Icelandic fisheries: Profitability, resource rent, rent taxation and development

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Abstract

In 1990, Iceland introduced a uniform individual transferable quota system (ITQ) to manage almost all of the nation's fisheries. The development of Iceland's fisheries under this management system were examined in the five articles this thesis consists of. The emphasis was on profitability, resource rent and rent taxation. The fishing industry has been going through a sea change in the past three decades. It has adapted well to lower catches. The number of vessels and factories, as well as employment, has reduced. The industry is now focusing more on producing for a higher paying consumer market. Quotas have been consolidated and capitalised in the balance sheet of the industry, hence, increasing its debt level. All these developments have been caused or aided by the ITQ system, leading to increased profitability in Icelandic fisheries, both in fishing and especially in the processing component.

Since 2008, the Icelandic fishing industry has been producing significant resource rent. It took the industry almost two decades to start producing rent consistently. Reduced catches caused this delay. When catches started to increase, at the same time as the Icelandic krona fell in value, resource rent was introduced and has been significant for the past decade. The fishing fee was introduced in 2004. Its main purpose is to tax the resource rent the fishing industry is producing. The fee was low in the beginning, but it was increased considerably in 2012 and subsequently became a significant expense for the industry. Setting the fee was a difficult process where problems that cropped up were solved gradually. Three stakeholders have received the resource rent created in Iceland's fisheries. The government's share was around 20%. It received its portion through the fishing fee and revenues from higher corporate taxes caused by rent creation. Those who have sold their fishing rights have received around 40% of the rent. A similar portion, around 40% of the rent, has been acquired by the companies that operate in the industry.

Iceland's coastal fisheries started in 2009. These fisheries managed very differently, being classic open access fisheries with a derby style management, where the fishers race to fish. The findings of this research are that, as anticipated, the coastal fisheries are not profitable. However, contrary to expectations, the rate of accidents involving injuries was lower in coastal fisheries than in other ITQ-managed Icelandic fisheries. As expected, however, the rate of minor incidents, mostly mechanical failures, was much higher in coastal fisheries than other Icelandic fisheries.

Ágrip

Þessi ritgerð samanstendur af fimm greinum, þar sem rannsökuð var þróun íslensks sjávarútvegs frá árinu 1990, en þá náði kvótakerfið loks yfir nær allar fiskveiðar Íslendinga. Áhersla var lögð á hagnað, auðlindarentu og skattlagningu rentunnar. Miklar breytingar hafa orðið á íslenskum sjávarútvegi á síðustu þremur áratugum. Greinin hefur þurft að bregðast við minni afla. Skipum hefur fækkað sem og frystihúsum, rækjuvinnslum og loðnubræðslum. Störfum í greininni hefur einnig fækkað mikið. Aflaheimildir hafa þjappast saman og hafa þær verið seldar og eignfærðar í efnahagsreiknum atvinnugreinarinnar, og því hafa skuldir hækkað. Kvótakerfið hefur stuðlað að, eða valdið, þessari þróun sem hefur leitt til aukinnar arðsemi í íslenskum sjávarútvegi, í veiðunum og sérstaklega í vinnslunni.

Frá árinu 2008, hefur íslenskur sjávarútvegur framleitt verulega auðlindarentu. Það tók greinina nærri tvo áratugi, að laga afkomuna og búa til rentu. Samdráttur í afla réði mestu um tímalengdina. Þegar veiðar jukust, um leið og íslenska krónan féll, byrjaði atvinnugreinin að skapa verulega auðlindarentu og hefur rentan verið mikil síðasta áratug. Skattlagning greinarinnar með sérstökum veiðigjöldum hófst 2004, en aðaltilgangur veiðigjaldanna er að skattleggja sérstaklega rentuna sem atvinnugreinin framleiðir. Gjöldin voru lágt í upphafi, en voru hækkað verulega 2012, og urðu þá umtalsverður kostnaðarliður fyrir veiðihluta atvinnugreinarinnar. Það var erfitt og flókið í framkvæmd að koma veiðigjöldunum á, og hafa þau vandamál sem fylgdu verið leyst jafnhliða. Þrír aðilar hafa notið góðs af auðlindarentunni sem íslenskur sjávarútvegur hefur framleitt. Um 20% af rentunni hafa runnið til ríkisins. Það hefur fengið sinn hlut með veiðigjöldum og hærri tekjuskatti, sem lagður er á hagnað fyrirtækja. Þeir aðildar sem selt hafa kvóta og hætt í atvinnugreininni hafa fengið um 40% af rentunni. Að lokum hafa þau fyrirtæki sem enn starfa í íslenskum sjávarútvegi fengið sama hlut, eða 40%.

Strandveiðarnar hófust 2009. Þær voru veruleg breyting á stjórnun íslensks sjávarútvegs vegna þess að þær eru ólympískar og öllum opnar, öfugt við aðrar veiðar sem stjórnað er með kvótakerfinu. Eins og búist var við, eru strandveiðarnar ekki arðbærar. Hins vegar kemur á óvart að lítið er um slys, þar sem sjómenn meiðast, við strandveiðarnar og er hlutfallslega minna um slys við þær en við aðrar veiðar á Íslandi. En eins og búist var við, er mikið um minniháttar óhöpp, einkum vélarbilanir, við strandveiðarnar, og er tíðni þess konar atvika mun hærri en við aðrar veiðar.

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Abbreviations

CAPM	Capital asset pricing model
CFC	Calculated financial cost
CPUE	Catch per unit effort
EEZ	Exclusive economic zone
EBIT	Earnings before interest and taxes
EBITDA	Earnings before interest, taxes, depreciation and amortization
EBT	Earnings before taxes
EU	European Union
ET	Excess corporate taxes
GDP	Gross domestic product
GRT	Gross registered tonnage
IFDF	Icelandic fisheries development fund
IFRS	International financial reporting standards
IMR	Intra-marginal rent
ITQ	Individual transferable quota
IVQ	Individual vessel quota
MT	Metric tons
P&L	Profit and loss
REIBID	Reykjavík interbank bid rate
ROC	Return on capital
RR	Resource rent
TAC	Total allowable catch
WACC	Weighted average cost of capital

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List of papers

Paper I: Gunnlaugsson, S. B., and Saevaldsson, H. (2016). The Icelandic fishing industry: Its development and financial performance under a uniform individual quota system. *Marine Policy*, 71, 73–81.

Paper II: Gunnlaugsson, S. B., Kristofersson, D., and Agnarsson, S. (2018). Fishing for a fee: Resource rent taxation in Iceland's fisheries. *Ocean & Coastal Management*, 163, 141–150.

Paper III: Gunnlaugsson, S. B., and Agnarsson, S. (2019). Late arrival: The development of resource rent in Icelandic fisheries. *Fisheries Research*, 214, 126–135.

Paper IV: Gunnlaugsson, S. B., Saevaldsson, H., Kristofersson, D. and Agnarsson, S. (2020). Resource rent and its distribution in Iceland's fisheries. *Marine Resource Economics*, 35(2), 113–135.

Paper V: Gunnlaugsson, S. B., Saevaldsson, H., Kristofersson, D., Agnarsson, S. and Ishimura, G. Derby versus ITQ: Iceland's coastal fisheries explained and compared to its ITQ-managed fisheries. Submitted.

PART I: THESIS

1 Introduction

For centuries, fisheries have played a paramount role in the Icelandic economy. Seafood products were the nation's most significant export industry throughout the 20th century. However, the relative importance of the fishing industry has declined in recent decades, because of growth in services, especially tourism, and the expansion of other industries in the production sector. Nevertheless, fisheries remain an important contributor to the economy and seafood products now make up more than 40% of the nation's total value of exported goods. Iceland is recognised as one of the world's leaders in fisheries and fisheries management. The annual catch for the past 20 years was on average around 1.4 million metric tons. Iceland is normally ranked among the world's 20 major fishing nations and the 10 leading demersal fishing countries (FAO, 2017).

For most of the 20th century, Iceland had little control over its fishing resources. To gain control of its fishing stocks, the country extended its Exclusive Economic Zone (EEZ) in four steps. The end of this process occurred in 1975, when the EEZ was extended to 200 nautical miles and Iceland had full control of its fishing resources. After 1975, various forms of effort-based management systems managed Icelandic fishing resources. However, during the 1980s, harvesting firms, including those operating demersal and pelagic vessels, experienced severe financial difficulties. These problems were so critical that something had to be done to boost economic performance. The end solution was the individual transferable quota (ITQ) system in Iceland's fisheries, which resulted in significantly improved economic performance by the industry. ITQs are a management system where the regulators determine a species-specific total allowable catch (TAC). This is typically set by weight for a given time period. A specific portion of the TAC, called quota share, is allocated to the quota holders. The quota shares can normally be leased, bought and sold if they are fully transferable. This system was fully implemented in 1990 when the vast majority of Iceland's fishing industry was managed by a uniform ITQ system covering almost all of the nation's fisheries (Matthíasson, 2003; Hannesson, 2004; Arnason, 2005). Iceland is one of the largest fishing nations in the world and has been managing its fisheries according to ITQ principles for a long time. Therefore, Iceland's fisheries are a prime example when studying the impact of an ITQ management system on developments in fisheries and examining how fisheries progress when managed by an ITQ system.

The Icelandic ITQ system has always been controversial and often under heavy political debate (Eythórsson, 2000; Kokorsch et al., 2015). In the beginning, quotas were primarily allocated based on harvesting history

(Runolfsson and Arnason, 2001), and this practice has always been criticised as it gave the quota holders valuable fishing rights – without paying anything for them initially. As the system matured, the political and public opposition to the ITQ system has mostly focused on transfers of quotas, especially from firms located in vulnerable communities, quota consolidation, and how the profits from the fisheries should be shared between operators and the nation at large (Saevaldsson and Gunnlaugsson, 2015). However, it was not until after the financial situation of the industry began to recover that politicians and the public could start discussing in earnest how the resource rent (RR) should be shared. RR is a special kind of economic rent that comes from exploiting natural resources. This debate culminated in the establishment of a parliamentary resource committee which put forward two different modes of taxing the fishing industry: quota auctions and a fishing fee (Auðlindanefnd, 2000). The latter option was chosen, and the fishing fee came into effect in 2004, which was increased considerably in 2012. The purpose of this fee is twofold: to pay for the government's direct cost of managing the resource and to give the public a share of the RR that the Icelandic fishing industry generates. The introduction and existence of the fishing fee clearly demonstrated the virtues of a successful ITQ system, showing that such a management system can create the conditions for improved profitability. This again allows taxation to generate a revenue that can be used to improve general welfare. This fee has partially shifted the political debate in the country from discussing the basis and fairness of the ITQ system into a debate about the fishing fee, the methodology used for calculating the fee, and the level of taxation. It remains a highly controversial issue and under considerable political scrutiny and dispute.

The Icelandic coastal fisheries (strandveiðar) are a by-product of the opposition to the ITQ system. Two of the main critiques of the system focus on reduced employment and the difficulty newcomers face in entering the fishing industry (Chambers and Carothers, 2017; Kokorsch, 2018). The coastal fisheries were supposed to increase employment in coastal communities and encourage the entry of newcomers into fishing. Those communities have been struggling for the last few decades, with loss of employment and population decline, and the coastal fisheries were supposed to reverse or slow this development. These fisheries started in the summer of 2009 and have been ongoing since. The coastal fisheries are open access derby fisheries. An open access fishery is open to all vessels. In a derby fishery, the fishers race to fish during a limited season.

Being open to everybody, these fisheries represent a major change in Icelandic fishing policy, even though only a small portion of the nation's TAC, or around 1.5% by catch value, is assigned to this fishing effort. From a rational economic standpoint, the coastal fisheries are not efficient, since it would be cheaper to catch the fish with the current fleet operating within the ITQ system.

In addition, the coastal fisheries might be dangerous, because competitive fishing behaviour might increase the risk of accidents.

This thesis is divided into two parts. Part I consists of eight chapters. In the first chapter, the context of this research is introduced. The second chapter outlines the research questions and the objective of this dissertation. The third chapter charts the main management developments in Icelandic fisheries, profitability, landings and other important developments. This is mostly illustrated by referring to the five articles in Part II, which give a comprehensive overview of the development in Iceland's fisheries over the past three decades. The fourth chapter describes the theoretical framework and previous research relevant to this thesis. The fifth chapter explains the methodology applied and describes the data used. The sixth chapter provides a summary of the five papers. In the seventh chapter, the main findings of this research are discussed in relation to the theoretical framework and existing literature. The eighth chapter describes the policy implications of the findings presented in the articles together with the overall conclusions. Part II of this thesis consists of the five articles. Four of the articles have been published in peer-reviewed journals and one was submitted to a peer-reviewed journal and is currently under review.

2 The objective and research questions

A large and growing literature supports the statement that ITQ systems are probably the best fisheries management systems if the purpose is to increase economic efficiency (Grafton, 1996b; Hannesson, 2004; Arnason, 2012). The ITQ system terminates the race to fish and thus reduces costs and increases quality (Arnason, 2005; Asche et al., 2009; Asche et al., 2014). This system leads to improved economic performance as fishers have the incentive to adopt a method that ensures their catch share maximises profits (Grafton, 1996a; Arnason, 2008). In addition, an ITQ system should increase the value of landings because quota holders are able to manage fishing and landings in synchrony with markets, and hence increase the prices of landed catches (Knútsson et al., 2016). Quota management systems shift the fishers' focus from quantity to profitability (Arnason, 2012). Finally, this management system should improve economic performance as better run firms can be expected to buy quotas form less efficient firms with higher average cost (Dupont et al., 2002; Asche et al., 2008).

However, the literature is lacking a study where RR creation, rent taxation and the RR distribution of entire fisheries are estimated and examined. The objective of this thesis is to address this dearth of research in the academic literature in a comprehensive manner. The overall research question for this project is: *How have profits, and resource rent developed, been distributed and taxed in Icelandic fisheries since the introduction of the uniform ITQ system?* However, the specific questions addressed in the five papers are:

1. How has profitability developed in Icelandic fisheries? (Paper I, Paper II and Paper V).
2. How have debts evolved in Iceland's fisheries since the initiation of the ITQ management system? (Paper I).
3. What are the main problems connected with setting RR taxation in fisheries, and how have they been solved when setting the Icelandic fishing fee? (Paper II).
4. How much RR has been produced in Icelandic fisheries? (Paper III and Paper IV).
5. How much of the RR has the fishing fee captured? (Paper III).
6. Why did it take almost two decades for RR to appear in Iceland's fisheries? (Paper III).
7. How was RR in Icelandic fisheries distributed? (Paper IV).

8. Is there a difference in profitability between the Icelandic coastal fisheries, which are a classic case of open access derby fisheries, and other Icelandic fisheries, managed by the ITQ system? (Paper V).
9. Are the Icelandic coastal fisheries more prone to accidents or minor incidents without personal injury than other Icelandic fisheries, managed by the ITQ system? (Paper V).

3 Icelandic fisheries, management and development

This thesis is comprised of five papers. All these papers to some extent describe developments in Iceland's fisheries. Hence, in combination, they provide a thorough description of the management system, financial developments and other changes in the industry from 1990 when the uniform ITQ system was introduced. In table 2, there is an overview of the papers. However, a comprehensive outline of changes in the management system and other important events is missing in the articles. This chapter presents the outline for the past five decades, and an overview is presented in table 1.

3.1 Changes in management and important events

The collapse of the Atlantic herring fisheries in 1968 had a huge impact on Icelandic fisheries and the economy of the entire country. It alarmed the nation and made them feel that the fishing resource was not inexhaustible, and its sustainable management was necessary. The result was that the TAC was imposed in the Icelandic herring fisheries in 1969. To improve economic performance, individual vessel quotas (IVQs) were set in the Icelandic herring fisheries in 1975. IVQ systems are similar to ITQ systems as the regulators set a species-specific TAC. A portion of the TAC, called quota share, is allocated to the quota holder. However, unlike under an ITQ management regime, the quota shares are not transferable (Asche et al., 2008). In 1975, Iceland acquired full control of its fishing resource with the 200 nautical mile exclusive economic zone (EEZ). Immediately, a TAC was established in the cod fisheries; catches exceeded the TAC, however, and fishing stocks were depleted. Effort restrictions were then implemented in the cod fisheries. In 1977, these restrictions were in the form of limited allowable fishing days for existing vessels. As an example, in 1977, trawlers could fish cod for 323 days. In 1981, this limit was reduced to only 215 days. The system was, therefore, wasteful. When the TAC in the cod fisheries was considerably reduced in 1984, IVQs were applied to improve economic performance in the demersal fisheries, as the vessels were unprofitable at that time. Alongside the IVQs' quota system in demersal fisheries, vessels could opt for an effort restriction instead of IVQs. This option (the effort restriction) remained open until the uniform ITQs system was introduced in 1990 (Wellings, 2017).

Primary fish markets were deregulated in 1986 and 1987. Before that time, the price mechanism in fish trading between harvesters and processors was arbitrary. A committee, whose members represented the fish industry and the government, set the price. The mechanism was changed in 1986 and 1987 when the price setting in fish trading between harvesters and processors was

liberalised. Due to this change, fish auctions, and the fish markets where auctions are conducted, began in 1986. These markets have had a substantial impact on the Icelandic fishing industry, especially the processing component. The fish markets allow the processors to specialise, which improves quality, value and profitability. Moreover, the fish markets increase fish prices, because specialisation should lead to higher end product prices, hence benefiting the whole fishing industry (Knútsson et al., 2016). Even though only a small portion of the landing is sold at these auctions (normally 20-30% of demersal catches and a smaller percentage of the pelagic landings), the influence of these markets has been substantial.

A notable development in Iceland's fisheries was the emergence of vertically integrated companies. The portion of fishing rights these companies hold has been increasing steadily for the past few decades and now they control most fishing rights (quotas) in Iceland's fisheries. Vertically integrated companies own quotas, boats and factories. They catch the fish, process it and sell their own products; thus, they control the whole value chain, which makes them better able to manage the fisheries, eliminate seasonality and guarantee a steady supply to important customers. The Icelandic fishing industry has been focusing increasingly on premium markets. This is evident in the processing and marketing of important demersal species. Today, an important proportion of the catch is processed in Iceland and transported fresh, mostly by air, to Europe and sold at a premium price in supermarkets. The ITQ system, as well as the emergence of the vertically integrated companies, has made this development possible (Saevaldsson and Gunnlaugsson, 2015; Knútsson et al., 2016).

