that the Namibian research programme is central in other international programmes. However, a report from the Benguela Current Large Marine Ecosystem programme (BCLME 2005) found that Namibia does not possess sufficient fisheries managers, nor do they have necessary development initiatives in place to train and develop young fisheries managers.

Costs associated with the implementation of a FMS can be tough burdens for the government. During 2002 and 2003 around 40% of the Namibian fishing industry revenue (consisting of quotas levies, licence fees etc.) was used for the MCS organisation (Bergh & Davies 2004). In comparison with other FMS worldwide, those kinds of figures can be considered high but as the authors point out the total cost of the FMS in Namibia was covered by the revenue. Bergh and Davies further acknowledge that even though the compliance of the MCS system has generally improved over the years there are important improvements of the MCS system to be made. The authors' main conclusion shows that the MCS did not ensure that revenues were calculated properly upon landing, indicating that the government lose out on large amount of money from taxes and fees.

Armstrong *et al.* (2004) investigate the costs and benefit from the implementation of the Namibianisation policy. Their results show that there are many gains from the policy though they are not always easy to quantify (due to estimations of different units). Since the policy came into effect both employment and ownership of Namibian-owned licensed fishing vessels have increased[3]. The authors do however find flaws with the policy. An example is the non-transferable quota system which is bypassed through leasing of quotas from quota owners to more established firms with vessel licences (Arnason 2002). This disturbs the investment climate the government intend to improve. But regardless of the policy's imperfection the gains from allocating quotas to many smaller producers are greater compared to the gains from allocating them to the already established firms. This is due to multiplier effects in the economy, especially in employment. The quota allocation to the previously disadvantaged came with fee rebates so that the quota holders could quickly generate substantial income. Armstrong *et al.* (2004) found that the Namibianisation policy also in this perspective is performing well since the difference in potential and actual quota fees is increasing, indicating that fewer fees are being collected. The authors' critique focuses on the lack of rent the industry captures in its current state. They mean that the little rent captured goes to a few rich operators instead of to Namibians as a whole.

Olsen (2004) explains and clarifies how the institutional framework of the Namibian FMS came to place after independence. Her research, based on interviews from 1997-98 and 2000, describes the industry's experience and expectations regarding their participation in the management process within the new institutions. She finds that, though the purpose is to involve the industry in the decision-making process, there is a general dissatisfaction with the institutional arrangements. Lack of communication with the ministry is a reoccurring complaint from industry representatives who find the institutional structure so rigid and often inefficient that responds from the ministry take far too long time. Olsen argues that some pre-independence bureaucracy prevails as civil servants from before independence retained their posts and privileges also after.

3. Fisheries management in theory and in practice

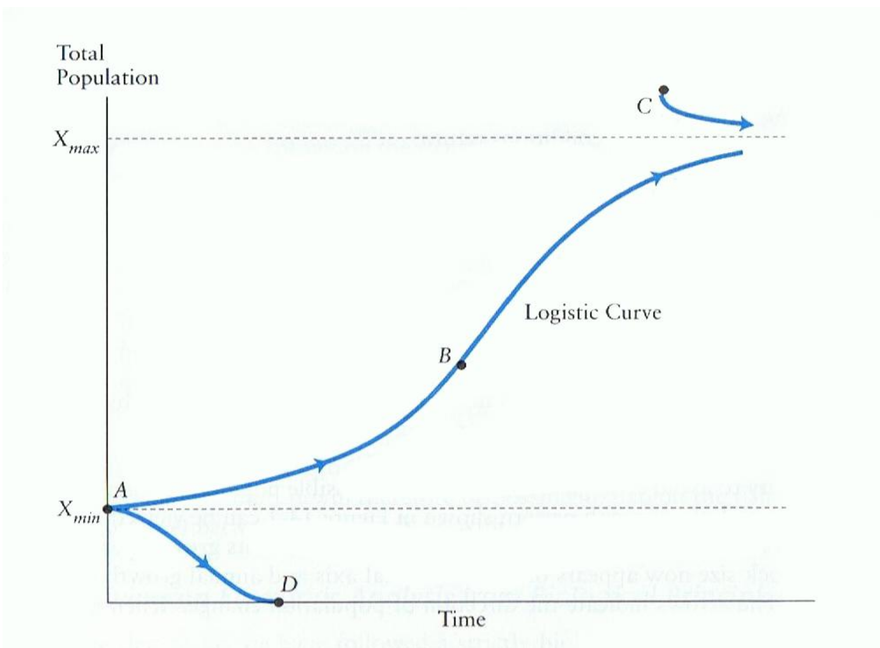
Expansion in global economic activity has had major impacts on our planet's renewable resources including tropical forest, groundwater and fisheries. Thorough planning and cross-border, worldwide collaborations are necessary to solve issues with unsustainable levels of renewable

[3] Employment onboard the fishing vessels are 68% Namibian and nearly all shore-based workers are Namibians (Nichols 2004). Namibian-owned licensed fishing vessels have increased from about 60% in 1993 to 85% in 1999 (Armstrong *et al.* 2004).

resource production. The fisheries management systems we see implemented today are the results of years of scientific research.

3.1 Basic models of fisheries

Early biological models of fisheries, such as the Gordon-Schaefer model (1957), take stock population, reproduction and effort levels into consideration (Teitenberg 2009, p. 325). The model is constructed in order to create a sustainable system that protects the marine resources from overexploitation but still maximises production (Hanley, Shogren & White 2007, p.281). However, before one can examine the economic implications of what fundamentally is a biological system it is important to analyse the biological aspects of fisheries. Population biology identifies the change in population of a live organism, in this case fish species, in its natural environment (Harris 2002, p.279). The basic pattern of population change, for a species over time, is shown in figure 3-1.



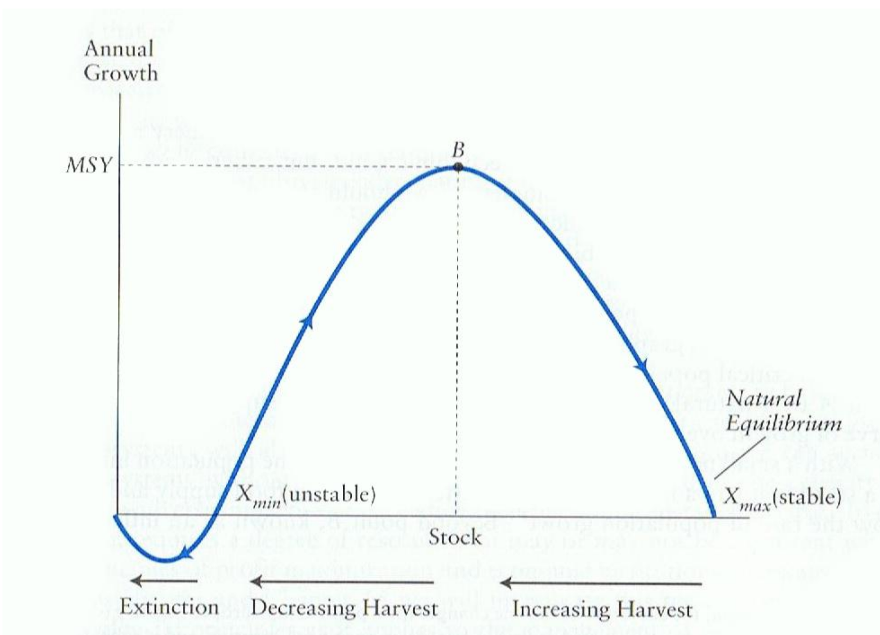
Source: Harris 2002

Figure 3-1: Species population growth over time

The natural state, in which the species lives, is limited by for example levels of food supply, living space and threat from predatory species within the ecological system. Considering the limitations, the population change can over time either take a negative or positive path from the minimum population size determined at point *A.* If the food supply is abundant the species grows towards its natural equilibrium and eventually becomes in balance with its ecological surrounding (in the graph denominated at X_{max}). However, if the population falls below the critical minimum level X_{min}

it will keep declining to its extinction. Insufficient food supply, disease and predation are all examples of what could cause such a result. A far more likely reason for a possible extinction is excessive harvesting by humans.

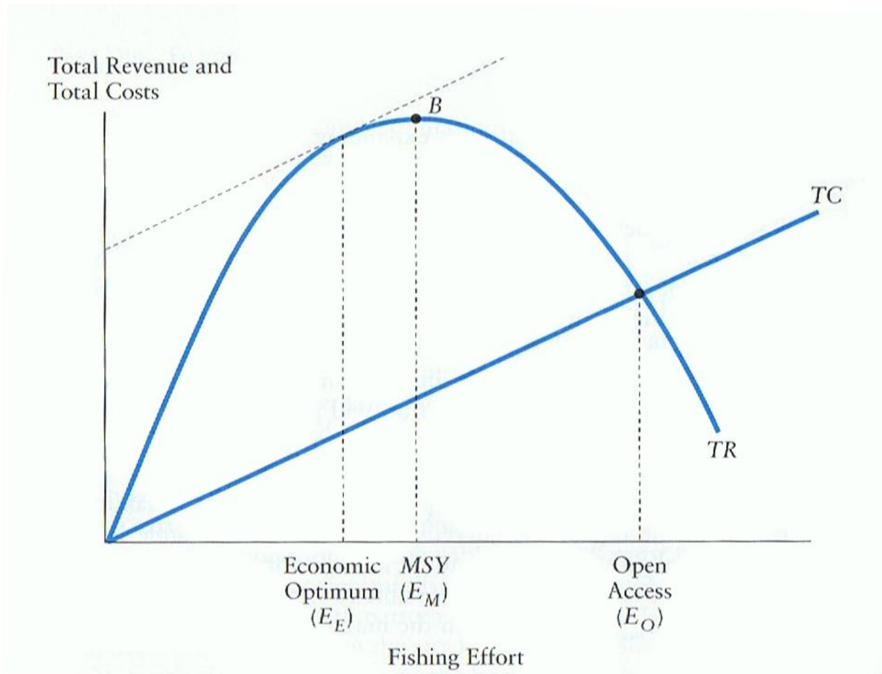
Figure 3-2 also shows the population growth pattern relating the population size to its annual growth. It clearly shows how the annual growth increases towards point *B* before it starts declining as the population approaches X_{max} (Harris 2002, p.280). The figure also shows how at X_{min} a slight increase in food supply can put the species back on track for recovery; whereas a slight decrease will push it towards extinction. The delicate situation at X_{min} makes it an unstable equilibrium. At X_{max} however, the population could only temporary exceed this upper limit in the event of for example an increase in food supply. When the food conditions return back to normal the population decreases back to X_{max} and for that reason it is considered a stable equilibrium.



Source: Harris 2002

Figure 3-2: Species population and annual growth

In figure 3-2 one can also determine the so called maximum sustainable yield (MSY). The *MSY* shows the maximum sustainable harvest level of fish equal to the highest amount of annual population growth. In order to maximise production, without causing the stock population to decrease, the fishermen have to harvest an amount equal to the annual growth at point *B* (Harris 2002, p.281). Production levels exceeding beyond the sustainable level results in short-term increases of net benefits but jeopardise future catch sizes since the fish stock gets reduced to a size not big enough to reproduce back to its original population (Tietenberg 2008, p. 327). The analysis of the model has so far been strictly biological therefore not regarding the economic implications. Figure 3-3 shows an economic view of the same biological pattern which is derived from the fish population production of figure 3-2.



Source: Harris 2002

Figure 3-3: Total revenues and costs in the fishery

The total revenue (TR) curve has the same general shape as the yield curve in figure 3-2[4]. Increased fishing efforts move right to left in figure 3-2, but left to right in figure 3-3. Also included in figure 3-3 are the costs of fishing (TC). Total costs increase with effort, the TC curve is linear and implies that there is a constant cost per unit of fishing effort. The combination of costs and revenues shown in figure 3-3 adds two new possible equilibriums. The open access equilibrium (E_O) shows what happens if the fishery is unregulated and new actors are allowed to enter the market without restrictions. New fishermen will enter until total revenues are equal to total costs whereby marginal revenues will be equal to zero. The economic optimum (E_E) is found where the slopes of the total revenue and total costs curves are equal. This optimum is also referred to as the maximum economic yield (MEY). Here, the number of participants is held at a level maximising production and the distance between from the TR curve and the TC curve where E_E crosses make up the marginal revenues. Note also that the distance from *B* to the TC curve is

[4] The TR curve is simply: fish caught (measured in tonnes) multiplied by the price of the fish.

shorter than the distance from the TR curve to the TC curve where E_E crosses. Hence, the economic optimum maximises revenues at a level below the maximum sustainable yield.

The poor state, in which many fisheries around the world are today, is proof of failures to comply with the MEY or MSY theories. It forces fishermen to decrease their effort levels in order for the species to get time to reproduce and return to previous stock sizes. At the E_O equilibrium the major problem with trying to control effort levels of open-access resources is that it includes situations where the individual fisherman only has an incentive to do what is best for the group if the group too act with him. If he decides to act by himself, the incentive is lost (Scott 2000). The short-term incentives of smaller but instant revenues do in most cases outweigh the long-term goals of larger constant catch sizes. This has to do with the fact that there is the incentive for new fishermen to enter the market as long as their costs of operating the boat are less than their average revenue mentioned earlier (Harris 2002, p.79). In theory, a restricted number of participants would be both economically efficient and environmentally optimal. However, these drastic measures are associated with large decreases in numbers of fishermen and vessels and would mean that many fishermen would have to stop fishing and look for an alternative source of income. This is a big concern to many coastal nations with large fishing fleets, which in many places also are heavily subsidised.

Based on the biologic and economic models described above, many countries nowadays decide how much fish their fishermen are allowed to fish each year. In Namibia, the MFMR set TACs for seven major species: sardine, hake, horse mackerel, red crab and rock lobster, orange roughy and monkfish (Nichols 2004). The fisheries are managed after biological assessments made by scientists employed by the ministry. The TAC levels are set to ensure sustainable fishing operations and to strengthen the status of each stock. Today, 90 % of the total Namibian production is determined by TACs established on an annual basis[5] (Armstrong *et al.* 2004).

3.2 Property rights

With an open-access resource like a fishery, an unregulated utilisation can lead to the undesired equilibrium of E_O in figure 3-3 with zero marginal revenue and declining fish stocks. Limiting the actors on the market therefore becomes essential to the future wellbeing of marine ecosystems. Access to the resource becomes a question of ownership and rights to utilisation, and since fisheries lack boundaries and one cannot prevent species from moving across large areas, fishermen and policy makers have had to rely on property rights specifically designed for fisheries. By introducing property rights a government can restrict the access to the resource and adopt a price for its utilisation. However, a property right can have different kinds characteristics and it

[5] The remaining 10 % is bycatch which is managed by effort limitations. An effort limitations programme is one which regulates bycatch sizes by determining maximum allowable effort levels.

therefore becomes important to clarify the differences of what the rights holder *owns* and *has rights to do*, especially since the rights of one property rights holder is a limitation of someone else's behaviour (Brady & Waldo 2008).