One of the most significant and controversial consequences of the Icelandic ITQ system has been the concentration of quota ownership. In 1984, the ten largest firms held 21.4% of the fishing rights in demersal fisheries. In 1996, this share had risen to 30.7%. Finally, in 2019, the share of the ten largest firms was 50.8% of allocated quotas in the demersal fisheries (Directorate of Fisheries, 2019). The ownership balance is even more skewed in Iceland's pelagic fisheries, where only eight companies now hold more than 90% of the quotas (Saevaldsson and Gunnlaugsson, 2015). To reduce the consolidation of fishing rights, a "quota ceiling" was introduced in 1998, which sets the maximum quota each company is allowed to hold. It is now set at 12% of the total quota in all Iceland's fisheries, measured in cod-equivalent tonnes. The ceiling is 20% for most species, but for some it is as high as 35%.

A major change in Iceland's fisheries management was the introduction of the fishing fee in 2004. The purpose of the fee was to cover the management cost of the fishing resource and to give the Icelandic public (the government) a share of the RR produced by the fishing industry. The fee was low in the beginning; however, it was increased considerably in 2012 and has, since that year, been a major cost to quota owners in the Icelandic fishing industry. The

coastal fisheries began in 2009. The coastal fisheries are open access derby fisheries where fishers race to fish. Even though the coastal fisheries are only a fraction of Iceland's fisheries, amounting to around 1.5% of the catch value of all Icelandic fisheries from 2009 to 2017, they, nevertheless, represented a major policy change in fisheries management.

Table 1. Important events and changes in fisheries management in Iceland's fisheries 1968 to 2012.

Year	Important events or changes in management
1968	Collapse of the Atlantic herring fisheries
1969	TAC imposed on Icelandic herring fisheries
1975	IVQs introduced in Icelandic herring fisheries
1975	200-mile EEZ
1977	Effort limitation in demersal fisheries
1979	ITQs in Icelandic herring fisheries
1980	IVQs in capelin fisheries
1984	IVQs introduced in demersal fisheries, effort restriction option parallel
1986	Fish auctions start and primary fish markets are deregulated
1986	ITQs in capelin fisheries
1990	Uniform ITQ system in almost all Iceland's fisheries
1998	The quota ceiling set
2004	The fishing fee introduced
2009	The coastal fisheries started
2012	The fishing fee increased considerably

Sources: (Runolfsson and Arnason, 2001; Auðlindanefnd, 2000; Saevaldsson and Gunnlaugsson, 2015; Wellings, 2017).

3.2 Overview of the papers

An overview of the topics addressed by each paper is presented in table 2. As the table shows, all the papers combined provide a detailed description of the management system, history, landings and other developments in Iceland's fisheries since the implementation of the uniform ITQ system. Paper I is mostly descriptive, presenting a detailed account of developments in the Icelandic fishing industry from the introduction of the uniform ITQ system in Iceland's fisheries in 1990. In the article, the progress of catches is charted from 1950 to 2013. From 1991, the export value of fish products, export prices, number of jobs, fleet size and other indicators are shown. The paper displays the profitability of fishing and processing from 1991 to 2013. Finally, the paper

charts the development of debt levels and debt sustainability in the whole fishing industry. Paper II traces the record of profitability in Icelandic fisheries from 1980 to 2014 by using a fixed 6% cost of capital. The paper describes the fishing fee in detail, its amount and various problems that occurred when setting the fee in the period from 2004 to 2015.

Paper III estimates the RR produced in Iceland's fisheries. In this article, the progression of landings is charted from 1991 to 2016. In addition, the development and introduction of the ITQ system is briefly described and the current management system explained. Paper IV evaluates RR in Iceland's fisheries and, more importantly, charts its distribution between major stakeholders. In the article, the development of landings in the Icelandic EEZ is shown from 1945 to 2015. In addition, this article describes the building up of a management system in Icelandic fisheries and offers a detailed description of the current system. Paper V describes the coastal fisheries in detail, especially their management system and its development. The main theme of the paper is a comparison in profitability and rate of accidents between coastal and other Icelandic fisheries.

Table 2. An overview of the papers.

	Paper I	Paper II	Paper III	Paper IV	Paper V
The ITQ management system and its history		X	X	X	
Employment	X		X		
Catch	X		X	X	
Profitability	X	X	X		X
Balance sheet (debt and assets)	X	X			
Resource rent			X	X	
Resource rent taxation		X	X	X	
Resource rent distribution				X	
The coastal fisheries' management system					X
Accidents					X

4 Theoretical framework and literature review

4.1 Open access fisheries

Open access fisheries lead to rent dissipation, overcapitalisation and often to overfishing (Hannesson, 2004; Grafton et al., 2008). This was first demonstrated in Gordon's seminal paper (Gordon, 1954). In his article, the theory was introduced that open access fisheries would lead to overexploitation of the fishing resource, excess capitalisation in vessels and labour and hence rent dissipation. The reasons for this, as identified by Gordon, were the absence of ownership of the resource and ill-defined property rights. The literature is full of examples of the poor economic performance of open access fisheries. Research has shown that these fisheries lead to overcapacity, economic waste and poor quality of the catch (Clark and Clark, 1985; Homans and Wilen, 2005). This is because under open access an excessive fishing effort will characterise the fisheries (Bjørndal and Conrad, 1987). Under an open access regime, vessels will enter the industry if the revenue per unit effort is greater than the cost of effort, and consequently exit the fishery when revenue is less than cost.

The literature has many examples of low profitability, overcapitalisation and rent dissipation in open access fisheries. Examples of this are evident in Canada (Dupont, 2014); Denmark (Andersen et al., 2010; Merayo et al., 2018); the Faroe Islands (Danielsen and Agnarsson, 2018; Jacobsen, 2019); Iceland (Matthíasson, 2003; Arnason, 2005); the North Sea (Arnason et al., 2018; Holt and Raicevich, 2018); Norway (Standal and Aarset, 2008; Greaker et al., 2017); Sweden (Waldo and Paulrud, 2013); and various fisheries in the US (Agar et al., 2014; Warlick et al., 2018; Hsueh and Kasperski, 2018). All the fisheries referred to were open access in the past; however, the management system in most of these fisheries has now been converted to various forms of quota systems.

4.2 ITQ fisheries management

ITQs were first introduced partially in the Netherlands in 1976. This management system has been gaining popularity ever since. In 2007, 18 countries applied this system for managing their fisheries for around 250 species (Chu, 2009). New-Zealand was the first country to implement a major ITQ program in 1986, and Iceland was a close second (Annala, 1996). One of the main reasons for managing fisheries with an ITQ system is to promote economic efficiency. However, in some countries, ITQs have been set as a management system where the main motive has been to aid the recovery of

overexploited fish stocks (Chu, 2009). Nevertheless, it is controversial whether the positive effects of ITQs on fish stocks and biomass are related to the ITQ system or occurred just because a TAC was set and maintained. However, ITQs systems have been linked to improved environmental outcomes because the fisher's (or quota holder's) environmental stewardship increases (van Putten et al., 2014). A study showing this is an extensive analysis involving an examination of around 11,000 of the world fisheries from 1950 to 2003. The findings were that the likelihood of a collapse of fisheries was significantly lower in catch share managed fisheries than other management systems (Costello et al., 2008). Similar results were reported by a paper studying around 4,700 fisheries, representing around 78% of the global reported fish catch. The paper concluded that rights-based fisheries management, which focuses on economic return, would achieve the highest level of fish stock biomass (Costello et al., 2016). In most ITQ fisheries, there are some input controls. An example of this are mesh sizes, boat size limits and a closed season to protect the breeding stock (Emery et al., 2017).

The purpose of an ITQ system is mostly to promote economic efficiency, rather than to conserve fish stocks. The conservation of fish stocks is primarily obtained by setting and holding a TAC based on scientific advice. ITQs lead to a so-called "autonomous adjustment" of the size of the fleet. That is, the fishing effort (e.g., number of vessels, gear, size of vessels) adjusts to an efficient size (Hoshino et al., 2020). In addition, the ITQ system brings about higher prices for landings, as harvesters organise fishing to obtain as high a price as possible for the landings, but not to maximise catches, while aiming to catch the allocated quota with as low a cost as possible (Asche et al., 2008; Asche et al., 2009). These effects have been witnessed in Argentina (Bertolotti et al., 2016); Australia (Kompas and Che, 2005; Thébaud et al., 2014; Gardner et al., 2015); and Canada (Casey et al., 1995; Dupont, 2014). Similar results are reported in Chile (Pena-Torres, 1997; Gómez-Lobo et al., 2011); Denmark (Andersen et al., 2010; Merayo et al., 2018; Hammarlund et al., 2018); Iceland (Arnason, 1993; Arnason, 2005; Knútsson et al., 2016); Norway (Flaaten et al., 1995; Hannesson, 2013; Flaaten et al., 2017); New Zealand (Dewees, 1989; Annala, 1996; Breen et al., 2016); Peru (Kroetz et al., 2019); Sweden (Waldo and Paulrud, 2013) and the US (Gauvin et al., 1994; Matulich, 2008; Agar et al., 2014). In all these fisheries, the introduction of ITQs or a similar management system led to increased profits and smaller fishing fleets.

4.3 Resource rent

Economic rent has a long history in economics. It was first presented by Adam Smith as a component of profits (Smith, 1776). David Ricardo further developed this concept and applied it to agriculture (Ricardo, 1891). Economic rents are defined as surpluses after all costs have been paid, even the cost of

capital, which is the necessary return on capital, both borrowed and owned (Gray, 1914; Wessel, 1967). RR is a special kind of economic rent that comes from utilising scarce natural resources (e.g., gold, silver, oil, forests and fish). Since the natural resources from which the RR is produced are very scarce. It is not possible for industries that utilise theses scarce resources, to supply an output that satisfies market demand. Therefore, excess economic profit is often present when utilising scarce natural resources. This excess profit is RR. If excess economic profit were produced in competitive industries that do not depend on scarce resources, this circumstance would attract new entrants. In addition, current producers would increase production if any extraordinary profits were present. The results would be lower prices and less profit. Ultimately, in the presence of more market competition, an equilibrium would occur with normal economic profits comparable to those in other industries with a similar risk. By contrast, excess profits do not evaporate in industries that utilize a scarce natural resource such as fish, oil, and gold, where entry is limited, and hence RR is often created in these industries (Bulte et al., 1995; Grafton et al., 2008; Manning and Uchida, 2016).

RR is not present in open access fisheries. However, because the cost structure of open access fisheries is heterogeneous, more efficient boats with lower cost might earn more than normal economic profit (Flaaten et al., 1995). This profit is often referred to as intra-marginal rent (IMR) or producer surplus (Coglan and Pascoe, 1999). Figure 1 explains this. The figure shows two vessels operating in open access fisheries in equilibrium. The x-axis shows effort; that is, the total inputs (e.g., fuel, gear, and labour) used by the vessel. The average revenue (AR) line is flat because individual vessels do not influence the price received for the catch. Hence, the marginal revenue (MR) line is the same as the AR line. The returns (profits) of both boats are maximised at the effort level where marginal cost (MC) equals MR. However, heterogeneity of the fleet is shown by the different cost structures of the two vessels. Vessel m is the marginal vessel. It is only earning a normal economic profit so no IMR is present. Vessel 1 has a lower cost structure than the marginal vessel, thus lower average cost (AC) and a profit which is higher than the normal economic profit. This profit is referred to as intra marginal rent (IMR). Some vessels with a higher cost structure than the marginal vessel will be making economic losses. Those vessels will either leave the industry or find a way to improve their economic performance by lowering their cost.

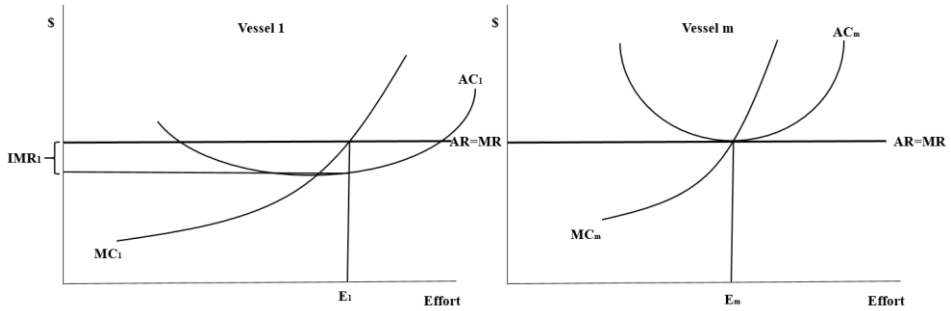

Figure 1. Heterogeneous fishing fleet in an open access unregulated fishery.

As time passes and ITQ systems mature, RR should be created in ITQ managed fisheries (Grafton, 1996b). This is because the fishers will catch the allocated quota at the lowest possible cost and thereby maximise profits. ITQ governed fisheries are closed to new entrants, unless they buy fishing rights, so excess profits do not attract the new enterprises that would increase competition and drive down profits. Both RR and IMR should be present in ITQ managed fisheries as the cost structure of vessels is heterogeneous. Figure 2 shows RR and IMR in fisheries managed by an ITQ system. Figure 2 is mostly similar to figure 1. The main difference is that the x-axis shows the quantity of fish allocated to the vessel under the ITQ system. Each vessel catches the quantity Q, which the ITQ system allocates to the vessel, with the lowest possible cost. Hence, the AC line is at its lowest point where it crosses Q and costs are minimised. Vessel 1 is earning both IMR and RR as it has a low cost structure and significantly lower cost than vessel m, which is only earning RR. Vessel m is only earning RR as it has a high cost structure. Some vessels might have an even higher cost structure than vessel m. Their IMR is, therefore, negative; nevertheless, they might still be profitable. This is because of the RR in the fisheries from which these vessels benefit. They will, therefore, not necessarily leave the industry.

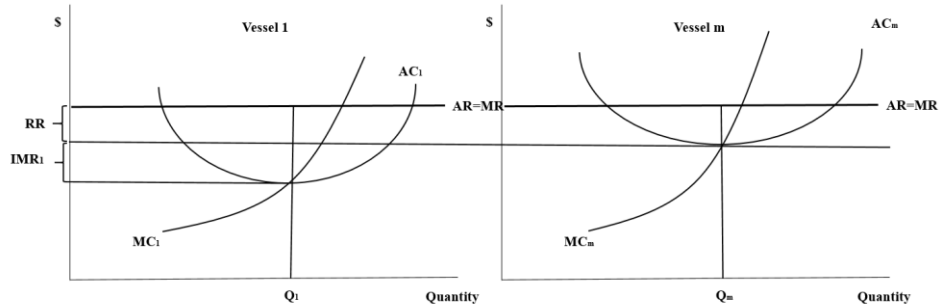

Figure 2. Heterogeneous fishing fleet in an ITQ regulated fishery.

Surprisingly little has been written about the RR which world fisheries are generating. The published literature is mostly focused on potential rent which unregulated or poorly regulated fisheries would possibly generate if their management systems were changed to catch share systems and the fish stocks were managed sustainably. An example of this is the well-known *Sunken Billion* report which the World Bank published. The report stated that global losses in RR amounted to 50 billion USD per year. According to the report, rent dissipation in the world's fisheries is mostly caused by overexploitation of fish stocks and overcapitalised fishing fleets (The World Bank, 2009). A recent study calculated the potential rent generation of the North Sea herring fisheries. The paper concluded that rent could be substantial if it was not dissipated because of suboptimal stock size and excess fishing effort. However, no RR is currently produced in those fisheries (Arnason et al., 2018). In Sweden, it was estimated that if individual vessel quotas were introduced in cod fisheries, the potential RR would be 25-30% of landed value (Eggert and Tveterås, 2007).

Among studies estimating actual RR production in North Atlantic fisheries is a paper by Andersen et al., (2010) where they estimated the actual RR generated in Danish fisheries. ITQs were introduced partially in 2003 and fully in 2007 into the country's fisheries. The findings were that the introduction of ITQ increased RR. However, Merayo et al., (2018) published contrasting findings. Their conclusions were that rents did not increase in the Danish demersal fisheries after the introduction of ITQ, stating that this was due to exogenous factors, which were mostly lower catches and fish prices. An extensive study where actual RR was estimated in Norwegian fisheries showed that the Norwegian fishing industry has not been producing any RR. The rent was negative in the 1980s and 1990s, but the situation has improved and now the rent is around zero (i.e., is not negative). Norway's fisheries management is segmented and complicated, often based on IVQs. The study concluded that Norwegian fisheries would be able to produce substantial resource rent if harvested efficiently (Greaker et al., 2017). An article analysed Northeast Atlantic pelagic fisheries conducted by vessels from the Faroe Islands, Norway, Denmark, the United Kingdom and Iceland. The findings were that the fisheries were profitable and significant RR was present (Nielsen et al., 2017). Those fisheries are mostly managed by ITQs or IVQs.

Only one published article has estimated RR in Iceland's fisheries before the two articles presented in this thesis. Flaaten et al., (2017) estimated RR in Iceland's fisheries from 2009 to 2013. Their findings were that the RR was substantial, around 330 to 470 million USD per year, or approximately 13-19% of the value of exported Icelandic seafood. The methodology included an assumed 6% fixed cost of capital to all assets except for capitalised fishing rights. The transfer of RR from fishing to processing was estimated. Moreover, the article estimated the fishers' share of the RR, which was substantial. However, the article did not consider the fishing fee when estimating the RR.

4.4 Resource rent taxes

The taxation of RR has been implemented in many industries that utilise natural resources. Generally, non-renewable resources are taxed more heavily than renewable resources. This is primarily because rent from utilisation of non-renewable resources is not perpetual. Therefore, it is considered important in countries that possess non-renewable resources to 'save for a rainy day' when those resources are depleted. Many do so (e.g., Alaska, Norway, Qatar, Kuwait and Saudi Arabia) and all of these examples possess considerable wealth funds which are the results of rent generated by petroleum resources (Johnson, 2007). In addition, the rent that non-renewable resources produce, (e.g., oil and gold) is often significantly higher than that generated by renewable resources, such as forests and fish. Finally, most renewable resources have been utilised for a longer time than non-renewable resources. Taxing those who have been using the resource for a longer time is more difficult than those who only recently began using a resource (Kern, 2007). All of these factors lead to the utilisation of non-renewable resources often being taxed more highly than renewable resources.

Methods of RR taxation vary in the oil industry. A common way of taxing this sector is a combination of royalty payments and taxes. The royalty payment can be in the form of a minimum payment but is often based on the value or volume of oil or gas exploited. The tax is normally in the form of a regular income tax, which all companies pay, plus a RR tax, which captures a considerable part of the profits. One of the problems with RR taxes on oil is that they are back-loaded i.e., they are late in the project as projects are often not profitable in the beginning. Therefore, most countries combine royalty payments with RR taxes (Sunley et al., 2003). In Norway, the petroleum tax system has three main elements: a corporate income tax, a special petroleum tax, and a royalty. The purpose of the special petroleum tax is for the state to acquire a large fraction of the RR (Lund, 2014). In Britain, the extraction of oil in the North Sea is mainly subject to normal corporate tax with an additional 20% supplementary charge on profits which, however, permit no deduction for financial costs (Nakhle, 2007). In the US, taxes on the oil industry are divided into taxes on production, property, and income. The production tax is levied on the value or volume of production of the resource as it is extracted from the ground. State and local governments also demand property taxes on the assessed market value of equipment above ground and/or reserves beneath the ground (Chakravorty et al., 2010).

In mining, the calculated RR is sometimes taxed in addition to royalty payments. Additionally, the companies utilising the resources are subject to normal corporate taxes (Boadway et al., 1987; Otto, 1998; Tilton, 2004; Yan-hua, 2006; Bell and Hindmoor, 2014). Australia has the purest form of RR taxes. There the mining industry (e.g., iron ore and coal) is subject to a special

mining RR tax of 30%, which taxes the economic profit of the resource; it is complex to calculate, and taxes the net present value of the profit of the resources. In addition, the mining industry pays a corporate tax rate of 29% (Hogan, 2012; Guj, 2012). Chile has low corporate taxes and no RR taxes on large copper mines. They pay a "sliding scale" royalty which is 0 to 5% of revenue (Daniel et al., 2010).

Industries that use renewable resources may be subject to royalties or RR taxes. In forestry, those utilising the resource are sometimes charged a royalty where the tax base is the volume or the weight of the trees logged (Morck et al., 1989; Amacher and Brazee, 1997; Paris and Ruzicka, 1993). Producers of hydroelectricity are often taxed specially. In Norway, the industry pays a special purpose hydropower tax, which taxes the RR of individual hydropower plants at the rate of 33% in addition to a normal corporate tax rate of 25% (Frestad, 2010). Swedish hydropower plants pay a significant property tax, which is 2.8% of the real estate value. In addition, the hydro industry in Sweden pays normal corporate taxes (Shmelev and Speck, 2018).

A Pigouvian tax is a tax that is levied on a market activity that generates negative externalities (Pigou, 2013). Examples are pollution and negative spill over impacts on human health. Therefore, Pigouvian taxes are often levied on fuel (Metcalf and Weisbach, 2009), sugar (Cremer et al., 2019), tobacco (Gruber and Koszegi, 2008), and alcohol (Parry et al., 2009). The purpose of the tax is to correct a sub-optimal outcome on the market. The tax seeks to correct for the deadweight losses caused by the externalities and also provide the government with a source of revenue to combat the additional cost burden on society. In addition, in market supply and demand analysis, the tax shifts the supply curve upwards, resulting in higher prices and lower output in the market equilibrium. Licence fee, or other fees, where fisheries are taxed, and the amount is based on the landed volume, can be considered a Pigouvian tax. Because the fee has the effect to reduce the landed volume and therefore reduce overexploitation.

There are some similarities that can be observed between RR taxes and Pigouvian taxes. This is because a RR tax levied on the extraction of a resource can be used to align the private and social cost of the extraction. However, many countries levy Pigouvian taxes on some industries, especially fuel taxes to reduce emissions, even though RR taxes are paid by these industries. The Icelandic fishing industry is a good example of this. It pays the fishing fee which is a RR tax. In addition, the industry pays a special carbon tax levied on fuel consumption, which is a classic example of a Pigouvian tax.

The common theme when resources are taxed is that RR taxes are never the only form of taxation. When they are applied, they are a combination of RR taxes, corporate taxes, taxes on revenue, taxes on the value of assets, Pigouvian taxes, and license fees. This is because pure RR taxes are highly volatile. When

economic conditions are favourable and prices are high, those taxes soar – but become non-existent when the industry faces a depression. Thus, these taxes are hugely pro-cyclical and amplify the effects of economic cycles when there are booms and busts in the utilised resource. Therefore, countries reliant on resources for wealth generation use other taxes as well as pure RR taxes (Land, 2008). This can be applied to the case of Iceland. The fishing industry is a significant contributor to the Icelandic economy. Until 2014, it was the largest export industry in the country. Hence, RR taxes in fisheries are pro-cyclical, and soar when the Icelandic economy is reaping the benefits of favourable conditions in the fishing industry.

4.5 Fees and resource rent taxes in fisheries

Few countries tax companies engaged in fisheries more than the normal corporate tax rate. Significant fees, or RR taxes, are uncommon in the world's fisheries. The fees imposed on the industry are normally small license fees that barely cover the administrative and research costs. The most notable exceptions are Iceland, Greenland, Morocco and the Falkland Islands, where the fee collected from the industry is significantly higher than the management cost of the resource. Several countries, most notably Chile and Australia, have announced their intention to introduce RR taxes to their fishing industries, which they have started to generate under ITQ management systems. Conversely, the US and New Zealand have announced their intention not to introduce RR taxes in fisheries (Arnason, 2013). There used to be some form of RR taxation in New Zealand. In the beginning, those taxes were based on the quota value, the expected net return of fishing, and other factors considered important by New Zealand authorities (Grafton, 1992). Those taxes were abandoned as part of a dispute settlement between the industry and government (Hannesson, 2005).

In Eastern Canada and Newfoundland, the fishing industry pays licensing fees for most species. Those fees are low, only covering a portion of administrative cost. In Namibia, there is a small quota fee for hake. In 1997, the fee for hake was around 175 USD per metric ton if caught by foreign freezer vessels. It was lower for Namibian vessels and a significant rebate of this small fee was available if the catch was processed on land. Those fees were then reduced and are now insignificant (Kirchner and Leiman, 2014). In the Faroe Islands, those catching pelagic species paid a significant fee of around 0.35-0.70 Danish krona per kilogram (Einarsson, 2014). In Alaska, the fishing industry pays considerable taxes and is subject to a Fisheries Business Tax. This tax is levied on companies which process or export fish from Alaska. In addition, the fishing industry in Alaska pays the so-called Fishery Resource Landing Tax, which is mainly collected from factory trawlers and floating processors utilising

the fishery resource outside the state's 3-mile limit (United Fishermen of Alaska, 2014).

Greenland has been charging fisheries fees since 1984. These are now significant and have many attributes of an RR tax. In Greenland, all catches, except coastal fisheries, are subject to a small administrative fee of 60 Danish krona (DKK) per metric ton for all species. In addition, there are significant special fees on catches of shrimp and Greenland halibut. The special fee for Greenlandic halibut changes every three months. The variables that influence the fee are the price of Greenlandic halibut and the price of oil. As may be expected, an increase in the price of halibut increases the fee and an increase in the price of oil decreases this special fee. For shrimps, the special fee depends on the price development of shrimps. Those fees reached approximately 130 million DKK for shrimp and 28 million DKK for Greenland halibut in 2014 (Einarsson, 2014).

Morocco has a fisheries partnership agreement with the European Union (EU). This agreement stipulates that the EU pays the Moroccan government 30 million euros annually, of which 16 million will compensate Morocco for access to the resource, and 14 million will go towards supporting and strengthening the Moroccan fisheries sector. The vessels that operate under this agreement pay an additional 10 million euros based on the weight of their catch. The species the agreement covers are mainly pelagic, where the annual catch is expected to reach around 80 thousand metric tons (European Comission, 2016). A fishing fee is a major contributor to the economy of the Falkland Islands. The total catch around the islands is approximately 200 thousand metric tons on average and most of it, around 75%, consists of squid. The squid is mainly caught by vessels from Asia, but also by trawlers registered in the Falklands that are owned jointly by the Falkland Islands government and European companies. All those catching the squid and other species pay a fee. This fishing fee, which the national government collects, has been on average around 20 million GBP a year, of which around 6 million is spent on management of the resource and research. The fee is, therefore, an important source of income for this small island community of only 3,400 inhabitants (Falkland Island government, 2014).

5 Methodological approach and data

This research applied financial analyses to examine financial performance and estimate RR. Various financial ratios were used to examine profitability, balance sheet structure, debt sustainability and financial strength. Methods based on financial ratios and portfolio theory were used to measure the cost of capital. These findings were applied to estimate RR and its distribution in Iceland's fisheries. The adopted methodology is thoroughly explained in each paper.

5.1 Data

The most important data, used in all the five articles, comes from Statistics Iceland. Every year this government agency publishes detailed reports online showing the financial situation of the fishing industry. These reports are detailed and include information on cost, revenue, and profit, as well as assets and liabilities, and the other main components of the balance sheet of the fishing industry. Good financial data exists only since 1997, with earlier data being less detailed. These reports are based on a very large sample (70-90%) of companies operating in Icelandic fisheries. The figures are official statistics and considered reliable. In addition, Statistics Iceland publishes yearly information about landings, prices, fleet size, export value, and other important data.

The data from Creditinfo is extensive because it contains the main components of both the profit and loss account and balance sheet of every company in Iceland involved in fisheries. The data showing the rate of incidents and accidents was obtained from the Icelandic Transportation Safety Board, a government agency that collects data about every reported incident in traffic, aviation and fisheries. Its data is comprehensive, as this institution must be notified of every reported accident. The Directorate of Fisheries supplied data used in the papers. An Icelandic government agency manages the daily administration of Iceland's fisheries and enforces the compliance of quota holders in accordance with the management system. The agency provides data on number of vessels, fishing fee, quota and other similar items of information used in this research. Various other institutions provided information used in the thesis. These include the Central Bank of Iceland, Iceland's Stock Exchange, Deloitte, an audit agency for most of the largest companies in Iceland's fisheries, and Íslandsbanki, one of the biggest banks in Iceland. Their respective contributions is explained in the articles. It is my assessment that the data used in this research is reliable, the results presented are accurate and the quality of the data is sufficient to perform the analyses and draw the conclusions presented in the papers.

5.2 Financial ratios and indicators

Several financial indicators and ratios were used in the articles. These show profitability and financial strength. These ratios are based on numbers from the profit and loss (P&L) accounts and balance sheets of the companies that operate in Iceland's fisheries. Table 3 gives an overview of the P&L account according to the principles of international financial reporting standards (IFRS), those being the accounting standards companies operating in Icelandic fisheries comply with when compiling their financial statements. In addition, table 4 illustrates the main components of the balance sheet, on which these ratios are based.

Table 3. An overview of the P&L account according to IFRS principles.

P&L account	Explanation
Revenue	Income from fishing and processing.
-Operating costs	Wages, fuel, raw materials, fishing fee, maintenance, administration.
=EBITDA	Earnings before interest, taxes, depreciation and amortisation.
-Depreciation	Depreciated based on the straight-line method.
=EBIT	Earnings before interest and taxes.
-Financial charges	Interest expenses and currency changes.
=EBT	Earnings before taxes.
Taxes	Corporate taxes levied on profits.
=Profit	

Sources: (IFRS, 2020).

Table 4. An overview of the balance sheet according to IFRS principles.

Balance sheet	Explanation
Assets:	
Non-current assets	Property, plant, vessels, equipment, capitalised fishing rights, intangible assets.
Current assets	Inventories, receivables, cash.
Liabilities:	
Non-current liabilities	Borrowings, deferred tax, provisions.
Current liabilities	Payables, current tax liabilities.
Equity:	Share capital, retained earnings.

Sources: (IFRS, 2020).

Equation (1) shows the earnings margin before interest, taxes, depreciation and amortisation (EBITDA). This ratio shows what is left after all operating costs (e.g., wages, fuel, fishing fee, maintenance, etc.) have been paid and is represented as a percentage of revenue. This ratio was used to estimate and compare financial performance. The profit margin is represented by equation (2). This shows earnings before taxes (EBT), which are total revenue less total expenses, except for corporate taxes levied on profits, as a ratio of revenue. This ratio was used to examine profitability and its development. The return on capital (ROC) ratio was used to assess financial performance and estimate RR. It is shown in equation (3). This simply represents earnings before interest and taxes (EBIT) as a ratio of assets. This ratio shows the return on all capital invested in an enterprise, both own and borrowed capital. It should be higher than the cost of borrowing and the opportunity cost of own capital, otherwise the companies are not making economic profit.

$$EBITDA\ margin = \frac{EBITDA}{Revenue} \quad (1)$$

$$Profit\ margin = \frac{EBT}{Revenue} \quad (2)$$

$$ROC = \frac{EBIT}{Assets} \quad (3)$$

The equity ratio is the most important ratio for showing financial strength. It is represented by equation (4) as equity divided by assets. It is generally assumed that in normal production industries (like fisheries) this ratio has to be above 30% in order for the financial situation to be considered sound (Tinoco and Wilson, 2013). The debt sustainability ratio (equation (6)) was used to examine financial strength. Net debt was calculated by using equation (5) when estimating the debt sustainability ratio. The debt sustainability ratio shows roughly how many years it would take a company to pay all its debts if the cash flow produced was only used for that purpose and the company neither invested nor paid taxes or interest. A common rule of thumb used in credit analysis in Icelandic banks is that this ratio should be below 4.0 if the financial situation is to be classified as good or satisfactory. If this ratio is higher than 10.0 then the debt burden is probably unsustainable. However, the appropriate level of this ratio varies from one industry to another. Companies with little reinvestment needs and low cost of capital can tolerate higher debt levels, for example power plants and similar industries (Asquith et al., 2005). This is not the case in Icelandic fisheries and the levels already mentioned (i.e., below 4.0 being good and above 10.0 unsustainable) are therefore appropriate.

$$Equity\ ratio = \frac{Equity}{Assets} \quad (4)$$

$$Net\ \ debt = \text{Liabilities} - \text{Current assets} \quad (5)$$

$$Debt\ sustainability\ ratio = \frac{Net\ debt}{EBITDA} \quad (6)$$

5.3 Rent estimation and distribution

There are many problems when estimating RR in fisheries. The most important point is that in fisheries there may be more than one source of rent, for example, IMR in addition to RR. Distinguishing between these different types of rent may prove challenging (Copes, 1972; Coglan and Pascoe, 1999). Another issue relates to the calculations of input costs, especially the opportunity costs of labour and capital. Financial statements will normally show correct costs for most intermediate inputs, but this may not hold for labour and capital. In addition, deprecation in financial statements may under- or overestimate necessary investment to maintain the operations of the company (Wessel, 1967; Flaaten et al., 1995; Flaaten et al., 2017). Therefore, adjustments of the information shown in the financial statements might be necessary when estimating RR. These issues were considered when estimating RR produced in Iceland's fisheries. Table 5 gives an overview of the P&L account and the main issues which arise when calculating RR.

Table 5. The P&L account and issues in RR calculation.

P&L account	Explanation	Issues in RR calculation
Revenue	Income from fishing and processing.	All income from fishing and processing. Income from leasing fishing rights should be excluded.
-Operating costs	Wages, fuel, raw materials, fishing fee, maintenance, administration.	The costs of leasing fishing rights should be excluded. The fishing fee should be excluded. If fishers' wages are above their opportunity cost, their wages should be adjusted.
=EBITDA	Earnings before interest, taxes, depreciation and amortisation.	
-Depreciation	Depreciated based on the straight-line method.	Depreciation should represent the replacement cost of assets. Depreciation of fishing rights should be excluded.
=EBIT	Earnings before interest and taxes.	
-Financial charges	Interest expenses and currency changes.	Financial cost should be estimated for both debt and equity. The financial cost of capitalised fishing rights should be omitted.
Taxes	Corporate taxes levied on profits.	Corporate taxes should be excluded.
=Profit		

Sources: (Flaaten et al., 2017; IFRS, 2020).

Profit and RR are concepts which are related. Profit or profitability is a basic indicator that measures the financial performance of firms. Profit is simply the financial benefit realized when revenue generated from a company's operations exceed its costs. If costs exceed revenue then profits are negative and a firm is operating at a loss. Profit is estimated according to the P&L account, and in Icelandic fisheries the P&L account is constructed in accordance with the IFRS principles. RR is an evaluation of the impact of a resource on economic welfare. Profits do not equal RR, even though there is a significant relationship between RR and profits. In their paper, Flaaten et al., (2017) analysed RR and profits in Icelandic and Norwegian fisheries from 2009 to 2013. Their findings

were that profits were lower than estimated RR in both countries during this period.

In this thesis, the financial statements of the fishing industry were used to estimate the RR. In all the methods applied the fisheries' share of the RR was not estimated in the RR calculations, as it was presumed that their wages were in accordance with their opportunity cost. In addition, it was assumed that reported depreciation sufficiently represented the replacement cost of assets. The main adjustments made in the RR calculations, from the information presented in the P&L accounts, were regarding the fishing fee and the cost of capital.

Three methods were employed to estimate the RR in Iceland's fisheries. These methods are similar in principle. The common module when calculating the RR according to two of the methods is presented in equation (7). In this equation, RR was estimated in year t. It was calculated as reported $EBIT_t$ in both fishing and processing plus the fishing fee (FF_t) minus c times the difference between the book value of all assets (A_t) except for the book value of capitalised fishing rights (V_t). The coefficient c represents the cost of all capital invested, both borrowed and own.

$$RR_t = EBIT_t + FF_t - c(A_t - V_t) \qquad (7)$$

$$ROC_{F,t} = \frac{EBIT_t + FF_t}{A_t - V_t} \qquad (8)$$

$$RR_t = (ROC_{F,t} - ROC_{A,t})(A_t - V_t) \qquad (9)$$

The three methods used to measure RR differ in the estimation of the cost of capital. Two methods accord with equation (7). One method applied in this thesis calculated the cost of capital (i.e., c in equation (7)) as the estimated weighted average cost of capital ($WACC_t$) in Icelandic fisheries, which varied considerably between periods. Another method valued the RR by setting the cost of capital (i.e., c in equation (7)) as fixed at 4.6%, since this rate has been the average long-term ROC in Icelandic industries. The RR was then calculated by equation (7). Finally, the RR was estimated by the difference in ROC between fisheries ($ROC_{F,t}$) which was calculated by applying equation (8) and the ROC of other industries in the Icelandic economy ($ROC_{A,t}$) and assumed that RR caused the excessive ROC in fisheries. Equation (9) was then applied to calculate the RR according to this methodology. This methodology gave more stable (less fluctuation in financial cost) results than estimating $WACC_t$. Detailed descriptions of the methodologies applied to calculate the RR are presented in the materials and methods sections in papers III and IV.

The most difficult issue when estimating RR in fisheries is to dismantle IMR from RR accurately. By estimating the WACC in fisheries, the cost of capital for both borrowed and owned capital is calculated. IMR should be included in the cost because it is part of the necessary return on the owners' equity. Therefore, IMR is probably dismantled sufficiently from the RR when WACC calculations are applied. When calculating the RR as the difference in the ROC in fisheries compared to other companies in Iceland's economy, RR should be properly estimated and dismantled from the IMR. This is because there is unlikely to be a significant difference in IMR between fisheries and other parts of the Icelandic economy. Hence, estimating the RR as the difference in ROC should eliminate the IMR in the calculations.