Compared to sole ownership, the various rights in a complete rights-based system are divided to different individuals or groups. *Access*, *withdrawal*, *management*, *exclusion* and *alienation* are all important instruments a policy maker should consider when constructing a rights-based system. Because of the flexibility of these instruments they can be adapted to many different situations (Brady & Waldo 2008).

As with other natural resource extraction activities, fisheries are among the economic activities where property rights are poorly defined or even nonexistent (Arnason 2000). In a property right-based system the fishermen do not own the fish itself but rather different rights to fish or utilise the marine resources (Brady & Waldo 2008). How the fishing rights, or fishing licenses, should be designed and what they should entitle is up to the originators implementing such systems. The fishing rights give the fishermen access to the resource and to do something there. But what they are allowed to do is sometimes unclear. Scott (2000) emphasises that it is essential to realise that administrative fishing rights or licenses are different kinds of property rights, ones that have few of the characteristics that other property rights do. Compared to a farmer that owns a piece of land, rights holders of fishing licenses face less tangible and conceptually measurable property rights. A farmer may enjoy the *exclusivity* of utilising his own land whereas a fisherman has to compete with other fishermen in areas rich of fish. The d*uration* decides the length in time of the property right and can vary greatly among fishing right, licenses and permits. The *quality of title* refers to the security and enforceability of the property right (OECD 2006). A high quality of title demands a highly predictable entitlement. *Transferability* explains to which extent the property right can be transferred to another rights holder. Transferability creates a platform to make rights-based systems more efficient as a rights holder can sell his rights to another actor whom operates a more efficient production. But it can also create a situation where a market is dominated by only a few large actors. The gains and losses from transferability is discussed more extensively further below.

Divisibility refers to the ability to divide access rights into narrower forms, *id est* dividing a quota into smaller amounts and transfer a part of the quota to others (OECD 2006). *Flexibility* refers to the ability of property rights holders to freely structure operations to achieve their goals. It allows the rights holder to adjust production to e.g. natural fluctuations. This last characteristic creates opportunities for more efficient production as the property holder could be allowed to e.g bank quotas from one period to another or lease quotas to others.

3.2.1 Property rights in fisheries

To make property rights in fisheries more complete, higher degrees of *exclusivity* and *transferability* are needed for the fishermen to enjoy their rights to a fuller extent (Scott 2000). Early fishing licenses gave no real boundaries to the fish stock and therefore the fishermen perceived no connection between how their catches today influenced catches in the future. For a single fisherman the stock was not his and therefore he had little incentive to look after its wellbeing. Initiating quota licenses changed his behaviour and gave him power as though he was an owner. He then enjoyed higher exclusivity and together with the duration and security characteristics it induced the fisherman to manage his resource to a larger extent.

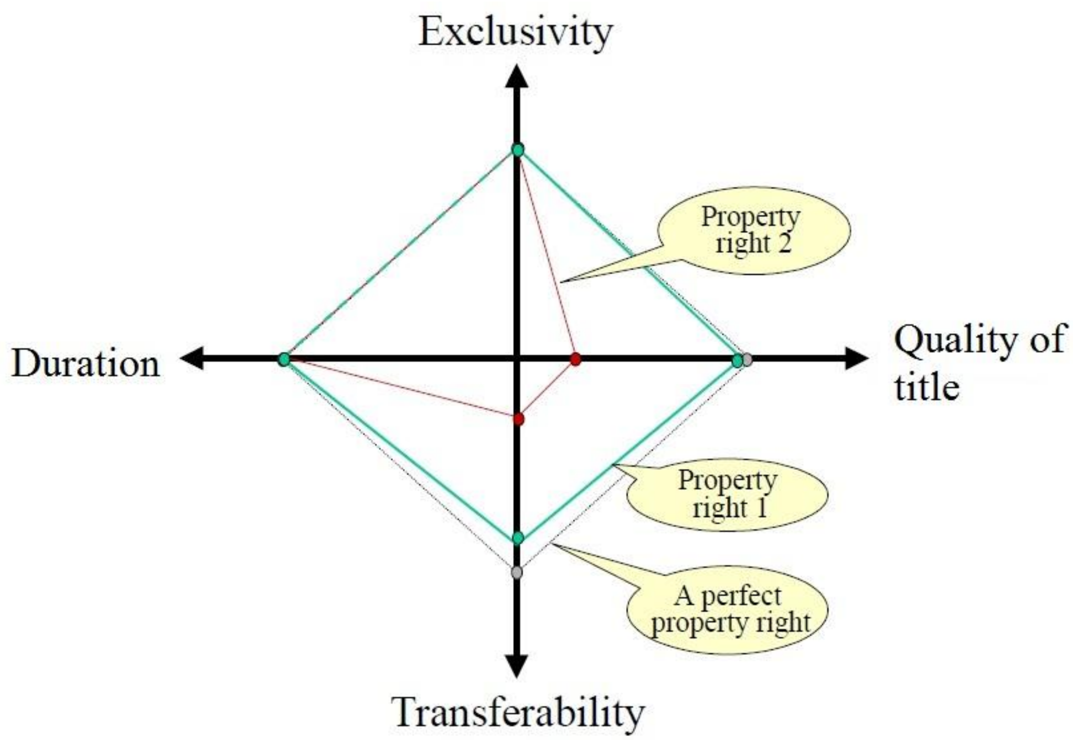
If a right-holder also can make the quota license *permanent* and *transferable*, long-term goals of production will be easier to achieve. Permanence enables the right-holder to act more like a farmer as he can adjust his business to a particular type of species. Transferability allows for allocation of time and attention to the fishery. If a rights-holder sees opportunities in other industries he can sell or rent his quotas to others. By contrast he could also buy more quotas from other rights-holders to increase his business and enjoy economies of scale production (Scott 2000). Individual transferable quota (ITQ) systems changed the competitive behaviour of the fishermen. Though it did not eliminate competition, it enabled the fishermen to adapt the costs of their activities to new ways of operating.

With the implementation of the Namibianisation policy the Namibian government intended to secure a greater Namibian involvement in the fisheries. Fishing rights have since then been allocated to previously disadvantaged Namibians or applicants with ability to contribute to the development of the industry. There are no economic criteria for allocation and the rights are permanent and non-transferable (Armstrong *et al.* 2004). Originally, the rights were allocated for periods of 4, 7 or 10 years but were later increased to 7, 10, 15 or 20 years intended to improve the investing climate. Quotas are allocated annually as a share of TACs to the rights holders. The government also enacted on an empowerment policy in an attempt to allocate quotas to newcomer applicants. As will be discussed further below, the individual quotas are non-transferable but some attributes of transferability may have crept into the system. The socio-economic goals of the Namibianisation policy seem to outmatch some of the more theoretically based market approaches other governments take for similar rights-based regimes.

With an ITQ-based management system, governments can take control over their marine resources and make the fish production more efficient. The economic mechanisms can, in a well working system, lead an efficiently adapted fleet to extract fish based on long-term economic and biologic goals (Brady & Waldo 2008). Pressure from the industry and consumers can force officials to set unsustainably high TACs but justified ITQs can create incentives to hold TAC levels down.

3.2.2 Instruments for a market-liked approach

The distinguishable characteristics mentioned earlier are often used as instruments for managing fisheries in OECD countries (OECD 2006). Together they can be used in a quality map of a property right and be the foundation in management systems. They can also guide policy makers in the right direction in their influence of fishers' incentives. A high quality-property right is achieved when the actual property right lies close to the perfect property right outlines (property right 2) shown in figure 3-5. Whereas a property right of poorer quality lies further away from the outlines (property right 1).