The market value of the quota (permanent quota shares) traded in Iceland's ITQ fisheries should give an estimation of the RR in the industry. That is because the market value of the quota should be the industry's consensus of the present value of future RR (Newell et al., 2005). Therefore, the price of permanent quota shares gives some information about the RR in the fishing industry (Grafton, 1996b). Evidence of this is found in research on the New Zealand ITQ system, which concluded that the increase in the price of quota shares over the history of New Zealand's ITQ program was consistent with the increase in the profitability of the fisheries examined (Newell et al., 2005). New Zealand used the value of permanent quota share as a basis for RR taxation (Harte, 2007). However, a study of quota prices in Norway found that the price of permanent quota was higher than was explained by the profit of the industry. The study concluded that quota prices exceeded what was expected by the RR generated via utilization of the Norwegian fishing resource (Hannesson, 2017a). This method (i.e., to use the market value of permanent quota shares as an indicator of RR) has never been used when setting the fishing fee in Iceland's fisheries.

In this thesis, the relationship between RR and the price of permanent quota shares was not examined. The reason for that is primarily because it is difficult to obtain information showing the price in permanent quota share trading. These prices were never stored in a centralised database. In addition, the Icelandic quota market is not efficient, mainly because there are too few market participants (especially on the pelagic market) and there are two different classes of permanent quota shares in the demersal fisheries; one for smaller boats and another for other vessels. Additionally, the trading was very sporadic, especially in trading quota shares of the most important pelagic species. Therefore, this thesis does not use the market price of quota to estimate the RR produced in Iceland's fisheries.

The lease price of permeant quota share does give an indication of the RR produced in fisheries. The lease price should be an indication of the expected rent in the year in which the permanent quota share is leased. That is because

the quota holders would lease out their quota share if the money they received was higher than the RR they would collect if the quota holders used their quota and caught the fish themselves instead of leasing the fishing rights (Newell et al., 2005; Matthiasson, 2008). However, the lease price may be too high as it may not include fixed costs (Hannesson, 2017a). In their paper, Asche et al., (2008) found out that the lease price of quota did not reflect the profitability of Icelandic fisheries. The paper studied this from 1997 to 1999. The lease price was between 73% and 84% of the ex-vessel catch price. This is much higher than is possible to explain by the financial performance of the industry at that time.

The distribution of RR was calculated in Paper IV. The main assumption in the calculation was that three stakeholders have received the rent. The government receives its share of the rent through the fishing fee and excess corporate taxes. The amount of the fishing fee is public information. However, estimating the excess corporate taxes caused by RR is difficult. The path taken was to use the historical average corporate tax payments of the fishing industry and assume that higher payments than the historical average from 2011 to 2017 were caused by the RR, and hence excess corporate tax payments. Quota sellers, that is, those who originally acquired the fishing rights, but have sold their permanent quota share, are a specific group of stakeholders who received a significant share of the rent. The method chosen to estimate their share of the rent was to assume that the capitalised fishing rights in Iceland's fisheries were a sound estimate of the cumulative sum the quota sellers have received when selling their fishing rights. The opportunity cost of those fishing rights was then estimated as their share of the RR. Finally, companies that operate in the industry have received their share of the rent. Those companies are last in line of the three stakeholders. Their share was what was left after all costs; that is, those holding all assets, paying the fishing fee, and excess corporate taxes caused by RR. For a detailed description of the methodology of assessing the distribution of the RR to the three stakeholders, see the material and methods section in Paper IV.

6 Summary and main findings

6.1 Paper I

The first paper was titled: “The Icelandic fishing industry: Its development and financial performance under a uniform individual quota system." It was published in the journal *Marine Policy* in May 2016.[1] Here, the development of landings, fish prices, fleet size and number of jobs in the industry is charted since 1991. The main theme of the paper is the development of financials in the fishing industry. The main findings are that landings have been declining in the fishing industry for the past three decades. The industry has adapted to these reductions by closing factories and scrapping boats. The ITQ system has made these adaptations easier. The profitability of the fishing industry has increased markedly in recent years, although more so in the processing component of the industry than the fishing section. The fishing industry in Iceland piled on debt from 2004-2008. Since 2008, debts have been decreasing.

Several important findings are presented in the article, for example, that economic strength was greatest among the smallest and largest firms, and that many middle-sized firms had unsustainable debt levels. The paper concludes that the ITQ system has made it easier for the fishing industry to adapt to negative developments. The system leads to adaptability and has facilitated specialised production; hence, it has made access to specialised markets easier. The increased profitability resulting from the ITQ system has made it possible to impose a special RR tax (i.e., the fishing fee). The fee is a significant expense for the fishing component of the industry. However, the ITQ system has escalated indebtedness as companies operating in the industry have bought expensive fishing rights, hence increasing their debt level. This trend is clearly influenced by the availability of cheap credit, mostly between 2004 and 2007, when inexpensive credit flooded the Icelandic economy.

[1] The role of the doctoral student (Stefán B. Gunnlaugsson) was to carry out all research actives relating to financial development and financial strength and writing most of the paper. Hörður Sævaldsson participated in the writing of the paper, especially in the catch and employment sections.

6.2 Paper II

The second paper titled: "Fishing for a fee: Resource rent taxation in Iceland's fisheries" was published in *Ocean & Coastal Management* in September 2018.[2] It charts the progression of the Icelandic fishing fee and the previous fees it replaced. The fishing fee was introduced in 2004. It was low in the beginning but was increased considerably in 2012 when it became a major expense item for the fishing component of the Icelandic fishing industry. There were two reasons for setting the fee. The first was to cover the cost associated with the management and supervision of the fishing resource. The second and main reason for introducing the fee was to give the Icelandic public a visible share of the RR produced in Icelandic fisheries.

Five problems had to be tackled when setting the fee. The first was levying the correct fee for various species. Initially, the fee was set as a fixed amount on each cod equivalent kilo. However, as this measure was not a reliable indicator of profitability, when fishing various species, a better method was used (i.e., the calculated profit coefficient of each species). The second problem was that profitability varied significantly between individual companies. The chosen solution was to shield smaller firms from the fee and to give indebted companies a rebate, which lowered the fishing fee those companies paid. The third problem was that increasingly the profitability of the Icelandic fishing industry is sourced from its processing rather than fishing component. Most of the largest companies are vertically integrated which means that they operate in fishing, processing and sell their own products. The tendency in these firms is to lower prices in intra-trading because fishers' wages are linked to the catch value. The chosen solution, when setting the fishing fee, was to look at profit in both fishing and processing when setting the fishing fee. The fourth problem was the unsustainable debt burden of the fishing industry. It was almost untenable from 2008 to 2011, but the economic situation of the fishing industry has improved since then. The difficult financial situation and heavy debt burden was the main reason for the setting of a low fishing fee until 2012. When conditions improved, the fee was increased. As a relief aimed at the most severely indebted companies, a special rebate of the fee was set for that particular purpose. Finally, the fifth problem has been difficulty in getting timely and reliable data. The paper concludes that it is a complex task in practice to set a fee, which serves the function of an RR tax in fisheries. Other countries that might follow Iceland's path and administer RR taxation on the fishing industry will probably encounter the same problems.

[2] The role of the doctoral student (Stefán B. Gunnlaugsson) in this paper was to carry out all of the research activities and writing the paper. Professors Sveinn Agnarsson and Daði Már Kristófersson guided the doctoral student during the research activities and writing process.

6.3 Paper III

The third paper, titled: "Late arrival: The development of resource rent in Icelandic fisheries" was published in the journal *Fisheries Research* in February 2019.[3] Here, the resource rent produced in Iceland's fisheries is calculated by using two innovative methods, neither of which has been applied before in the academic literature to measure RR. The first method is based upon estimating the WACC (weighted average cost of capital) in Iceland's fisheries and then calculating the RR. The second method compares the ROC in fisheries to that of other industries in Iceland, assuming that higher ROC in fisheries was a robust estimate of the resource rent produced in the industry. The findings are that no rent was produced in Iceland's fisheries until 2008. Since that year, however, it has been significant, around 16-19% of the export value of the fishing industry. The fishing fee has captured around 13-15% of the estimated rent since 2009, and therefore it has been modest.

It took the Icelandic fishing industry a long time to produce the rent, or almost two decades, as the ITQ system was fully implemented in 1990 but RR was not produced consistently until 2008. The reason for this long delay was an almost continuous decline in fish catches during those years. It was not until catches began to increase in 2009 that rent became apparent and consistent. The exchange rate of the Icelandic krona was also important. It weakened in 2008, consequently the financial performance of the industry improved, and rent was produced. The paper concludes that ITQ systems generate excess returns in fisheries. However, it may take time for RR to appear. Therefore, long-term thinking and patience is needed in fisheries management.

6.4 Paper IV

The fourth paper was titled: "Resource rent and its distribution in Iceland's fisheries." It was published in the economic journal *Marine Resource Economics* in April 2020.[4] This article calculates the RR produced in Iceland's fisheries from 1997 to 2017 and divides it between three stakeholders. The rent was estimated by setting the cost of capital at 4.6%, as this was the average return on capital in all Iceland's industries. In addition, a sensitivity analysis was performed where the cost of capital was set in the range 4.0-6.0%. The

[3] The role of the doctoral student (Stefán B. Gunnlaugsson) in this paper was to carry out all of the research activities and writing the paper. Professor Sveinn Agnarsson guided the doctoral student during the research activities and writing process.

[4] The role of the doctoral student (Stefán B. Gunnlaugsson) in this paper was to carry out all of the research activities and writing the paper. Professors Sveinn Agnarsson and Daði Már Kristófersson guided the doctoral student during the research activities and writing process. Hörður Sævaldsson participated in the writing of the paper, especially in the Icelandic fisheries section.

main contribution of this paper to the literature was the knowledge gained about the distribution of rent between three stakeholders. The government acquired its share of the rent through the fishing fee and excess corporate taxes. Those who originally received their quota by grandfathering, but have since sold their fishing rights (i.e., the quota-sellers), receive part of the rent. Finally, those companies that operate in the industry acquire their share of the rent after the two other stakeholders have obtained theirs.

The results indicate that significant rent has been present in Iceland's fisheries for the last decade. The findings are that from 1997 to 2017, the government has received around 20% of the RR. The remainder was evenly split between the other two stakeholders. Hence, the quota-sellers received 40% and the companies operating in the industry the same share. The article concludes that RR produced in fisheries should be taxed. Iceland has chosen to tax only companies operating in the industry but not those who sold their fishing rights. Here, Iceland has seemingly made a mistake. Applying a special tax on quota-sellers should always be considered and implemented when ITQ systems are introduced in fisheries since this would probably lead to higher government revenue, and more political acceptance of the ITQ system.

6.5 Paper V

The final and fifth paper was titled: "Derby versus ITQ: Iceland's coastal fisheries explained and compared to its ITQ-managed fisheries." It was submitted to a peer-reviewed journal in September 2020.[5] In the paper, Iceland's coastal fisheries (strandveiðar) are described and studied. In addition, their management principles are explained since the inception of the fisheries in 2009. These fisheries are classic open access derby fisheries where fishers race to fish. Because almost all other fisheries in Iceland are managed by a uniform ITQ system, the coastal fisheries provide a unique opportunity to examine and compare derby fisheries to ITQ managed fisheries. The paper compares the economic performance and rate of accidents in the coastal fisheries to those of other Icelandic fisheries. Fisheries economics theory predicts that the coastal fisheries should not be profitable because of their open access nature. If the coastal fisheries were profitable, new vessels would enter the fisheries until no profit was present. The findings are in accordance with that theory. The coastal fisheries have been making small losses while other fisheries in Iceland have on average been profitable.

[5] The role of the doctoral student (Stefán B. Gunnlaugsson) in this paper was to carry out all of the research activities and writing the paper. Professors Sveinn Agnarsson, Daði Már Kristófersson and Gakushi Ishimura guided the doctoral student during the research activities and writing process. Hörður Sævaldsson participated in the writing of the paper, mostly in the coastal fisheries section.

The theory also predicted that accidents would be more common in the coastal fisheries than other Icelandic fisheries. However, the results are not what was anticipated. Accidents where a fisher was injured were relatively uncommon in the coastal fisheries and the rate of accidents was significantly lower than would be predicted by the scale of coastal fisheries compared to other Icelandic fisheries. However, minor incidents, mostly caused by mechanical failure, were very frequent in the coastal fisheries; indeed, much more frequent than in other Icelandic fisheries. The article concludes that coastal fisheries are economically wasteful, because it would be much cheaper to fish the cod (around 88% of the fish caught by the coastal vessels is cod) caught by the coastal boats by other vessels which operate within the ITQ system.

6.6 Profit and rent

One of the findings of this research, which is not presented in any of the five papers, is the relationship between reported profit (EBT) of the Icelandic fishing industry according to IFRS standards and the estimated RR in Iceland's fisheries. This thesis estimated the RR in Icelandic fisheries using three methods. In Paper III, the RR was calculated from 1989 to 2016 based upon estimating the WACC in Icelandic fisheries. The second method, applied in Paper III, was to compare the ROC in fisheries to that of other industries in Iceland, assuming that higher ROC in fisheries was a good estimation of RR. This method was applied from 2002 to 2016. Finally, in Paper IV the RR was calculated by setting the cost of capital at 4.6%, because it was the average ROC in all Icelandic industries.

The results indicate that there was little difference in reported profit (EBT) in Icelandic fisheries and estimated RR. Evidence of this is that EBT (both fishing and processing calculated jointly), as ratio of export value of Icelandic fisheries, was 6.6% on average from 2002 to 2016. During the same period, the RR was on average 5.7% of export value by using WACC to estimate the financial cost, and 11.5% on average by comparing ROC in fisheries to the ROC of other industries. The RR was estimated to be 11.4% of the export value when a fixed cost of capital of 4.6% was used to calculate the RR during this period. The estimated RR and EBT were similar most years. A statistical analysis, using both nonparametric and parametric methods, found no statistically significant difference between RR and EBT for all of the three methods applied that estimated the RR. However, there was a notable exception in 2008. That year, the total EBT of the Icelandic fishing industry was -91.3% of its export value! The same year the RR was estimated, it was -1.2%, 14.1% and 16.3% of the export value by the three methods applied in this thesis. The huge difference between reported profit and estimated RR that year was because of the fall in the value of the Icelandic krona in 2008, which lost half of its

value. The results were huge currency losses on loans taken out by the fishing industry (an explanation of this is presented in Paper I). The results were reported losses in the P&L account of the industry. Because the RR calculations estimate the financial cost, no such losses affected the RR calculations. Hence, some RR was produced in 2008, by two of the three methods applied here, even though huge losses were reported in the financial statements of the industry.

7 Discussion

Iceland launched an ITQ system in some pelagic fisheries in 1979. IVQs were introduced in demersal fisheries in 1984 and in 1990 the uniform ITQ system was launched, covering almost all the country's fisheries. Due to those management initiatives, the profitability of the Icelandic fishing industry has increased considerably. The findings presented here are that since 2008, the Icelandic fishing industry has been highly profitable and producing significant RR. The Icelandic ITQ system has clearly improved economic efficiency. It has made it easier for the fishing industry to adapt to negative eventualities, especially lower catches. In addition, it has facilitated specialisation and thus widened access to specialised markets. The visible profitably of the Icelandic fishing industry has led to special RR taxation, (i.e., the fishing fee). The fee was introduced in 2004 and increased significantly in 2012. Establishing RR taxation in fisheries is a difficult process, at least this has been the Icelandic experience. Problems will appear when setting this kind of fee and these difficulties must be solved gradually. The solution chosen in Iceland was to let the largest and financially strongest firms pay the bulk of the fee, with shielding provided to smaller and financially weaker firms.

Significant user fees, or RR taxes, are uncommon in the world's fisheries. The fees imposed on the industry are normally small license fees that barely cover the administrative and research costs. Hannesson, (2005) stated that this is because special fees have mainly been set in fisheries where foreign vessels take a significant portion of the catch (e.g., in the Falkland Islands and Morocco). In these situations, nobody has any qualms about taxing foreign companies heavily. Where foreigners are not present, the fishing industry has generally been able to fight any proposal for a substantial fishing or user fee. The government is concerned that the industry would abandon its support for a quota system if it were to pay significant RR taxes. Moreover, the support of the industry is considered vital for ITQ systems to be successful. In addition, those who later buy entry into the fishing industry would have the viability of their business undermined when faced with high RR taxes, which they did not anticipate when buying a fishing license or quotas and entering the fishing industry. Other reasons for the opposition to user fees or RR taxes in fisheries concern the well-being of rural communities. In countries where fishing is an important industry, it is normally a crucial part of employment in rural communities. Those communities are often afflicted with outward migration and depopulation. Fees and other taxes on the fishing industry might hit those struggling communities the hardest, and consequently governments are reluctant to introduce special taxes on fisheries. In addition, most fisheries do not

generate any RR at all, or, if it is present, it is very low. Thus, there is a natural reluctance to levy taxes on rent which scarcely exists. Finally, the difficulty in calculating RR discourages most governments from implementing those taxes in fisheries. The RR varies between species, vessels, and companies. Those obstacles make calculating the tax extremely difficult and complicated to implement and enforce. So most government only enforce fees, which are simple to calculate and enforce but only cover some of the costs of research and management (Squires et al., 1998).

All these arguments and problems have been addressed when introducing and then increasing the Icelandic fishing fee. The only exception is that the argument was never proposed that the Icelandic fishing industry would abandon its support for the quota system if paying high user fees. The support of the ITQ system is so strong among the owners of the fishing rights that it is almost unthinkable that those currently holding the fishing quotas would suggest another system to manage the fishing resource.

As ITQ systems mature, more and more of the initial quota allocation is traded. Hannesson, (2017b) predicted that if quota trading remained unrestricted then the return on capital in the fishing industry would be comparable to that of other industries with similar risk. Therefore, the industry would accumulate debt and assets. The assets would then be capitalised fishing rights. The result would be a similar return on capital as in other industries because the capital base would be bloated. This was Copes, (1986) main argument when criticising the ITQ system. His critique was based on the so-called “transitional gains trap”, first defined by Tullock, (1975), and according to which all programmes, when initiated, yield transitional gains benefiting individuals or companies in the industry where those programs are launched. As time passes, the gains become fully capitalised in the industry and consequently that particular industry is not performing any better than other parts of the economy. If this happens in ITQ managed fisheries all, or most of, the RR generated would accumulate to those who originally acquired the fishing rights but have since sold their quotas.