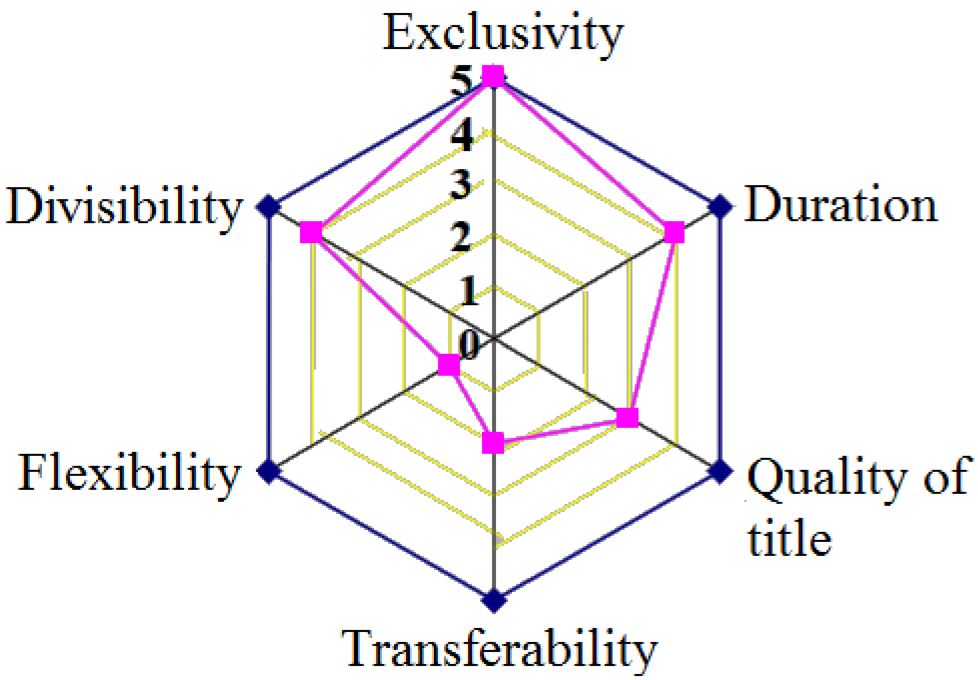


Source: FAO

Figure 3-4: The quality map of a property right

These kinds of schematics are also used in various ways in research to decide the quality of already introduced property rights regimes and to estimate intentions of a regime still in the early state of planning. A similar quality map to the one shown in figure 3-5 has been developed by the

OECD and includes the two last added features discussed earlier. Figure 3-6 shows the extended schematics[6].



Source: OECD

Figure 3-5: The quality map of market-like instruments

Market-like instruments are in some cases met with resistance from people in the fishing industry. The instruments are sometimes wrongfully mistaken for being synonymous with ITQs when ITQs are in fact just a continuum of market-like instruments.

3.3 Fisheries management systems

When governments are considering implementing FMSs they are also faced with different choices of institutional order for said FMS. A state model is a centralised and bureaucratic form of fisheries management and is appropriate for when fisheries are overexploited (Hersoug & Holm 2000). The model introduces control of the resources and effort regulations become highly prioritised. It is characterised by hierarchical order and uni-dimensional relationships. Although the state model is quite dominant it is also often criticised for being inefficient. A market model

[6] *Divisibility* refers to the ability to divide access rights into narrower forms or quotas into smaller amounts (OECD 2006). *Flexibility* refers to the ability of property rights holders to freely structure operations to achieve their goals.

emphasises market efficiency and uses market-like instruments mentioned earlier for quota allocations. When a government is faced with economic problems due to over-capacity or inefficient allocations of resources, the market model is most suitable. The community model is based on local structures and co-management and is most common in countries with large artisanal fishing sectors (Olsen 2004). It stresses fair access to the marine resources and legitimacy amongst the people enrolled in the fishery sector.

When it comes to determining how to design a fishery management system there are various harvesting aspects a government has to take into consideration. It is important to distinguish between the different kinds of property rights that are at the government's disposal, as area-, input- and output property rights require different degrees of *management* (Anderson 2000). The distinctions of these property rights clarify what the possessor actually own and what the ownership *include*. These clarifications are critical to the implementation, the operation and success of the system. Rights designated to geographical areas are mostly used for harvesting of molluscs (mussels, clams, oysters, scallops etc.) where small individual areas can be harvest independently.

Rights denominated in terms of inputs do not necessarily demand knowledge of the exact stock sizes or wellbeing of the resources. These rights can be based on physical harvesting capacity and are measured in terms of number of participating boats or attributes of boats. The attributes can be measured in GRT (Gross Registered Tonnage), horsepower (kilowatts) or traps, which limit the boats to a certain number of days at sea (Anderson 2000). Important to point out here is that input property rights are on the one hand easy to implement, demands very little monitoring of resources and are easy to allocate amongst possessors. On the other hand, if authorities have little control over the actual production these rights create opportunities for property rights owners to abuse the system and harvest more than the set capture levels. Input property rights are commonly used in many West African coastal states which have small underdeveloped domestic fishing industries. The small domestic fishing fleet prevents the state from utilising the marine resources effectively which is why the government in many cases sells fishing rights to foreign fishing fleets (see Alder & Sumaila 2004 and Kaczynski & Fluharty 2001).

Rights denominated in terms of outputs enable FMS policy makers to grant rights owners a certain amount of fish each year. TACs that are divided into quotas are allocated to the participants of the programme, limiting them to harvest a specific amount of a specific species each year. Depending on the *specifications* or the complexity of the system, the rights owners may be allowed to buy and sell the quotas to each other giving them the opportunity to plan their fishing efforts. As mentioned earlier the FMS in Namibia does not allow complete transferability. Whether or not fishing rights should be transferable has been widely discussed in the literature. Some argue that making fishing rights transferable creates a permanent and sometime free transfer of a public resource to a private individual (Anderson 2000). Others say that the transferability is a necessary market mechanism that helps minimise inefficiencies associated with a state-centred model (Hersoug & Holm 2000). In the case of the Namibian fisheries, the Namibian government found a centralised model being more suitable than a market based model (Olsen 2004). As the uncontrolled fishing by European and South African fishing fleets had led to the depletion of the main commercial stocks and as the new government wished to ensure benefits to previously excluded population groups, the 'state model' was introduced. Different criteria determine the allocation of fishing rights. They depended on whether the applicant was a Namibian citizen, if the applicant company's beneficial control is vested in Namibian citizens and if the applicant had beneficial control of the vessels used. Other, more special, criteria advanced the possibility of obtaining fishing rights (Armstrong *et al.* 2004). If the applicant for example have invested or intend to invest in regional development in Namibia, or if the applicant can improve the situation for the previously disadvantaged, he or she would have a higher probability of obtaining fishing rights. These special criteria were part of a so-called empowerment policy which the government hoped would have a positive socio-economic effect.

4. Data and descriptive figures

Presented in this following section are the different features of the data. It also describes how data was collected and explains the characteristics of the different samples and estimates, followed by a short discussion on data reliability. Descriptive figures retrieved from the statistical work will be discussed as well as some restrictions that the author has had to consider. The chosen time period of 1987 to 2008 features several interesting events. In 1990, Namibia gained their independence, an event that appears to have had a big impact on the marine environment in the region. During the following two decades several environmentally and economically important policies have been introduced in all three countries, the New Fisheries Law in Angola introduced in 2004 being the most recent one. Multinational cross-sectoral initiatives and regional training programmes have started and FPAs signed early on have expired. The time period is restricted to 2008 due to the availability of more recent data.

4.1 Data collection

The fishery statistics programme database of FAO has been used for the empirical work of this study. The production statistics from the online query panels of the Department of Fisheries and Aquaculture provides the best and most detailed data available. The database is freely available and can be customised for desired purposes. Error of measurement can occur if the department receives incorrect values or if values of missing data have been estimated.

The fishery statistics programme database is run by the Fisheries and Aquaculture Information Statistics Service (FIES) that collects and compares annual data from countries worldwide. The authorities from each country report the data by filling in questionnaires, which can later be followed up by clarification if numbers are questionable. The clarification comes after collected data is cross-checked with data from other sources such as for example Regional Fishery Bodies (RFB). When there is no data available FIES and consultant experts use estimates based on the best information available from any source. Estimating missing data is of course not optimal. However, estimates are better than having several years of missing data when observing trends in capture data or fish stock quantity over longer periods of time. It should however be pointed out that the production data in this sample has very few estimates and therefore should be considered reliable.

The TAC and ITQ statistics have been gathered from legislative or other governmental documentations[7]. In some cases additional information has been collected from FAO reports. Namibia installed TAC immediately after independence in 1990 (Arnason 2002). The quota framework was designed in the 1992 Sea Fisheries Act but fishing rights, and ultimately quotas, were not introduced until 1994 (Nichols 2004, Elago 2004). In 1997, two new fisheries (monk and orange roughy) were included in the quota system. A TAC and quota regime has been in place in South Africa during the entire time period[8]. Of 21 commercial species, 9 are managed in terms of TAC (BCLME 2005). In Angola TAC and quotas were introduced with the 2004 New Fisheries Law (Nova Lei Das Pescas 6-A/04, 2004). The previous law, n° 20/92, only regulated fisheries with fishing licenses and does not specifically addresses conservation measures (BCLME 2005).

4.2 Descriptive figures

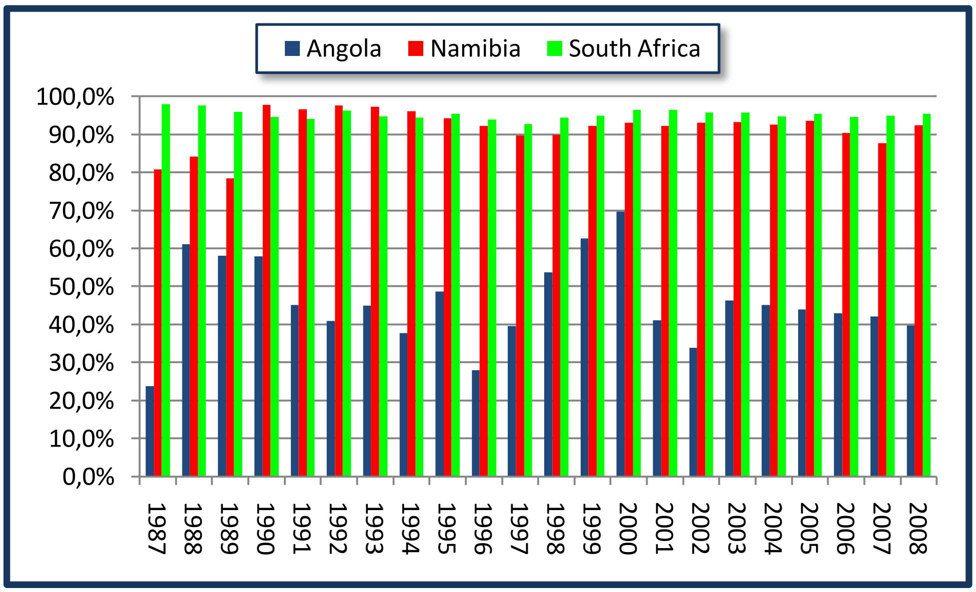
FAO global production statistics are divided into family groups categorised by different species in accordance with the FAO classification system ISSCAAP[9]. As almost all of the catches in Namibia are determined by TAC, which are set for only seven species, many of the 50 ISSCAAP groups have been excluded. Before excluding groups, a control for species targeted by Angolan and South African TAC found that the commercial sector in South African targets more or less the same species. The statistics from the Angolan production are however slightly different. The seven targeted species account for between 24 to 70 percent of the total Angolan catch over the time period. This large variation is unfortunate but has been accepted for the sake of empirical uniformity. It should also be pointed out that a large amount of the Angolan production was classified as *not identified* which leads to beliefs that the reported catches could be species in the targeted family groups but reporting obstacles occurring from the time the fish was caught to when it was reported could be the reason to the inadequate statistics. Since almost 50% of the accounted Angolan production comes from its artisanal fishery sector this seems fairly

[7] The Sea Fisheries Act of 1992, the White Paper of December 1991 and the Marine Resource Act (2000)

[8] Constituted in the Sea Fishery Act, 1988 and the Marine Living Resources Act 1998.

[9] International Standard Statistical Classification of Aquatic Animals and Plants.

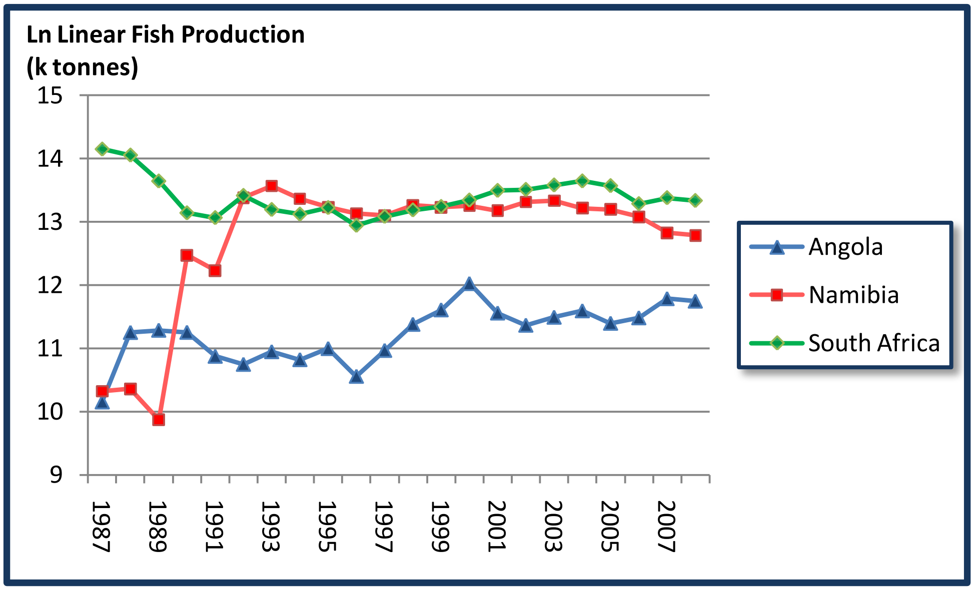
reasonable. One should also point out that even though seven specific species are targeted other species within the same family groups frequently are caught. Smaller catches of for example chub mackerel are simply registered as being part of the horse mackerel quotas and not regarded as bycatch. Figure 4-1 shows the production of the seven targeted species as a percentage of total production. As can be seen, the targeted species account for 90% or more of total production in South Africa during the entire time period. In Namibia the TAC species range from 78-98% of total production.



Source: FAO

Figure 4-1: The 7 targeted species as percentage of total production

Figure 4-2 shows the log linearized production from 1987 to 2008 in Angola, Namibia and South Africa. Note the vast production increase in Namibia around their independence in 1990. Note also that South African production decreased during the same period which could be explained by the fact that South African vessels no longer were allowed to fish in Namibian waters. Angola showed a promising increase in the late 1990's but broke off and experienced decreasing catches in the beginning of the early 21st century.