The literature lacks studies of the actual distribution of RR in ITQ managed fisheries. Flaaten et al., (2017) predicted that the rent would go to six stakeholders: some would go to harvesters in the industry; processors might get part of the RR through transfer pricing of raw material; fishers might get a portion of the rent if their wages were above the opportunity cost; financial institutions might get a share of the rent if surpluses were deposited with them; the government might get some of the rent through special rent taxes and corporate taxes; finally, those who were originally allocated the fishing rights and sold their quota would receive some, or even most, of the rent. This study estimated the distribution of the rent from 1997 to 2017. The rent was divided between three stakeholders: the companies operating in the industry (harvesters

and processers were calculated jointly); the government, which received a share of the rent through the fishing fee and excess corporate taxes; and those who were originally granted the fishing rights, but have since traded them away. The results indicate that the distribution of the rent has been rather even. Thus, the so-called transitional gains trap has not fully materialised in Iceland's fisheries, as those who were granted the fishing rights in the beginning and have traded their quotas have not taken all the RR that has been produced.

Iceland provides an excellent opportunity to examine open access derby fisheries and compare them to fisheries managed according to ITQ principles. This is because derby style fisheries were adopted in Iceland's fisheries in 2009. These are the coastal fisheries (strandveiðar). However, almost all other fisheries in Iceland are managed by the uniform ITQ system. The fact that these management systems coexist provides a unique opportunity to compare their outcomes. Economic performance and rate of accidents were compared between open access derby fisheries and ITQ fisheries in Iceland. The findings in this study are mostly in accordance with what was predicted. The Icelandic coastal fisheries have been unprofitable on average almost every year since their inception. Meanwhile other fisheries in Iceland, managed by the uniform ITQ system, have been profitable. This is precisely as was expected due to the open access nature of the coastal fisheries.

The race to fish nature of derby fisheries increases the risk of on-board accidents because even though the weather is bad, the fishers might go fishing. They might lose the race to fish by staying at home when their competitors (other fishers) go fishing. Fisheries managed by catch share are very different, since fishers can choose the best time to fish. Not surprisingly, high wind speed is one of the strongest contributors to accidents in fisheries (Jin et al., 2002; Jin and Thunberg, 2005; Laursen et al., 2008). Thus, a higher rate of accidents is expected in derby fishery than fisheries managed by an ITQ system (Lincoln et al., 2007). The best evidence of this was an extensive study on various fisheries on the US west coast. The findings were that the probability of fishers going fishing in windy weather declined considerably when catch shares were introduced in all the fisheries examined (Pfeiffer and Gratz, 2016). However, the literature lacks a comparison of the rate of accidents in derby fisheries to those found in fisheries managed by an ITQ system or another form of catch share management. This was examined in the Icelandic coastal fisheries. The surprising findings in the study are that the coastal fisheries have a lower frequency of accidents than other fisheries in Iceland. There are five possible reasons for these findings. Firstly, the coastal fisheries are only conducted in the summer, the season of best weather. Secondly, the fishing method used in the coastal fisheries is relatively safe. Thirdly, coastal fishers are less likely to report minor accidents than other Icelandic fishers. Fourthly, the race to fish might not be as fierce as expected in the coastal fisheries, as those fisheries only

represent a supplemental income for the fishers. Finally, extensive surveillance and mandatory crew safety training might reduce the numbers of accidents in Iceland's coastal fisheries.

8 Conclusions and policy implications

After almost 30 years with fisheries managed by the uniform ITQ system, other countries have a lot to learn from the Icelandic experience. The ITQ system in Iceland has provided the fishing industry with flexibility. It has been able to adapt to negative circumstances, mostly lower catches, by reducing the number of vessels and factories. The ITQ system has led to specialisation and facilitated the industry's access to premium consumer markets. However, the system has had negative aspects. Most noticeably, employment in Icelandic fisheries has been reduced by 50% since the introduction of the ITQ system. The nature of the management system is to maximise the utilisation of labour and capital, so this impact was expected. However, the decline in catches is also a major contributor to less employment in Iceland's fisheries. The lessons from Iceland are that a well-managed ITQ system will ultimately lead to higher profit in fisheries than in other sectors of the economy. However, it took the Icelandic fishing industry almost two decades to become more profitable than other industries in Iceland. The reason for that long delay was reduced catches. If catches are stable or increasing, it is likely that ITQ systems will lead to high profits and RR creation sooner than happened in Iceland's fisheries.

ITQs lead to bigger balance sheets. The Icelandic fishing industry accumulated debts from 2003 to 2007 when Iceland experienced an almost unprecedented financial bubble. These investments were mainly in the form of capitalised fishing rights, which were financed by borrowing. The result was that from 2008 to 2011 the financial situation of a significant portion of the fishing industry was unsustainable. However, during the past decade, the Icelandic fishing industry has been paying down debts, the situation has improved, and nowadays the industry's financial situation is generally sound.

This thesis shows that from 2008, the Icelandic fishing industry has been producing significant RR. Iceland chose to tax the RR creation of the fishing industry, albeit modestly. Iceland was late in introducing this taxation, which was in the form of the fishing fee. It was introduced in 2004 and was low in the beginning, not becoming substantial until 2012. The fee was low because politicians were reluctant to burden the industry with excessive taxation, mostly because the financial situation of the industry was too weak at that time. In addition, this form of taxation might affect struggling rural communities. Implementing RR taxation in fisheries is fraught with difficulties as the Icelandic experience demonstrates. Icelandic politicians chose to tax the largest and financially strongest firms more than others when setting the fishing fee. The experience in Iceland shows that RR taxes should be implemented when ITQ systems are introduced in fisheries. These fees should at least cover the

administrative cost of managing the fishing resource. The Icelandic ITQ system has always been controversial. The fishing fee has at least partially reduced opposition to the ITQ system, because the fee shows the public that the excess profitability of the industry can benefit the public and increase government revenue. The political debate surrounding Iceland's fisheries management now frequently involves the fishing fee and ways to raise or lower it, instead of criticising the ITQ system and thinking of ways to abolish it, which often used to be the case in Iceland's politics.

Iceland chose to impose a particular tax on firms operating in the fishing industry. However, no special taxes were levied on those who were originally granted the fishing rights and sold their quotas, thus reaping enormous benefits. In my opinion, this was a mistake. When ITQ systems are implemented, those who are allocated the fishing rights originally should be subject to special taxes when they sell their fishing rights because they gain a significant proportion of the RR rent. The thesis estimates that in Iceland, this share has been around 40%, and theory suggests that it might be even higher in other fisheries. In addition, specially taxing those who were awarded the fishing rights and later sell them might reduce political opposition to ITQ fisheries management and the public anger often aroused by the system. One of the main criticisms of the Icelandic ITQ system is that the wealth accrued to those who were granted the fishing rights. Taxing them when they sell their fishing rights should result in the perception of more "fairness" and less political opposition to the system, as well as increasing government revenue.

The coastal fisheries introduced in 2009 were a major policy change in Icelandic fisheries management, because these fisheries are open access derby fisheries where fishers race to fish. There were mostly two reasons for starting the coastal fisheries. Firstly, the aim was to facilitate entry of newcomers and, secondly, to support rural development in struggling fishing communities. Both of these aspects have been focused upon as the main criticisms of the ITQ system in Iceland's politics. As expected, the coastal fisheries are not profitable because of the open access nature of the fisheries. However, unexpectedly, the rate of accidents has been lower in Icelandic coastal fisheries than in other ITQ managed fisheries. The lessons from Iceland's coastal fisheries are that open access derby fisheries can coexist with ITQ managed fisheries. However, open access fisheries will always be economically wasteful as the coastal fisheries demonstrate. The coastal fisheries have solid public backing and abolishing them is politically unfeasible. Perhaps, the coastal fisheries are among the costs (in addition to the fishing fee) that the holders of Iceland's fishing rights under the ITQ regime must pay for their access to the fishing resource.

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PART II: PAPERS I-V

Paper I

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The Icelandic fishing industry: Its development and financial performance under a uniform individual quota system

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ABSTRACT

The Icelandic fishing industry has had to deal with reduced total catch for the past three decades. It has adapted well to the reduction and the Icelandic ITQ system has made this easier. The industry has adapted by reducing employment, closing factories and scrapping boats. Specialization has as well increased and the focus is more toward high-value markets. The profitability of the Icelandic fishing industry has markedly increased. This is especially true for the processing aspect of the industry where profits have soared. One of the main reasons for this increase is the ITQ management system. The rise in profitability of the fishing component, however, is considerably less than that of the processing part. This is the result of higher oil prices and the introduction of the fishing fee, and its subsequent increase, which is now a considerable expense for the fishing component of the Icelandic fishing industry. The debt levels of the industry reached a peak in 2008 after a massive escalation which began in 2004 and was mainly caused by the Icelandic financial bubble, 2004-2008, although the ITQ system also played a role here. Since 2008 the financial health of the industry has improved enormously. Currently, the financial situation of the Icelandic fishing industry is, on the average, sound; this particularly applies to the largest and smallest firms.

1. Introduction

The Icelandic fishing industry has been a paramount part of the Icelandic economy for centuries. It was one of the main employers and the largest export earner of the country until 2015 when tourism surpassed the fishing industry [1]. Thus, the development and management of this important industry have always been of utmost importance to the nation. Fishing around the island used to be open to all vessels until the 1950s, when Iceland extended its Exclusive Economic Zone (EEZ) in four stages; in 1976, this had reached 200 miles after which the commercially important stocks were completely under Icelandic jurisdiction. After 1976, the management of the fishing resource went through a few steps from fishing effort based management systems to a fisheries management based on individual transferable quotas (ITQs). In 1990, a uniform system of ITQs covering almost all fisheries in Iceland was established. It combined fundamental laws and regulations regarding fisheries into a comprehensive Fisheries Management Act (No. 38/1990), which entered into force in 1991 [2–4].

Since 1991, the Icelandic fishing industry has gone through many changes which were caused by developments in markets, technology and biology, as well as by the ITQ system [2,5,6]. The most notable aspect is that companies have become larger and more of them cover all stages of the value chain. They are involved in fishing, processing and marketing and are vertically integrated, thus maximizing value creation and profitability [2,5]. Fish auctions, which emerged in the 1980s after the de-regulation of primary fish markets, have had a profound effect on the Icelandic fishing industry. Even though a relatively small portion of catches is sold through them (about 20–30% of demersal species, but significantly less of pelagic) they have had a marked effect. They allow companies to specialize, thus enhancing value and production quality. The auctions also provide a stable flow of raw material for small and large companies which helps them to smooth out variations in the catch. The fish auctions have been of particular benefit to the processing industry, improving flexibility and specialization [5].

It is well documented that a quota system increases profitability in fisheries, the primary result being that fishing effort decreases, leading to a subsequent reduction of the fishing fleet [7–10]. Also, the system encourages fishermen to focus on quality instead of quantity; that is, they will try to maximize the price obtained for the catch [11–13]. Trading in fishing rights results in enterprises able to catch at the lowest cost buying the rights from other less efficient companies, thus improving the profitability of

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the industry [14,15]. This also increases debt, but not necessarily the debt burden, because lower cost should increase cash flow; thus offsetting the negative impact of additional debt on financial costs and profitability [14,16].

Previous research on the development of the Icelandic fishing industry has demonstrated that the ITQ system has yielded considerable economic benefits [5,14,16–21]. The findings in other countries have been similar [10,22–26]. However, these studies do not comprise a detailed analysis of long term trends in the profitability of the industry. Furthermore, they all lack a thorough examination of the development of debt levels and financial strength, both as regards the industry as a whole and individual companies. Thus, many questions remain unanswered regarding the lasting effect of ITQ systems. How has profitability developed in the long term? Which costs go down proportionally? Do profitability developments in the processing sector differ from those of the fisheries aspect of the industry? What is the impact of the fishing fee? How do debts evolve under a uniform ITQ system? This paper focuses on answering those questions by studying the Icelandic fishing industry and its development since the implementation of the uniform ITQ system in 1990. The novelty of this study is that new and extensive data regarding the development of the industry are presented. Comprehensive information about the financial performance and debt levels of the industry is analyzed and discussed in relation to the uniform ITQ system.

2. The catch, export value and prices

A good measure of the catch around Iceland is the development in the fishing in cod-equivalent kilos which is a measure of the value of different species based on their market value. It is used to compare landings of different species of fish in Iceland. To explain this, the cod-equivalent kilo of saithe (*Pollachius virens*) is now 0.77 [27] which means that 1.30 kg of saithe (1/0.77) equal the value of one kilogram of cod (*Gadus morhua*). Fig. 1 illustrates the catch of Icelandic vessels in cod-equivalent kilos since 1950. As the picture shows catches steadily increased until 1966. Then an almost complete collapse in the herring fishery (*Clupea harengus*) resulted in the total catch of Icelandic vessels dropping by 20% in cod-equivalent kilograms. A long period follows where landings steadily increased until the fisheries peaked in 1981, exceeding 750 thousand tonnes, as a result of a sharp rise in the fishing of cod that year which was then by far the most important species. From 1988 until 2008 catches steadily declined in cod-equivalent kilos, mainly because of reduced catches of groundfish species; that is, cod, haddock (*Melanogrammus aeglefinus*), redfish (*Sebastes marinus*) and Greenland halibut (*Reinhardtius hippoglossoides*). The landings reached a low in 2008 when they were only slightly above 400 thousand cod-equivalent tonnes. Since then they have kept increasing, climbing to 690 thousand tonnes in 2013. It is worth mentioning, however, that the cod-equivalent coefficient for each year follows fluctuations in the price change of that species [27]. Fig. 1 shows the catch in constant cod-equivalent kilos from 1990, demonstrating that increased catches in cod-equivalent tonnes since 2008 are mainly occasioned by shifts in the coefficients, but not because of more landings. The value of the coefficients for pelagic species has increased and this is the main reason for the upswing since 2008 [27].

Even though the total catch has declined since it reached its peak in the 1980s, in cod equivalent kilos, the export value of the Icelandic fishing industry has been sustained. Fig. 2 indicates the export value of Icelandic fish products 1991–2013 in both Icelandic kronur (ISK) and Euro (EUR). All numbers are at constant prices and thus the figure shows inflation-adjusted development. As the figure illustrates, the real value of fish products in ISK has increased by about 35% from the year 1991 even though the catch went down 19% in cod-equivalent kilos calculated with an average coefficient during that period. The export value peaked 2011–2012 when it exceeded 280 billion ISK. During this period, the catch of important pelagic species culminated, and in addition, the prices were also elevated. However, the export value in EUR has evolved differently, the value peaked in 2002 following record capelin (*Mallotus villosus*) seasons and favourable market prices. Around the 2008 global economy crisis seafood prices fell and simultaneously total catch declined. This lead up to low EUR export prices in 2009, but the ISK export value increased because of the devaluated IS krona.

There have been marked fluctuations in the prices of fish products during the past few decades. Fig. 3 presents the development of Icelandic seafood prices in SDR. SDR is an abbreviation for a currency unit used by the International Monetary Fund [30]. The prices of fishmeal and oil have risen most steeply, or by more than 220% during this period. There have been significant swings in the of fishmeal and oil prices which increased dramatically in 1996–1998, or by 60%. The following years saw some price reductions, but since 2005 price levels have risen by 190%. The main reason for a considerably steeper increase in fishmeal and oil prices than in those of other fish products lies in heightened demand in aquaculture which, in turn, has boosted the market prices of fishmeal and oil [31]. There has not been such a significant increase in the prices of prawn and groundfish. The price of groundfish increased

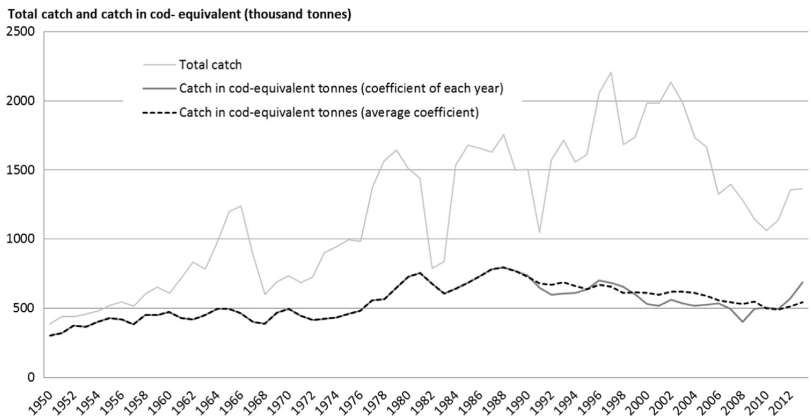

Fig. 1. The total catch of Icelandic vessels 1950–2013. The total catch in tonnes, catches in cod- equivalent tonnes and catches in cod-equivalent tonnes with an average cod-equivalent coefficient. Source: [28].

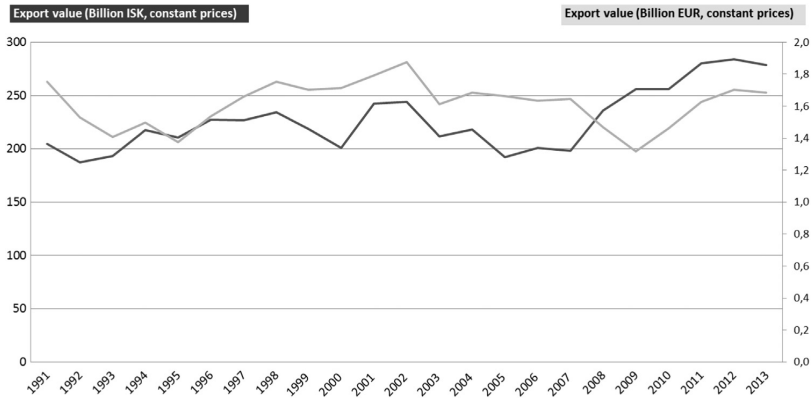

Fig. 2. The development of export value of Icelandic fish products in Icelandic krona (ISK) (left hand-axis) and Euros (EUR) (right hand-axis) 1991–2014 at constant 2014 prices. Source: [29].