Source: FAO

Figure 4-2: Ln linear fish production (k tonnes) in Angola, Namibia and South Africa

The different ISSCAAP groups are as follows (with targeted species in parentheses): “Crabs, sea-spiders” (red crab), “Lobsters, spiny-rock lobsters” (rock lobster), “Cods, hakes, haddocks” (hake), “Herrings, sardines, anchovies” (sardines), Miscellaneous demersal fishes” (monkfish and orange roughy) and “Miscellaneous pelagic fishes” (horse mackerel).

5. Empirical assessment

This paper investigates variations in fisheries production in Angola, Namibia and South Africa during the period 1987 to 2008. It discusses the importance of fisheries management systems in general and total allowable catches and quotas in particular. The attempts of combining FMS efforts and socio-economic improvements in Namibia are also discussed. This section explains how the collected data have been used in an empirical assessment. It clarifies how the econometric model is constructed and explains the different regression variables.

The data, structured into panel data, follows outcomes and characteristics of the countries and targeted species at multiple points in time. The performed tests control for country specific factors, observed or unobserved, that are fixed over time and space. By doing so, a potentially large source of omitted variable bias is removed. By using a fixed effects model one enables interpretation of the estimated effect as the effect of a within-unit change in treatment. It might however create greater measurement errors than in OLS which can influence the analysis.

Considering that an endogenous regressor could vary at the aggregate level (and not on the individual level), a differences-in-differences (DiD) model framework has been considered in the econometric process. The key assumption is that, considering the similar biologic characteristics of the three countries' coastal marine systems, the trends in production would be the same in both the treatment group (Namibia and South Africa) and the control group (Angola) in the absence of treatment. A so called parallel trend assumption could, if it holds, isolate the treatment effects from introducing TAC and ITQ by subtracting the trend from the no-treatment group from the change in the treatment group. The adopted policies in the three countries have implications on the DiD model in the way that production variations are compared between countries in the period of 1987 to 2003 where after it only compares variations over time. A sensitivity analysis with additional regressions will follow the initial regression in order to further highlight possible effects.

Summary statistics of the variables in the first, second and third regression is presented in the appendix. They show the number of observations as well as minimum, maximum, average (mean) and standard deviation values of each variable.

5.1 The econometric models

In the model, the treatment group consists of Namibia and South Africa and the control group consists of Angola.

The estimated equation of the model is specified as:

$$lnprod_{itp} = \delta tac_{itp} + \beta itq_{itp} + \lambda_t + \mu_{pi} + \varepsilon_{itp}$$

where *i* denotes country, *t* denotes year, *p* denotes species group, *lnprod* is the natural logarithm of domestic production in the country, *tac* is a treatment indicator for when TAC are introduced, *itq* is a treatment indicator for when ITQ are introduced and δ and β are the treatment effects of TAC and ITQ respectively.

The time dummy, λ, picks up common longer trends in, e.g., climate and global business cycles, that affects all countries similarly. The country-species dummy, μ, picks up particular level effects between the countries. Finally, ε, is the error term.

6. Results

Table 6-1 in the appendix shows the results from the first regression of the DiD model. The results show that there is no significance to any of the two treatment variables, *tac* and *itq*, indicating that the instalment of a TAC and quota systems in the three countries did not have an effect on production. The time dummies are included to get a correct DiD model and a Wald test (table 6-2 in the appendix) shows that they are significant on the 5 percent level. The values of sigma_u and sigma_e in table 6-1 refer to the standard deviations of the error terms and rho measures the importance of using a fixed effects model. The estimations, which included 396 observations, received an overall R^2 value of 0.25. This means that 25% of the variations of the production can be explained by the model. Autocorrelation could explain the insignificant coefficient values of *tac* and *itq* which is why two additional regressions were run as sensitivity tests.

The insignificant results of *tac* and *itq* from the regression contradict the theories of controlled and slowly increased production scientists hope to achieve. As mentioned in section 4, this study is subject to issues of data reliability that can have influenced the results. Data reliability is a concern and has not been disregarded. However, there is no data of higher quality available at the moment and many improvements in data collection, including more advanced measurement controls, provide a high quality statistical database. Another possible reason for the contradicting results might come from gaps between the theoretical framework and actual implementation. Though the MEY model and regulating catch sizes may work in theory it might not be fully implemented and preserved in practise. A country that introduces TAC and quotas together with an insufficient MCS system is subject to risks with catch sizes that exceed the annually set TAC. This has been known to happen fairly regularly, though in most cases the TAC are only exceeded by small amounts of excess catch. On the contrary, and perhaps less likely, a country that have no FMS in place might still fish within sustainable levels. In the Angolan case, their large artisanal fishing fleet consists of many small boats (some without an engine) limiting their possibilities of extracting large quantities.

It should also be pointed out that the composition of the fishing sectors of the two countries in the treatment group and Angola in the control group may have affected the outcome of the DiD model. The similarities of the three countries' coastal marine environment made them suitable for quantitative research of their fishery production. However, the many non-similarities among Angola, Namibia and South Africa may have greatly influenced the results.

Table 6-3 in the appendix shows the results from the second regression of the DiD model. Considering the introduction of Angolan TAC and quotas in 2004 the last five years of the time period were dropped in the regression to specify a clearer DiD model. A positive effect of the TAC treatment variable (*tac*) is confirmed as the parameters show a coefficient value of 1.86, significant on the 5 percent level. The coefficient value tells us that the implementation of TAC is associated with a 1.86 unit change in *lnprod*. Transforming the coefficient value into percentage by using the exponential function indicates that TAC increase production by 545%. Such high impact of a TAC regime should obviously be looked upon with great caution. It is possible that higher degree of measurement errors in the fixed effects model may have affected the size of the increase. It is also possible that the statistical handling improved significantly after TAC regimes and quotas were introduced, improving the quality and the extent of the statistics. This could also have some implications to the extent of the *tac* coefficient value. The ITQ treatment variable is still insignificant at any reasonable level of significance indicating that the instalment of quotas does not seem to have an effect on production. The model, which included 306 observations, received an overall R2 value of 0.27. This means that 27% of the variation in production can be explained by the model. A Wald test (table 6-4 in the appendix) was constructed also after the second regression and shows that the time dummies are significant on the 10 percent level.

The results of the third regression are presented in table 6-5 in the appendix. The regression was run over the same time period as in the first regression but excludes the ITQ treatment variable. The results show that there is indeed a strong relation between regulating TAC and production even when the Angola TAC regime is included. A positive effect of the TAC treatment variable (*tac*) is confirmed as the parameters show a coefficient value of 1.95, significant on the 1 percent level. The Wald test (table 6-6 in the appendix) shows that the year dummies are significant on the 1 percent level. The model, which included 396 observations, received an overall R2 value of 0.24.

The Fisheries Centre of the University of British Columbia initiated a detailed evaluation of fisheries in 53 countries compiled in a report published in 2006 (Pitcher *et al.* 2006). It investigated the countries' ambition and progress in meeting the objectives of the *FAO code of conduct for responsible fisheries*. The result is a great example of how market-like instruments and policy instruments can be combined for scientific research. A quick glance at their results for the three countries included in this thesis show that Namibia and South Africa seem to have succeeded in meeting most of the requirements of the FAO code of conduct for responsible fisheries. Figure 6-1 in the appendix shows what the research group call the *Code Compliance Kite* which is constructed in a similar manner as the "quality of property rights"-figure discussed in section 3[10]. Most impressive is the Namibian MCS system described in the introduction and in section two, which received great results and can be compared with MCS systems in developed fishing nations like Norway, New Zealand and Iceland (figure 6-2).