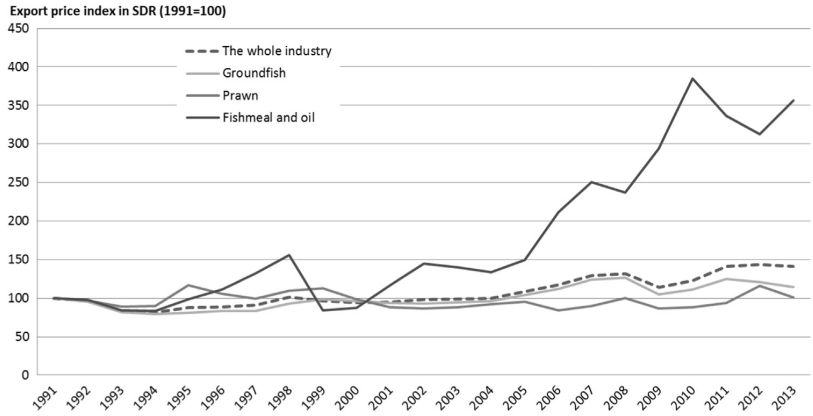

Fig. 3. Export price developments of Icelandic seafood in SDR 1991–2013. Source: [32].

by 24% in SDR during the period 1991–2014, reaching a peak in 2008, but declined in the depression 2009–2010. Since then the price has recovered as the world economy has gained momentum.

Prawn prices increased by 22% during that period, which is less than in other species, mainly because of a larger world catch and stronger production of hot water shrimp in aquaculture also had an effect [33]. On the whole industry, the price of Icelandic seafood has increased by 43% measured in SDR from 1991 to 2013. Those are nominal changes, whereas the real increase in prices is less than 5% taking into account inflation, which has averaged around 2% a year in SDR currencies during the above period [34].

It is a development worth noting that the export value of Icelandic fish products has increased even though prices have risen but little and total landings have gone down. This indicates that the Icelandic fishing industry has been able to adapt well to lower catches. This is mostly thanks to the ITQ system which has endowed the industry with an ability to regulate the flow of fish to the markets because the companies can choose when and where to catch the yearly quota. Many Icelandic companies now have contracts with the largest retailers in Western Europe, where they guarantee a constant stream of fish to their store shelves. This arrangement enables them to demand higher prices and specialize more in fish species and products [5,6,35].

3. Employment and size/age of the fleet

The number of people employed in the Icelandic fishing industry declined steadily until 2008. This is clearly demonstrated in Fig. 4 which shows the number of people employed in the industry. The data does show the number of people who name fishing and fish processing as their main profession – but not the number of man years. In 1991, there were 14,200 jobs in the industry; 6200 in fishing and 8000 in fish processing. That year, 10.4% of Icelandic workforce were employed in the fishing industry. The number of workers culminated in 1995–1996 when 16,000 were employed in fishing and fish processing; subsequent years saw a gradual decline and in 2008, only 7300 were employed in the Icelandic fishing industry, which then comprised only 4.1% of the Icelandic workforce. Thus, during that period, employment in the industry fell by 49%; 61% in fish processing and 32% in fishing. Since 2008, employment figures have recovered, although the number of fishermen has not grown significantly; jobs in fish processing, however, increased by 60% between 2008 and 2013. In the year 2013 the Icelandic fishing industry employed 8200 workers, or 5.0% of the Icelandic workforce [36]. When studying Alaskan crab fisheries the findings were that though the numbers of fishermen were reduced, when catch shares were introduced, the numbers of man hours were not. The reason being that day at sea remained the same but the days when the

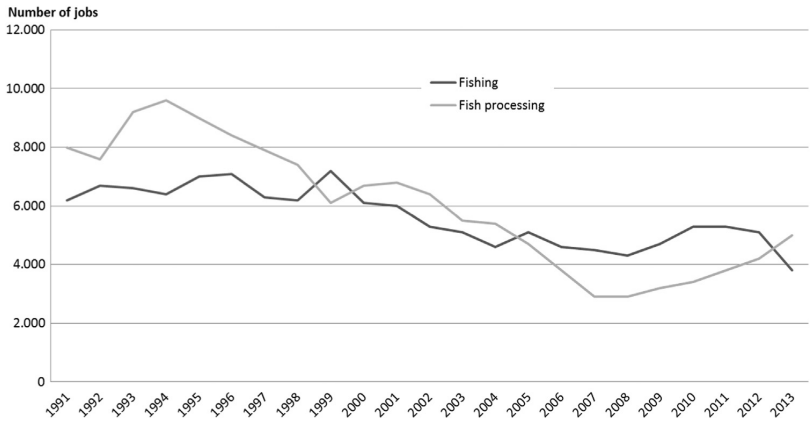

Fig. 4. Number of jobs, in Icelandic fishing and fish processing 1991–2013. Source: [36].

crews were not fishing were reduced dramatically [37]. It is unlikely that the same development is the reason for the reduction in the number of jobs in the Icelandic fishing. Now, more vessels have two sets of crews, which was almost unheard of 25 years ago. Therefore, the number of man hours in fishing might have gone down even more than the number of jobs. That does, though warrant a further research to be concluded.

It is unlikely, however, that the pattern of growing employment opportunities which have characterized the industry since 2008 will continue. This development has been underpinned by increased quotas to coastal communities and a boom in the pelagic industry, especially following the mackerel; an upsurge in the landings of cod also plays an important part here. It is expected that the long-term trend of reduced numbers of workers in the industry will continue as the offspring of improved technology, which has increased productivity and reduced employment. Furthermore, the consolidation of companies, resulting in fewer vessels and factories, will continue, although at a slower pace than previously.

As shown in Fig. 5, the size of the Icelandic fishing fleet has decreased. Fig. 5 shows that the size of the fishing fleet measured in gross tonnage went down by 16.5% during the period 1991–2013; the reduction was only 5.8%, however, when size is measured in terms of main engine horsepower. The number of decked fishing vessels was 993 in 1991, but was down to 834 in 2013, or a reduction by 16%, additionally there were 862 undecked vessels in the fleet not visible on the graph. Until 1999 fleet sizes were restricted; thus vessels could not be added to the fleet without vessels of similar size in gross registered tonnage (GRT) being decommissioned, thus limiting renewal [2]. During this period the fleet's average age has increased from 17 to 27 years. The focus has been on the fleet´s efficiency optimization with the consolidation of quotas, vessels have been sold and quotas merged, and there has been limited investment in new vessels.

This development is not surprising. As expected, improvements in processing and fishing technology have resulted in enhanced efficiency, which, in turn, causes losses of employment in the industry. Closures of fish processing plants and reduced numbers of fishing vessels have had the same impact. The ITQ system, in combination with improvements in technology, market changes, and lower fish catches, is responsible for this development, since the uniform ITQ system has given firms the means and opportunity to consolidate quotas. This has resulted in an almost continuous consolidation of fishing quotas since the system was introduced and, as a result, in 2013 only 10 firms held about 58% of total fish quotas measured in cod-equivalent kilos. In 1992, the then 10 largest firms controlled a 24% share of the quota [39,40]. This concentration has led to a reduction in the number of boats and factories, resulting in shrinking employment. The quota

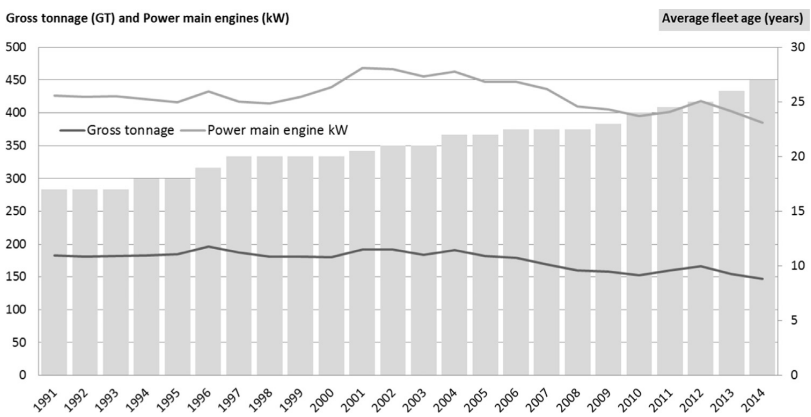

Fig. 5. The development of the total engine power of the main engine in kWh, total gross tonnage of the Icelandic fishing fleet (left hand-axis) and fleets average age (right hand-axis) 1991–2014. Source: [38].

Table 1.
Concentration of pelagic quotas in Iceland. Source: [41,42].

Year	Companies	Vessels	Factories	Capelin	Herring	Blue whiting	Mackerel
1982	41	52	21	100%	–	–	–
1992	33	43	19	100%	18%	–	–
2002	26	46	21	100%	88%	99.7%	–
2012	11	27	11	99%	99%	100%	82%

concentration is even higher within the Icelandic pelagic industry; in 2012 only 11 pelagic oriented companies were left and they managed 99% of almost all pelagic species within the EEZ, a drop by 30 companies from the initial capelin allocation in 1981 Table 1.

4. Profitability

When studying the profitability and debt level of the fishing industry official data from Statistics Iceland was examined. In that data the numbers obtained from the annual reports of firms working in the Icelandic fishing industry are consolidated. Thus, the figures reported here show accounted profit, cost and debt as the financial statements of the firms represent according to generally accepted accounting principles. Many other studies use economic profit (economic rent), that is the profit obtained after total assets have received a compensation equal to its opportunity cost, thus estimating the rent [43–46]. That is not applied here because accounting profit does give a better measure of the interaction of the balance sheet and debt with profits. The year 2008 shows this clearly because that year the fishing industry's accounting loss was enormous because of unfavourable financial charges. Thus, resulting in a massive increase in debt, but the economic profit was positive for the whole industry.

In general, the Icelandic fishing industry has been profitable, though there have been notable exceptions. Profitability has increased in recent years, especially in the fish processing component of the industry where prosperity has soared. The profitability of fishing has also increased, but not to the same extent. Fig. 6 shows the development of the profit margin ratio (profit after tax/revenue) and EBITDA (earnings before interest, taxes, depreciation and amortizations) margin (EBITDA/revenue) in the Icelandic fishery during 1991–2013. The EBITDA ratio is analyzed instead of EBIT (earnings before interest and taxes) which is often used, because the EBITDA ratio is more stable and also it is further away from the profit ratio because depreciation and amortizations are omitted in it. As the chart shows, there was low profit or even loss in the Icelandic fishing from 1991 until 2001. After that profitability improved. The year 2008, however, is an outlier when the loss sustained by the Icelandic fishing industry was in excess of 100% of income. The main reason was exorbitantly high financial charges when the fall of the Icelandic krona resulted in financial costs becoming more than 120% of revenues that year, since by far the greatest part of the debt of Icelandic fishing companies is denominated in foreign currencies, although financial statements are usually in the local currency [39,47]. Thus, the spectacular fall of the Icelandic krona in 2008, when it lost around half of its value, resulted in currency losses for those companies. Since then, the profitability of Icelandic fisheries has remained stable, and profit margins have averaged 13.7% of revenue since 2009.

A better measure of the financial performance of the Icelandic fishing fleet is the development of the EBITDA margin. This ratio shows how large a proportion of income is left after all general operating expenses have been accounted for, such as wages, fishing gear, oil and fishing fee. The fishing fee is classified as an expense (even though it could be considered a tax) and thus reduces the EBITDA of the companies. The fishing fee is displayed in Fig. 7, it was 9.8 billion ISK in 2013 which, at that time, comprised 6.6% of the revenue of the Icelandic fishing fleet and 3.7% of seafood export value, having amounted to 0.2% of the total revenue of the fleet and 0.1% of export value in 1993 [49]. This is an important source of income for the Icelandic government, constituting 1.7% of the total revenue of the treasury in the year 2013 [50]. The EBITDA margin has risen slightly since 1991, when it was 18.1%; this had reached 20.1% in 2013 which is a handsome increase, bearing in mind that oil, the second highest expense item of Icelandic fisheries, has surged during this period. In 1991, the cost of oil was 8.4% of revenue but had reached 10.9% in 2013 [48].

But what expenses has the fishing industry managed to reduce proportionally? When the numbers are examined, all costs, except oil and the fishing fee, have decreased proportionally. Salaries are by far the largest cost, and they are between 35% and 40% of total income. Icelandic fishermen get a fixed share of the catch value in accordance with wage agreements. Despite that wages have fallen by 3.6% points between 1991 and 2013.The cost of fishing gear, maintenance and management have also fallen sharply, proportionally.

The increase in profitability has been significantly higher in fish processing than in fishing as Fig. 8 indicates. There was little profit in Icelandic fish processing until 2001 when the situation began to improve. The year 2008 is an exception, bringing losses of 38% of revenue. As was the case with the fishing part of the industry, this negative outcome was caused by exchange losses on long-term

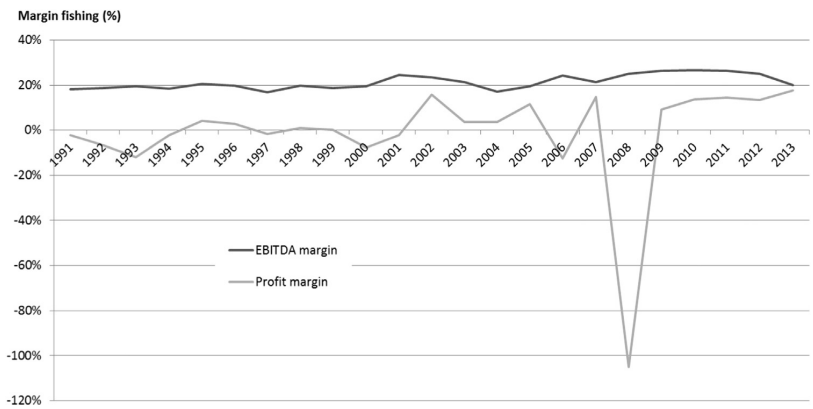

Fig. 6. The development of EBITA margin (EBITDA/revenues) and profit margin ratios (profit before tax/revenue) in Icelandic fishing 1991–2013. Source: [48].

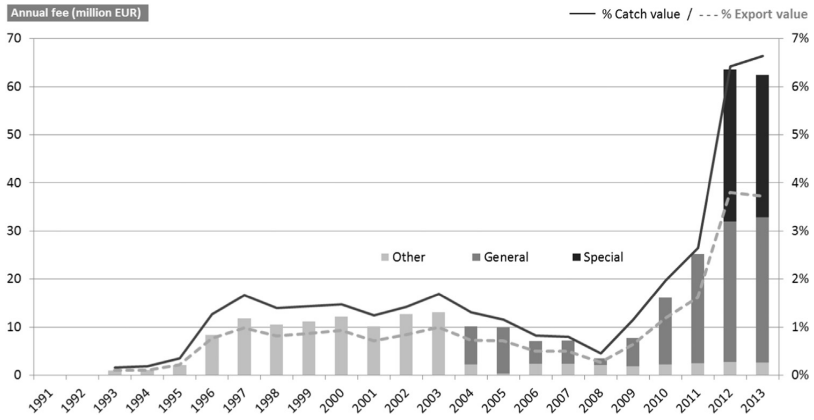

Fig. 7. Annual fishing fee (left hand-axis) and share of catch and export value (right hand-axis) 1991–2013. Source: [29,49,51].

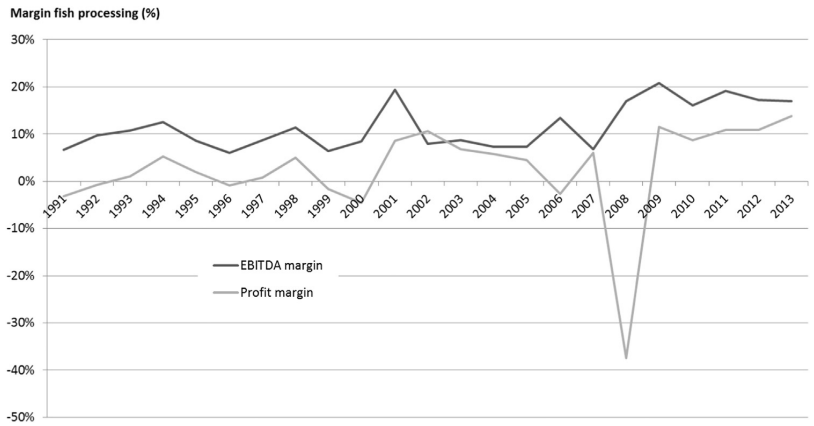

Fig. 8. The development of EBITA margin (EBITDA/revenues) and profit margin ratios (profit before tax/revenue) in Icelandic fish processing 1991–2013. Source: [48].

debt in foreign currencies. Interestingly, the loss is relatively smaller in fish processing than fishing in 2008, the reason being is that fish processing is relatively less leveraged, i.e. has less debt, than the fishing part of the industry [52]. Since 2009, the profitability of the industry has been sound and the profit margin in Icelandic fish processing has averaged 11.2% of revenue.

When the development of the EBITDA margin of the processing part of the industry is examined, it clearly shows significant improvement in profitability and efficiency. In the years 1991–2007, the EBITDA margin averaged 9.4%. Thereafter, the margin rose sharply to an average of 18.1% in 2009–2013. This is a massive increase in an industry which normally runs on a low margin. But what is the reason for this improvement? Which costs have fallen? By far the largest cost of the Icelandic fish processing industry is raw material; that is, fish bought for processing. In 1991, the proportion of raw materials to revenue in the processing industry was 57.8%; in 2013, this had fallen to 54.6%. The second highest cost is wages which were 20.8% of revenues in 1991 and had fallen to 12.4% in 2013. Wages in the processing industry consist mostly of hourly earnings unlike in fishing where fishermen receive a share of the value of the catch. Lower wage cost can be attributed to improved technology, consolidation of companies which has led to higher productivity. Other costs have also fallen proportionally [48].

Thus, the profitability of the processing component of the industry has increased dramatically during this period and outperformed the fishing component. This has been the result of improved efficiency, reduction in the number of fish processing plants, increased specialization of processing plants and better marketing. Also, the real exchange rate of the Icelandic krona has been low since 2008 resulting in low wages and reduced production costs [53].

The uniform ITQ system has played a pivotal part in the increased profitability of the Icelandic fishing industry. As referred to above, it has helped the industry to regulate the flow of fish, thus gaining better access to markets and higher prices. Also, the uniform ITQ system has given the firms the means and the opportunity to consolidate quotas and reduce the number of boats and factories, thus increasing the profitability of the industry. It is worth noting that the fishing component of the industry has been able to increase profits despite the implementation of the fishing fee. This fee is now a considerable cost item to the industry, dragging down its profitability, but it gives the Icelandic public; that is, the Icelandic government, a share in the resource rent of the industry. Whether that share is fair, or whether it is sufficient, is a highly controversial matter and subject to intense political debate [52,54,55].

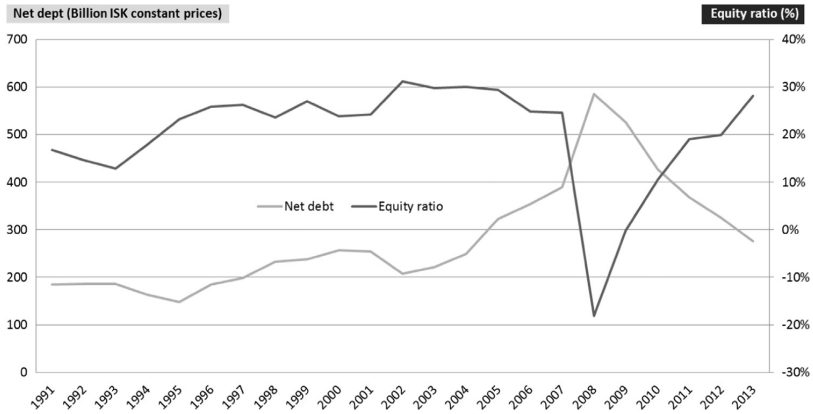

Fig. 9. The development of net debt (total debt – current assets), in constant prices (left-hand axis) and equity ratio (equity/assets) of the Icelandic fishing industry (right hand-axis) 1991–2013. Source: [48].

5. Balance sheet

The balance sheet of companies in the Icelandic fishing industry has undergone a sea change in recent years. Fig. 9 presents the development of net debt within the industry. Net debt is total debt minus current assets [56]. The figure shows the combined balance sheet of both the fishing and processing components of the industry. It is thus presented, because this is the only information at hand; that is, no data is available showing only the fishing or the processing part. Additionally, the figure shows the development of the equity ratio (equity/assets) [57]. The figure demonstrates an interesting development, as outlined here: The net debt of the Icelandic fishing industry did not change significantly during the years 1991–2004 remaining at around 200 billion Icelandic krona (around 1.4 billion EUR) in constant prices during this period. The equity ratio of the industry also remained stable, fluctuating between 25–30% from 1997 until 2004. Then, in 2005–2008, something dramatic happened. The industry started to pile up debt with its net debt climaxing at 600 billion Icelandic krona (ISK) in 2008. The main reason here was that the industry invested heavily in quotas 2004–2008, doubling the value of quota in its books during this period. Furthermore, other investments, mostly unrelated to the fishing industry increased considerably. All of these investments were mainly financed with debt obtained from Icelandic banks and these loans were predominantly in other currencies than the Icelandic krona. Finally, the spectacular crash of the Icelandic krona in 2008, when it lost half of its value, resulted in the debt burden culminating that year, as measured in ISK [39,47].

The figure indicates that all the equity of the industry vanished in 2008 when the fishing industry lost huge amounts of money mainly due to currency losses on debt denominated in foreign currencies. Since then, the industry has built up considerable equity and in 2013, the equity ratio had reached 30%. From 2008, the net debt of the industry has fallen from 600 billion Icelandic krona (ISK) in 2008 down to 275 billion in 2013. The debt reduction is primarily the result of the higher profitability of the industry, which has been used to pay down debt. In addition, investments have been small and below the normal level necessary to renew vessels, factories and equipment. Furthermore, some foreign currency loans have been ruled unlawful which has reduced debt. Finally debt has been written off in cases of firms which had unsustainable debt levels [39,52].

One of the most frequently applied ratios to measure the financial health of companies is the net debt/EBITDA ratio. This ratio indicates roughly how many years it would take for a company to pay down all debts if all the cash flow was used for this purpose, there were no investments and the company did not pay interest or taxes. Generally, it is assumed that this ratio has to be under 4.0 for the financial health of a company to be considered sound. If it is above 10.0, the debt of the company would be considered unsustainable [47,58]. The appropriate level of this ratio varies between industries. Those with moderate reinvestment requirements and low cost of capital, as, for example, hydropower plants, can survive a higher debt level. This, however, is not the case with the Icelandic fishing industry, so the levels already mentioned are appropriate. Fig. 10 shows the development of this ratio for the Icelandic fishing industry as a whole. In 1991 net debt/EBITDA stood at 5.4 in the industry. The ratio was at its best in 2001 when it was only 3.6. In 2008 it had reached 9.8 and the average debt situation of the industry was almost unsustainable. Since then the situation has significantly improved; the net debt/EBITDA ratio had come down to 3.8 at the end of 2013, and, on average, the financial strength of the industry was sound.

But what is the financial situation of individual companies? Is there a relationship between the size of companies and their economic strength? Table 2 indicates the financial position of the 200 largest companies in the Icelandic fishing industry in 2013. These companies thoroughly represent the industry, since they hold 99.5% of all allocated fishing quotas around the island [40]. The companies are ranked by size and the scale used to rank them is their total quota holding measured in cod-equivalent tonnes. The table shows the median of these ratios. In general, the table demonstrates that, as a rule, the companies are in a sound financial position. This particularly applies to the largest and the smallest companies. The smaller enterprises (companies 101–200 in size) show a median ratio of net debt/EBITDA below 1.0. Most of the smallest companies are almost exclusively enterprises which have only one small boat and a small quota holding; these companies hold about 3.2% of the total quota. Their median equity ratio is 26%, which is considered adequate. The financial strength of the 25 largest companies is also sound. Most of the larger companies are vertically integrated; that is, their operations consist both of fishing and fish processing and around a third of them partly operate in pelagic fisheries as well as in groundfish. The 25 largest companies make up the bulk of the Icelandic fishing industry and hold 79.9% of the total quotas. The ratio, net debt/EBITDA of 4.2, for this group indicates adequate financial strength and the book equity ratio is solid. Companies of medium size are in the worst financial position (companies 26–50 in size). Those

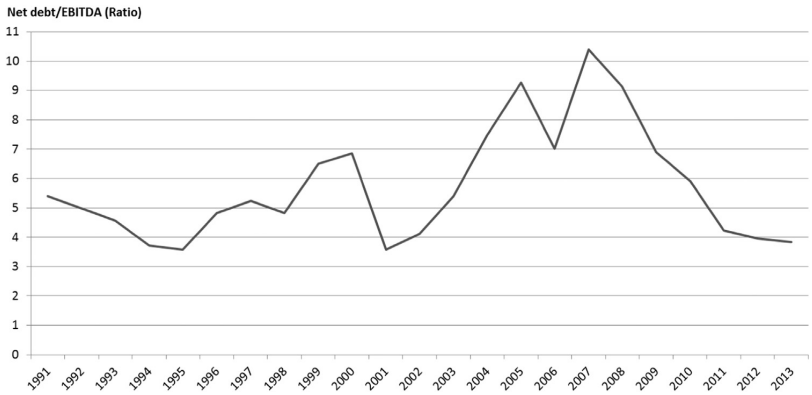

Fig. 10. The development of net debt/EBITDA ratio of the Icelandic fishing industry 1991–2013. Source: [48].

Table 2.
The median ratio of net debt/EBITDA and the equity ratio of Icelandic fishing companies ranked by size 2013. Source: [40].

Companies	Net debt/EBITDA	Equity ratio
25 large	4.2	25.3%
26–50 medium	12.2	2.3%
51–100 smaller medium	8.4	10.5%
101–200 small	0.8	26.0%

companies hold about 9.3% of total quotas. The debt level of many of them is unsustainable. They have on average almost no equity as demonstrated by a very low equity ratio. Most of these companies only operate in fishing and have no processing component. Also, they are not included in the highly profitable pelagic section of the Icelandic fishing industry. Companies classified as smaller medium (companies 51–100 in size) are, on average, in the somewhat difficult financial situation. Their share of the total quota is approximately 7.1%. Those companies consist mostly the operation of one boat and they have average quota holdings.

The balance sheet of companies in the Icelandic fishing industry has gone through a transformation in recent years. Debt levels were stable from 1991 until 2004, then the industry starts to pile up debt. The debt peaked in 2008 but has since fallen sharply and reached normal levels. There are three main causes for this increase in debt in 2004–2008. The first is the spectacular Icelandic financial bubble which resulted in an extremely misguided monetary situation and easy access to bank credit. As a result, the entire Icelandic economy, as well as the fishing industry, accumulated extravagant debt. The second reason is the fall of the Icelandic krona in 2008. The debt of the fishing industry was mainly carried in foreign currency. Thus, the fall of the local currency in 2008, when the Icelandic krona lost around half of its value resulted in near-doubling of the industry's debt burden, as measured in ISK. Finally, the ITQ system was one of the causes of this massive debt increase. The system makes fishing rights, i.e. quotas, valuable. Those rights became very expensive in Iceland during the financial bubble 2004–2008 [39,47]. As a result, many quota owners sold their quotas and left the industry. The buyers were the companies which remained in the industry; thus, the debt levels of the Icelandic fishing industry as a whole rose steeply.

6. Conclusion

The Icelandic fishing industry has had to deal with reductions in the catch for the past three decades. It has adapted well to this process, helped by the Icelandic ITQ system. The industry has responded by reducing employment, closing factories and scrapping boats, thus significantly lowering the number of people working in the industry, especially in the processing component. Even though the total catch has fallen in volume, its export value has increased slightly. This is a highly positive development, especially considering there has been little increase in the real price of fish products, except for fish meal and oil where prices have gone up significantly.

The profitability of the Icelandic fishing industry has markedly improved. This particularly applies to the processing component of the industry where profits have soared. However, the fishing component has improved considerably less in this respect than the processing component. This is mainly due to higher oil prices, as well as the introduction, and subsequent increase of the fishing fee, which is now a considerable expense item for the fishing part of the industry. The debt levels of the industry began to escalate in 2004, reaching a peak in 2008, mainly because of the Icelandic financial bubble in 2004–2008, although the ITQ system also plays a part in the steeply increased debt burden. Since then, the financial condition of the industry has dramatically improved and its financial health is now generally sound, especially as regards the largest and smallest firms.

These developments have profound policy implications. The Icelandic ITQ system has made it easier for the fishing industry to adapt to changes and negative developments, by merging companies, scrapping boats and lowering the number of people working in the industry. The system has also facilitated specialization and made access to specialized markets easier. Thus, the ITQ system has resulted in increased profitability of the industry. This profitability has made it possible for the Icelandic government the impose a resource rent tax, or a fishing fee, which is now an important part of Icelandic government revenue. Conversely, the Icelandic ITQ system has increased the debt of the industry when valuable fishing quotas have been sold to companies remaining in the industry, whose debt burden has grown correspondingly heavier. Such a development, however, is dependent on the availability of credit, as can be seen in the steep debt accumulation of the Icelandic fishing industry, during the Icelandic financial bubble in 2004–2008, when cheap credit flooded the Icelandic economy.

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Fishing for a fee: Resource rent taxation in Iceland's fisheries

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ABSTRACT

In 1990, Iceland established a comprehensive fisheries management system based on individual transferable quotas (ITQs). Simultaneously, low-cost licence fees, which the fishing industry paid to the government, were introduced. As the ITQ system became more mature and the financial performance of the fisheries improved, there was increasing public demand for the sharing of its resource rent. A special resource committee was set up in 1998 to address these views and concluded that a new fishing fee should be established to cover the cost associated with managing and supervising the use of marine resources, as well as making certain that a visible share of the resource rent accrued to the public. Although the fishing fee has changed since its introduction in 2004, the basic principles behind the taxation remain the same. Five issues have made the introduction and implementation of the fishing fees difficult. The first regards the fee amount for different species. The second relates to the variance in profitability between harvesting companies. The third concerns measurement of revenue and profits from harvesting in vertically integrated firms. The fourth issue is related to how to deal with the debt burden that became quite large for many Icelandic harvesting firms after the financial crisis of 2008. Finally, obtaining reliable data has been a major challenge. This paper provides a background to the implementation of the Icelandic fishing fee, describes and investigates fishing fees issues and their address by the government. In 2014, the fee amounted to 52 million euros, 6.0% of the catch value of Icelandic fishing vessels and around 1.2% of the total revenue of the Icelandic Treasury.

1. Introduction

A large and growing literature shows that catch share management systems, or quota systems, have positively affected efficiency and profitability in fisheries in New Zealand (Dewees, 1989; Annala, 1996; Batstone and Sharp, 1999), Australia (Kompas and Che, 2005; Thebaud et al., 2014), Norway (Hannesson, 2013), Denmark (Andersen et al., 2010), Chile (Pena-Torres, 1997; Gómez-Lobo et al., 2011), USA (Matulich, 2008; Gauvin et al., 1994; Agar et al., 2014; Ropicki et al., 2018) and Canada (Gardner, 1989; Casey et al., 1995; Dupont, 2014). Introducing quotas ends the race to fish, leading to effort reductions and increases the efficiency of the fishing fleet (Dupont et al., 2002; Standal and Aarset, 2008; Asche et al., 2014; Grafton, 1996; Emery et al., 2015; Hannesson, 2013). The transfer of quotas, permitted under individual transferable quotas (ITQs), will—over time—move fishing rights from less profitable to more profitable firms, improving economic performance even more. Research also suggests that introducing quotas may increase catch value because fishers are no longer under pressure to maximise catches and can organise fishing to obtain the highest value of their landings (Asche et al., 2008, 2009; Andersen et al., 2010).

Iceland was one of the first countries to implement a management system based on ITQs. Quotas were introduced into the pelagic fisheries in the 1970s and the most important demersal fisheries in 1984. Six years later the various quota systems were knitted together into a comprehensive ITQ system that currently covers almost all commercial fisheries. Studies have demonstrated that the ITQ system has yielded considerable economic benefits in Icelandic fisheries (Arnason, 1993, 2005, 2008; Matthiasson, 1997; Knútsson et al., 2016; Eythórsson, 2000; Yagi et al., 2012; Gunnlaugsson and Saevaldsson, 2016): harvesting costs have declined, fishing effort has been reduced considerably, and the consolidation of quotas has increased (Arnason, 2005; Agnarsson et al., 2016; Saevaldsson and Gunnlaugsson, 2015). The firms have become larger and many are now vertically integrated; that is, they are engaged in harvesting, processing, and marketing (Knútsson et al., 2016; Saevaldsson and Gunnlaugsson, 2015). Taken together, these developments have led to increased profitability in the industry.

Although the Icelandic fisheries are now conducted in both a

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responsible and efficient manner, the Icelandic ITQ system has right from the beginning been controversial and has never received full public and political backing (Saevaldsson and Gunnlaugsson, 2015; Sigurðardóttir, 2012). Opposition to the way the fisheries are managed has grown stronger through the years, not least because profits have become more visible as operators have learned to take advantage of the virtues of the ITQ system. To pacify critics of the ITQ system and raise a new form of tax revenue, the Icelandic government introduced a fishing fee in 2004, which the industry pays for access to the fishing resource around the island. The fee is levied on all Icelandic commercial fisheries, which are managed by Icelandic authorities and under Icelandic legislation, both those conducted inside Iceland's exclusive economic zone (EEZ) and in more distant waters. Thus, the fee applies both to fisheries which are conducted under the ITQ system and those that are managed in a different manner, such as the coastal fisheries that take place in the summer and the lumpfish *(Cyclopterus lumpus)* fishery in the spring and early summer. The fee is levied on landed catches and varies significantly between fish species. The purpose of this fee is twofold; to finance the direct cost which the government incurs from managing the resource, and provide the public with a fair share of the resource rent generated by the Icelandic fishing industry. Resource rent is the income from resource extraction in excess of costs, including opportunity cost and return on capital employed (Grafton et al., 2008). Therefore, the fee is both a licence fee and a form of resource rent taxation. This fee might be viewed as a success in fisheries management because it demonstrates the profitability a fisheries resource can produce when well managed under an ITQ system, and the fishing industry's ability to pay increased taxes that benefit the public. The fee has partially transformed the political discourse in the country from discussing the basis and fairness of the ITQ system into a debate about the fishing fee, its associated methodology, and its amount. Thus, this fee is controversial and under considerable political scrutiny and debate.

There are four kinds of fees and taxes in world fisheries. Firstly, normal corporate taxes, which apply to fisheries and all other industries, include taxes on profits and payroll, value added tax and other taxes levied on firms in the economy. The second form of taxation are fees to cover administrative costs arising from managing the resource and the fishing industry. This form of fee is common in many countries and often represented as a licence fee. An example can be found on the Canadian Atlantic coast (Sigurður Steinn Einarsson, 2014), and in Namibia (Kirchner and Leiman, 2014). Those fees are, however, low and only cover part of the administrative cost. Thirdly, some countries impose fees for access to the resource. These fees are lump sums that do not consider the profitability and rent generated by those utilising the resource. Such an agreement is for instance currently in place between Morocco and the European Comission (2016). Finally, there are pure resource rent taxes. Resource rent taxes in fisheries are taxes, which specifically target the resource rent that can be generated through careful utilisation of the fishing resource. This form of taxation is uncommon in world fisheries. New Zealand experimented with a resource rent tax, initially based on quota value, but those taxes were abandoned as part of a dispute settlement between the government and the industry (Grafton, 1992; Hannesson, 2005).

Implementing and determining the Icelandic fishing fee has been difficult. This Icelandic experience can be highly valuable for other countries considering introducing a similar resource taxation, because these countries are likely to face many of the same problems as Iceland did. Therefore, it is worthwhile to review some of the controversies and difficulties associated with the establishment of the fee: How high is the Icelandic fishing fee? What are the main problems connected with setting this type of fee? What do you levy the fee on? How do you protect small firms from this fee? Who has paid the fishing fee? All these questions have been addressed while implementing the fishing fee in Iceland since its introduction in 2004. The purpose of this paper is to answer the aforementioned questions and explain the methodology and process applied when formulating this form of taxation.

A previous study discusses the setting of the fishing fee in 2004 and developments in the next few years. During this period, the fee was low and its purpose was more to recover costs than to tax resource rents (Matthiasson, 2008). This paper, however, spans a much longer time period, during which time the methodology behind the fee has changed drastically, and the level of the fee has increased considerably. Today, the Icelandic fishing fee is an important source of tax revenue and a considerable expense for the Icelandic fishing industry. In 2014, the fee amounted to 52 million euros, 6.0% of the catch value of Icelandic fishing vessels and around 1.2% of the total revenue of the Icelandic Treasury (Ríkisreikningur, 2018).

This paper is organized as follows. In section two, the implementation of the fishing fee is described in four phases, while section three examines the five main issues, which have arisen when setting the fee. Section four, tabulates what companies have paid the fees and section five contains discussion. The final section concludes the paper.

2. Implementing the Icelandic fishing fee

Fisheries have been the main engine of the Icelandic economy for the last 150 years, and still constitute the backbone of economic activity on the island, not least in the small coastal communities. In 2014, harvesting and processing accounted for 8% of gross domestic product (GDP), and 23% of exported goods and services, second only to earnings from tourism which represented 29% of exports. Harvests of the Icelandic fishing fleet totalled 1.1 million metric tonnes with an export value of 1.9 billion euros. Cod (*Gadus morhua*), is by far the most important specie (37% of export value), but the value shares of mackerel (*Scomber scombrus*) and capelin (*Mallotus villosus*), 10% and 6%, were also considerable (Hagstofa Íslands, 2015a).