[10] The first three sections (objectives; framework; precaution) correspond to the *intension* of the state in ensuring compliance with the FAO code of conduct for responsible fisheries. The last three sections (Stocks, fleets and gears; socio-economics; monitoring, control and surveillance) measure the *effectiveness* of compliance with the code.

As can be seen in figure 6-1, Angola has still a long way to go when it comes to both developing the policy framework and improving the efficiency of their TAC and quota regime. Multinational cross-sectoral programmes and regional training programmes will continue being important to the whole region in general and Angola in particular. So will the joint scientific surveys with more developed fishing nations like Norway[11].

7. Concluding discussion

The general discussion presented in this paper highlights some of the issues with fisheries management many governments around the world are faced with today. A large amount of research has been conducted in order to both protect the global marine environment and to make the fishing industry more economically efficient. However, environmental issues are for many developing countries not prioritised as they struggle with more urgent issues like poverty and famine.

The scientific world fairly unanimously agrees that Namibia has done very well with implementing a FMS that protects the targeted species, contributes to the economy and creates jobs. The country uses biological assessments and conservative TAC to secure future production so that Namibia also in the future will be an important actor on the international fish market. Many authors emphasise that even though the quota system in Namibia is non-transferable there has sneaked in transferable attributes in the system. A quota holder can lease his quota to boat and process facility owners without an attempt at fishing the fish himself. With no hard rigorous requirements on investing in his, or her, own boat the goals of the Namibianisation policy is somewhat lost. However, it seems like the government, with its non-transferable quotas, has prevented a small group of powerful fishing companies to gain complete power over the industry and shut out the previously disadvantaged from it. The many positive aspects of the Namibian FMS should be taken into consideration when other developing countries are reviewing existing FPAs that are about to expire. Investments in fishing industry infrastructure could rather rapidly generate large amounts of economic and socio-economic gains.

The results from the DiD model indicate that TAC have some positive effects on fish production. Though the model cannot prove that quotas have the same positive effect the theories behind fisheries management highlight possible benefits. Possibilities to plan production ahead of time and transfer quotas between actors contribute to the sector becoming more efficient. Adopting property rights to better suit marine resources even further will most likely be of use to policy workers who face the challenges of designing new and more efficient FMSs in the future.

[11] All three countries co-operate with the Norwegian research vessel RN *Dr Fridjof Nansen* through the BCLME and the BENEFIT programmes (see MFMR 2006 and).

One should not forget that policy makers constantly are confronted with pressure from influential and powerful actors from the corporate world, who have certain expectations of how high future TAC limits should be. Keeping that in mind, it is perhaps reasonable to only expect slow increases in stock populations during the upcoming decades, provided that governments adopt the sustainable measures that are needed. It is clear that large declines in effort levels are needed for the fisheries to recover to stock populations seen five or six decades ago, both globally and in the Namibian case. Question is if that is at all possible with high consumer demand, pressure from the industry and a large amount of the planet's population dependent on fisheries as a source of income.

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Appendix

Graphs and tables

Table 5-1: Summary statistics of variables in the first and third regression

Variable	Obs	Mean	Std. Dev.	Min	Max
lnprod	398	8,243	3,805	0	13,922
tac	396	0,543	0,499	0	1
itq	396	0,518	0,500	0	1

Table 5-2: Summary statistics of variables in the second regression

Variable	Obs	Mean	Std. Dev.	Min	Max
lnprod	306	8,046	4,002	0	13,922
tac	306	0,474	0,500	0	1
itq	306	0,441	0,497	0	1

Table 6-1: Regression results for the first regression

Fixed-effects (within) regression	Number of obs	=	**396**
Group variable: **countryfish**	Number of groups	=	**18**
R-sq: within = **0,2747**	Obs per group: min	=	**22**
between = **0,2951**	Avg	=	**22.0**
overall = **0,2494**	Max	=	**22**
	F(23,355)	=	**5.85**
corr(u_i, Xb) =**0.2070**	Prob > F	=	**0.0000**

lnprod	Coef.	Std. Err.	T	P>t	[95% Conf.	Interval]
tac	1,14	0,72	1,57	0,12	-0,29	2,56
itq	0,88	0,68	1,29	0,20	-0,46	2,22
year						
1988	0,08	0,58	0,15	0,88	-1,05	1,22
1989	0,11	0,58	0,18	0,86	-1,03	1,24
1990	0,75	0,61	1,22	0,22	-0,45	1,95
1991	0,61	0,61	0,99	0,32	-0,59	1,81
1992	1,04	0,59	1,77	0,08	-0,12	2,19
1993	1,14	0,59	1,95	0,05	-0,01	2,29
1994	0,81	0,59	1,38	0,17	-0,34	1,96
1995	0,69	0,59	1,17	0,24	-0,46	1,84
1996	0,84	0,59	1,44	0,15	-0,31	1,99
1997	1,05	0,59	1,79	0,08	-0,11	2,21
1998	1,33	0,59	2,26	0,02	0,18	2,49
1999	1,65	0,59	2,79	0,01	0,49	2,80

2000	1,62	0,59	2,75	0,01	0,46	2,78
2001	1,95	0,59	3,31	0,00	0,79	3,11
2002	2,19	0,59	3,72	0,00	1,03	3,35
2003	1,95	0,59	3,32	0,00	0,79	3,11
2004	1,65	0,61	2,71	0,01	0,45	2,85
2005	1,58	0,61	2,59	0,01	0,38	2,78
2006	1,37	0,61	2,25	0,03	0,17	2,57
2007	1,47	0,61	2,41	0,02	0,27	2,67
2008	1,19	0,61	1,96	0,05	-0,01	2,40
cons	6,07	0,42	14,62	0,00	5,26	6,89
sigma_u	2,97					
sigma_e	1,73					
rho	0,77					

F test that all u_i=0: F(17,356) = 59.49 Prob>F = 0.000

Table 6-2: Wald test of year dummy in the first regression

1	1988.year	=	0	F(21, 355)	=	1.85
2	1989.year	=	0	Prob > F	=	0.0136
3	1990.year	=	0			
4	1991.year	=	0			
5	1992.year	=	0			
6	1993.year	=	0			
7	1994.year	=	0			
8	1995.year	=	0			
9	1996.year	=	0			
10	1997.year	=	0			
11	1998.year	=	0			
12	1999.year	=	0			
13	2000.year	=	0			
14	2001.year	=	0			
15	2002.year	=	0			
16	2003.year	=	0			
17	2004.year	=	0			
18	2005.year	=	0			
19	2006.year	=	0			
20	2007.year	=	0			
21	2008.year	=	0			

Table 6-3: Regression results from the second regression

Fixed-effects (within) regression	Number of obs	=	**306**
Group variable: **countryfish**	Number of groups	=	**18**
R-sq: within = **0,2783**	Obs per group: min	=	**17**
between = **0,2769**	avg	=	**17.00**
overall = **0,2699**	max	=	**17**
	F(23,355)	=	**5.78**
corr(u_i, Xb) = **0.1398**	Prob > F	=	**0.0000**

lnprod	**Coef.**	**Std. Err.**	**T**	**P>t**	**[95% Conf.**	**Interval]**
tac	1,86	0,82	2,29	0,02	0,26	3,47
itq	1,10	0,72	1,53	0,13	-0,32	2,52
year						
1988	0,08	0,60	0,14	0,89	-1,09	1,26
1989	0,11	0,60	0,18	0,86	-1,07	1,28
1990	0,54	0,64	0,85	0,40	-0,71	1,80
1991	0,40	0,64	0,63	0,53	-0,86	1,66
1992	0,77	0,62	1,25	0,21	-0,44	1,98
1993	0,88	0,62	1,43	0,16	-0,33	2,09
1994	0,54	0,62	0,88	0,38	-0,67	1,76
1995	0,42	0,62	0,68	0,49	-0,79	1,63
1996	0,58	0,62	0,94	0,35	-0,63	1,79
1997	0,73	0,62	1,18	0,24	-0,49	1,96
1998	1,02	0,62	1,63	0,10	-0,21	2,24
1999	1,33	0,62	2,13	0,03	0,10	2,56
2000	1,30	0,62	2,09	0,04	0,07	2,53
2001	1,63	0,62	2,62	0,01	0,40	2,86
2002	1,88	0,62	3,01	0,00	0,65	3,10
2003	1,63	0,62	2,62	0,01	0,41	2,86
_cons	5,86	0,44	13,36	0,00	5,00	6,73
sigma_u	3,08					
sigma_e	1,80					
Rho	0,75					

F test that all u_i=0: F(17,270) = 48.77 Prob>F = 0.000

Table 6-4: Wald test of year dummy in the second regression

1	1988.year	=	0	F(16, 270)	=	1.51
2	1989.year	=	0	Prob > F	=	0.0972
3	1990.year	=	0			
4	1991.year	=	0			
5	1992.year	=	0			
6	1993.year	=	0			
7	1994.year	=	0			
8	1995.year	=	0			
9	1996.year	=	0			
10	1997.year	=	0			
11	1998.year	=	0			
12	1999.year	=	0			
13	2000.year	=	0			
14	2001.year	=	0			
15	2002.year	=	0			
16	2003.year	=	0			

Table 6-5: Regression results from the third regression

Fixed-effects (within) regression	Number of obs	=	**396**
Group variable: **countryfish**	Number of groups	=	**18**
R-sq: within = **0,2713**	Obs per group: min	=	**22**
between = **0,2879**	avg	=	**22.0**
overall = **0,2440**	max	=	**22**
	F(23,355)	=	**6.03**
corr(u_i, Xb) = **0.2031**	Prob > F	=	**0.0000**

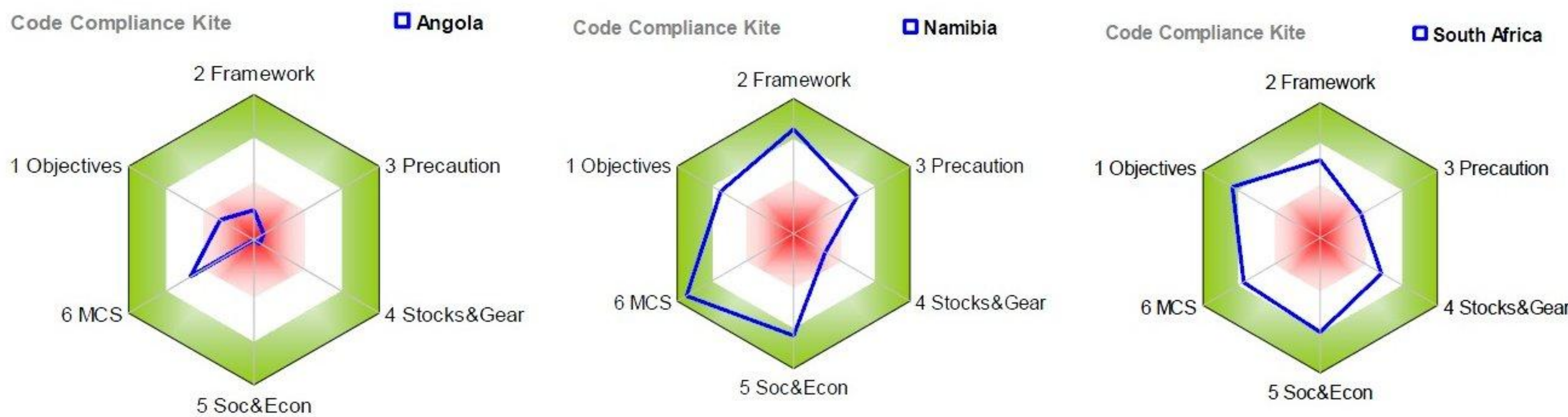
lnprod	**Coef.**	**Std. Err.**	**t**	**P>t**	**[95% Conf.**	**Interval]**
tac	1,95	0,36	5,40	0,00	1,24	2,65
year						
1988	0,08	0,58	0,15	0,88	-1,05	1,22
1989	0,11	0,58	0,18	0,86	-1,03	1,24
1990	0,52	0,59	0,89	0,37	-0,63	1,67
1991	0,38	0,59	0,65	0,51	-0,77	1,53
1992	1,05	0,59	1,80	0,07	-0,10	2,21
1993	1,16	0,59	1,98	0,05	0,01	2,31
1994	0,83	0,59	1,41	0,16	-0,32	1,98
1995	0,71	0,59	1,20	0,23	-0,45	1,86
1996	0,86	0,59	1,47	0,14	-0,29	2,01
1997	1,08	0,59	1,83	0,07	-0,08	2,23
1998	1,36	0,59	2,30	0,02	0,20	2,51
1999	1,67	0,59	2,83	0,01	0,51	2,83
2000	1,64	0,59	2,79	0,01	0,48	2,80
2001	1,97	0,59	3,35	0,00	0,81	3,13
2002	2,22	0,59	3,76	0,00	1,06	3,37
2003	1,97	0,59	3,35	0,00	0,82	3,13
2004	1,69	0,61	2,77	0,01	0,49	2,89
2005	1,62	0,61	2,65	0,01	0,42	2,82
2006	1,41	0,61	2,31	0,02	0,21	2,61
2007	1,51	0,61	2,47	0,01	0,31	2,71
2008	1,23	0,61	2,02	0,04	0,03	2,43
_cons	6,09	0,42	14,65	0,00	5,27	6,91
sigma_u	2,98					
sigma_e	1,73					
rho	0,75					

F test that all u_i=0: F(17,356) = 59.91 Prob>F = 0.000

Table 6-6: Wald test of year dummy in the third regression

1	1988.year	=	0
2	1989.year	=	0
3	1990.year	=	0
4	1991.year	=	0
5	1992.year	=	0
6	1993.year	=	0
7	1994.year	=	0
8	1995.year	=	0
9	1996.year	=	0
10	1997.year	=	0
11	1998.year	=	0
12	1999.year	=	0
13	2000.year	=	0
14	2001.year	=	0
15	2002.year	=	0
16	2003.year	=	0
17	2004.year	=	0
18	2005.year	=	0
19	2006.year	=	0
20	2007.year	=	0
21	2008.year	=	0

F(21, 355)	=	2.10
Prob > F	=	0.0036



Source: Fisheries Centre of UBC

Figure 6-1: Code compliance kites of Angola, Namibia and South Africa

Source: Fisheries Centre of UBC

Figure 6-2: Code compliance kites of Norway, New Zealand and Iceland

Glossary

Name	**Definition**
EEZ	The Exclusive Economic Zones give each country special rights over the use of the marine resources within the zone, preventing boats from other nations to operate in the most marine rich area.
UNCLOS	The United Nations Convention on the Law of the Sea was created to establish a legal order for the world's seas and oceans. It were to enable better international communications and to promote a more peaceful use of the oceanic environment and its resources.
RFB	Regional Fishery Bodies are a mechanism through which States of organisations that are parties to an international fishery agreement or arrangement work together towards the conservation, management and/or development of fisheries.