The annual total allowable catch (TAC) for each stock is set every year by the Ministry of Industries and Innovation based on scientific advice given by the Icelandic Marine Research Institute. Its recommendations are based on systematic research on the distribution, size and yield potential of main species. Thus, the TAC is based on conservation and optimal harvesting (Iceland Responsible Fisheries for the benefit of future generations, 2018).

It is worth noting that there was little or no profitability in the Icelandic fisheries before the introduction of the ITQ system in 1990. This is clearly illustrated in Fig. 1, which shows the developments in the profit ratio (profit/revenue) of the Icelandic fishing industry from 1980 to 2014. Profitability was so poor in the 1980s that the average loss of the fishing component was approximately 7% of revenues during that decade. When the ITQ system was introduced, economic performance began to recover, albeit slowly at first. Since 2000, the harvesting sector has on average enjoyed a profit of 12.7% but profits in the processing industry have been slightly lower, or 8.9%. The improved financial performance of the fishing sectors and visible profitability is one of the fundamental factors that allowed for the implementation of the Icelandic fishing fee.

The implementation of the Icelandic fishing fee may be divided into four phases of different characteristics and fee structures. The first phase covers the years 1990–2003 and comprised licence fees which were intended to partly cover costs associated with the administration of the fishing resource. The fishing fee was introduced in 2004 and then raised each year in 2009–2011. Finally, the fee was increased significantly in 2012, making it a crucial expense item. Fig. 2 traces the development of the fees in 1993–2014, while Table 1 provides a more detailed overview of the changes in the license fees and fishing fees.

2.1. Phase 1: licence fees, from 1990 to 2003

This phase was characterized by low but increasing profitability. The average profit ratio (profit/revenue) in harvesting amounted to 4.8% but only 2.2% in the processing industry (Fig. 1).

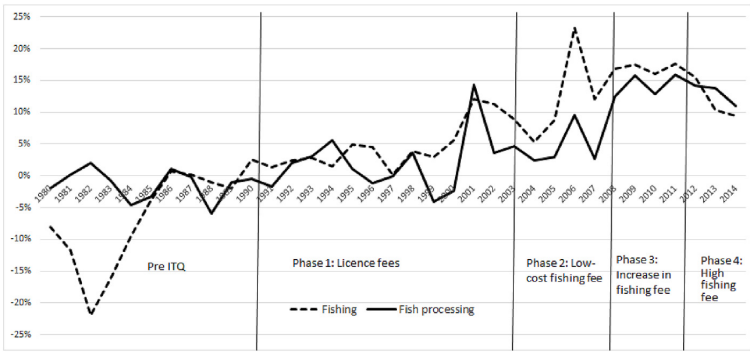

Fig. 1. Profit ratio (profit/revenue) of Icelandic fishing and processing, 1980 to 2014, using imputed cost of capital. Sources: Einarsson (2012); Hagstofa Íslands (2015b).

In 1990, a uniform ITQ system was introduced which applied to all vessels larger than six gross registered tonnes (GRT). Smaller boats were exempt from the system. These were managed by complex effort regulations until the early 2000s when they were finally incorporated into the ITQ regime (Agnarsson et al., 2016). The Fisheries Management Act of 1990, on which the ITQ system is based, obligated the Minister of Fisheries to set a fee, that is, a supervision fee, which the fishing industry would pay. The purpose of the fee was to pay for the monitoring of the fishing resource. The amount of the fee was set to cover half the direct cost of running the Directorate of Fisheries (Fiskistofa), which task is monitoring fisheries and the daily administration of the fisheries' management system in Iceland. The law clearly stipulated that the fee should be less than 0.2% of the value of the catch of individual vessels (Lög um stjórn fiskveiða, 1990). The regulation, where the fee was introduced, levied this fee on cod-equivalent tonnes of allocated quota. The supervision fee was introduced in 1990 and was not significant, or ISK (Icelandic krona) 60 per cod-equivalent tonne (approximately EUR 0.46), in 1990 (Reglugerð um veiðieftirlitsgjald, 1989).

The cod-equivalent kilo was the main basis on which fees were levied in Icelandic fisheries until 2013, when this scheme was replaced by the special cod-equivalent coefficient. A cod-equivalent kilo is a measure of the value of different species based on their market rate and has been used in Iceland to compare the value of landings of different species. This ratio is set annually and represents the relative value of each species to cod (*Gadus morhua*), which always has the cod-equivalent coefficient of 1.0. To explain this, the cod-equivalent coefficient of saithe (*Pollachius virens*) is now 0.72, meaning that 1.39 kg of saithe (1/0.72) equals the value of 1 kg of cod (Fiskistofa, 2015b). From 1990 to 2003, when this fee was abolished, the supervision fee increased gradually from ISK 60 (EUR 0.46) to ISK 664 (EUR 5.10) per cod-equivalent tonne (Fiskistofa, 2015a).

In 1991, The Minister of Fisheries a set up an expert committee often referred to as the 'double head committee' (Tvíhöfðanefndin) in 1991 which was charged with a review the Icelandic fisheries policy. The committee concluded that the ITQ system should be strengthened and cover all Icelandic fisheries, but also that the fishing industry should pay more for access to the resource and that overcapacity of the fishing fleet and fish processing sector needed to be addressed (Stjornarradid, 2010). As a result, the Icelandic Fisheries Development Fund (IFDF) was established with the objective to facilitate the scrapping of boats and fish factories. In 1995, the industry started to pay into this fund and payments continued until 2004. The fees were initially based on the tonnage of the fleet. Those fees were insignificant and less than 1 million euros for the whole industry each year. The fees paid to the IFDF became two-tier in 1996 when the industry started to pay an additional fee based on allocated quotas. As with the supervision fee already in place, the new additional fee was levied on cod-equivalent tonnes. At first those payments were small, ISK 1090 per tonne (EUR 8.4), but they gradually increased to ISK 1441 per tonne in 2003 (EUR 11.1) (Fiskistofa, 2015a; Reglugerð um þróunarsjóð sjávarútvegsins, 2018).

Taken together, these two payments (i.e. the supervision fee and payments to the IFDF), shown jointly as other fees in Fig. 2, were always not significant and never amounted to more than 1.6% of the catch value. The fees were the lowest in the beginning, when only the supervision fee was applied; 0.2% of the catch value in 1993, but after the development fund fee came into effect, the combined fees corresponded to 1.2%–1.6% of the value of the catch.

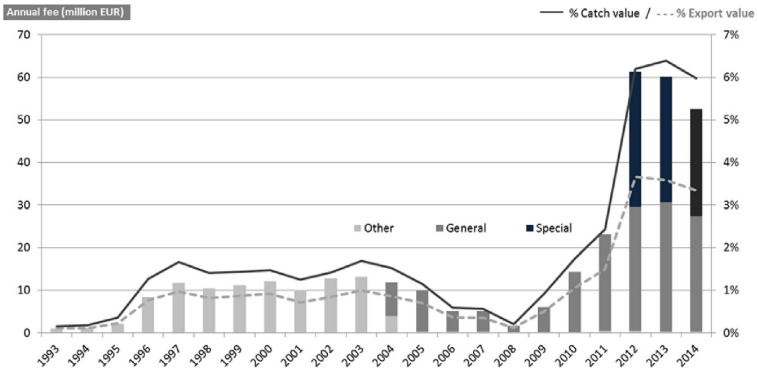

Fig. 2. Fishing fee and other fees (left-hand axis) and the share of catch and export value (right-hand axis) from 1993 to 2014. Sources: Hagstofa Íslands (2015a, 2016); Fiskistofa (2015a).

Table 1
Development of fishing and other fees in the Icelandic fishing industry from 1990 to 2015. Sources: Lög um stjórn fiskveiða, (1990); Fiskistofa (2015b); Forsætisráðuneytið (2000); Reglugerð um fjárhæð (2014); Reglugerð um fjárhæð (2012); Reglugerð um fjárhæð (2015); 74/2012 2012; Reglugerð um fjárhæð (2013).

Year	Issues
1990–2004	A small supervision fee, mostly to cover supervision of the Directorate of Fisheries.
1996–2004	An additional fee to the Icelandic Fisheries Development Fund.
2002	Legislation is passed to introduce the Icelandic fishing fee.
2004–2008	Fishing fee based on cod-equivalent kilo. ISK 1.99 in 2004, ISK 1.53 in 2005, ISK 0.91 in 2006, ISK 1.45 in 2007 and ISK 0.71 in 2008. No fishing fees paid on cod catches in 2008.
2009–2011	The fishing fee is increased considerably. From ISK 3.47 per cod-equivalent kilo in 2009, to ISK 6.44 in 2010 and ISK 9.46 in 2011.
2012	The special fishing fee is introduced. A fishing fee committee is established. Special fishing fee is set at ISK 27.5 and ISK 23.2 per cod-equivalent kilo for pelagic species and demersal species, respectively. Complex rules are introduced which exempt heavily indebted companies from the special fishing fee. Smaller firms are also shielded from this fee; that is, all firms pay no special fishing fee for the first 30 cod eq. tonnes and only half for the next 70. Additionally, all firms pay the conventional fishing fee of 9.50 ISK per cod-equivalent kilo.
2013	The fishing fee committee is unable to set the fishing fee according to the 2012 law. The base is changed, that is, calculated on the special cod-equivalent coefficient. The special fishing fee for pelagic and demersal species is ISK 27.5 and ISK 7.38 per special cod- eq. kilo, respectively. The conventional fishing fee remains the same at ISK 9.50. Indebted and small companies are still shielded from the special fishing fee.
2014	The special fishing fee for pelagic and demersal species is ISK 38.25 and ISK 7.38 per special cod-equivalent kilo, respectively. The conventional fishing fee remains at ISK 9.50. Indebted and small companies are still shielded from the special fishing fee.
2015	The base the fishing fee was levied on is changed. A new basis is introduced; that is, a new coefficient named the 'profit coefficient' (afkomustuðull) based on the gross margin of fishing of individual species. New rules that shield smaller companies are set when the special fishing fee is reduced by ISK 250,000. Rules which reduce the fishing fee paid by indebted companies continue to apply.

2.2. Phase 2: low-cost fishing fee from 2004 to 2008

This phase was characterized by increasing profitability. The average profit ratio of harvesting amounted to 13.2% and 6.0% in the processing industries (Fig. 1). The introduction of the fishing fee followed the recommendations of the resource committee (Auðlindanefnd) set up by the Icelandic Parliament in 1998. The remit of the committee was to define Iceland's natural resources and provide guidelines for the management of the resources, including user fees. The committee recommended that all users of country's natural resources should pay fees that would on the one hand cover the costs associated with sustainable management and supervision of the resource and on the other give the public a visible share of the resource rent that the utilisation generated (Stjornarradid, 2010). The fishing fee was introduced through Act no. 85 in 2002, but to date such user fees have not applied to exploitation of other natural resources in Iceland. The new fishing fee replaced the both the supervision fees and payments to the IFDF previous fees. Although the fee was levied on each firm, calculations of the fee were based on aggregate data. The base of the fee was the aggregate value of the catches of all vessels in the Icelandic fishing fleet, but the costs of oil, wages, and other operating expenses were deducted from that amount (1477/127, 2017). The fishing fee was levied on the allocated quota measured in cod-equivalent kilos, as the previous fees had been. The fishing fee was first implemented in the fishing year 2004/2005 (September 1–August 31) but has, since then, been revised and set for each fishing year.

As shown in Fig. 2, the new fishing fee was significantly lower than the fees previously levied on the fisheries and declined during this period: from approximately 1.5% of catch value in 2004 to 0.2% in 2008. The new fee did not cover all the administrative and management costs, and the reasons as to why the fee was set so low were mainly political. The right wing government in office at the time was reluctant to increase fees and taxes, and because the boom enjoyed during these years generated high general tax revenues there was not perceived to be any need to raise taxes on the fisheries (Matthiasson, 2008; Policy Statement, 2017; Fréttasafn, 2017). In addition, the catches of cod, the most valuable species in the Icelandic fisheries, were very low during that period and a moderate fishing fee was a means to compensate the fishing industry for their consequent financial difficulties.

2.3. Phase 3: increase in fishing fee from 2009 to 2011

Following the financial crisis in 2008, the Icelandic economy experienced a severe recession 2008–2010, and the Treasury had a considerable deficit; therefore, it was in dire need of additional tax revenues. The spectacular fall of the Icelandic krona in 2008, when it lost approximately half its value, had—among other developments—resulted in considerable improvement in the economic performance of the Icelandic fishing industry (Gunnlaugsson and Saevaldsson, 2016). This phase was therefore characterized by increasing and high profitability. There was especially a radical improvement in the financial performance of the processing sector where profits averaged 14.8%. Average profits in harvesting were 17.0% (Fig. 1).

When a new left-wing government took office in 2009, a radical shift in the attitude towards fees and special taxes aimed at the Icelandic fishing industry occurred. This new government formed a committee in June 2009, later named the reconciliation committee (Sáttanefnd), which submitted its results in September 2010. The purpose of the committee was to review the Icelandic fisheries policy and fee structures. The committee did not reach a consensus; however, there was a broad agreement that the current ITQ system should be maintained. The majority of the committee, comprising the leading political parties, concluded that the industry should pay a reasonable fee for the allocated quotas, but the minority disagreed (Stjornarradid, 2010).

Based on the work of the committee, this new government started by increasing the fishing fee for 2010 and 2011. Nevertheless, the fee remained relatively modest, approximately 1.7% and 2.3% of the catch value in 2010 and 2011, respectively (Fig. 2), and did not have a substantial effect on the industry. Given the financial crisis in Iceland, one may wonder why increase in the fee was not greater. The reason for this was that the Icelandic fishing industry had not escaped the debt problems facing the rest of the country; it had been accruing debt during the run-up to the crisis of 2008, and many companies were struggling (In section 3.4, the debt problem and development are charted.). Thus, taxing the industry heavily was not considered advisable because the result would be the bankruptcies of crucial companies in weak rural areas (Kristófersson and Gunnlaugsson, 2011). The results were low fees that did not even cover the supervision and management of the fishing resource.

2.4. Phase 4: high fishing fee from 2012

This phase was characterized by good profitability, although the performance of the harvesting sector deteriorated slightly due to the higher fishing fee. Still, harvesting firms returned on average 11.8%

profits while profits in the processing industries averaged 13.0% in this phase (Fig. 1). There was a significant change in the structure and increase of the fishing fee in 2012. The left-wing government, which came to power in 2009, was still in charge. In 2012, this administration managed to enforce changes and increase fishing fees, as the majority of the reconciliation committee had recommended. The main change was that the fees were increased in a two-tier structure; that is, the same general fee that all firms had been paying and a new special fee, which only some firms paid. As a result, for the first time, there was a difference in the amount firms paid, and this was based on their size and financial strength. The general fee remained almost the same: ISK 9.5 (EUR 0.073) per cod-equivalent kilo. The purpose of the general fee was to pay for the management and supervision of the resource. Its amount was approximately the total direct cost the Icelandic government paid for the operations of government agencies and institution which monitor and supervise the utilization of the fishing resource. The new special fishing fee was, as the general fee, levied on cod-equivalent kilo of allocated quotas. The purpose of this fee was to provide the Icelandic public a share of the resource rent of the Icelandic fishing industry (Reglugerð um fjárhæð, 2012). The special fishing fee was set at ISK 27.5 and 23.2 per cod-equivalent kilo of pelagic and other species, respectively. The resulting fishing fee (Fig. 2) was close to 6% of the catch value from 2012 to 2014 and approximately 3.5% of the export value of Icelandic fisheries during that time.

Although lower than initially proposed, the sum of those two fees were substantial and would have had a particularly negative effect on firms struggling with debt payments. To mitigate this effect, a deduction of the special fishing fee was introduced and aimed at highly indebted companies. This deduction was based on financial costs resulting from previous purchases of fishing quotas. The rebate was, at most, 4% of the book value of the quota holdings. This situation resulted in a minor to no special fee on firms struggling with high debt. To shield smaller firms, every company holding a quota did not pay a special fishing fee for the first 30 cod-equivalent tonnes of quota and only half the fee for the next 70 (Reglugerð um fjárhæð, 2012). As outlined in section 4, the outcome was that smaller and indebted companies did not pay a special fishing fee, and its payment was concentrated among the largest and financially strongest companies (Fiskistofa, 2015a).

Another change in 2012 was the establishment of the fishing fee committee, whose purpose was to determine the special fishing fee for each fishing year. This committee, which is still operating today, consists of three members; one form the government, one academic and one former financial manager of the largest fishing company in Iceland. The committee is independent form the industry and was charged with calculating the resource rent of the fishing industry and determine the special fishing fee, thus setting the appropriate fees (Reglugerð um fjárhæð, 2012). The intention in 2012, was that the fishing fee committee would calculate the resource rent for individual spices and then set the special fishing fee based on their rent. That turned out to be difficult, due to data limitation, and the basis of the fee became aggregate EBT (earnings before taxes) profits in fishing and a share of aggregate EBT profits in processing.

In 2013, however, the fishing fee committee made a significant change to the base the fishing fee was levied on. The new base was the allocated quota calculated with a special cod-equivalent coefficient, instead of the conventional cod-equivalent coefficient. The new coefficients were more in line with the profitability of fishing and the processing of individual species (Table 2 in section 3.1). Another important change in 2013 was that the special fee paid for demersal species was lowered considerably, from ISK 23.2 to 7.38 per special cod-equivalent kilos. The reason for this reduction was mostly political. A new centre-right government, which came into office in 2013, was less willing to tax the Icelandic fishing industry over other industries. This administration cut and slightly increased the fee for demersal and pelagic species, respectively. The increase in the fee for pelagic species was achieved by increasing the share of processing in the basis of the fee. This change was justified by very high profitability in that sector at the time and the fact that almost the entire industry is vertically integrated, making ex-vessel price determination very difficult. The lower fee for demersal fishing was justified by difficult market conditions, that is, lower prices of cod which dragged down profitability in the groundfish part of the industry (Reglugerd um fjárhæð, 2013).

Table 2
Cod-equivalent coefficients in 2014, special cod-equivalent coefficients in 2014, and profit coefficients in 2015. Sources: (Fiskistofa, 2015b; Reglugerð um fjárhæð, 2014; Reglugerð um fjárhæð, 2013).

	Cod-equivalent coefficients 2014	Special cod-equivalent coefficients 2014	Profit coefficients 2015
Cod *(Gadus morhua)*	1.00	1.00	1.00
Haddock *(Melanogrammus aeglefinus)*	1.30	1.17	1.37
Saithe *(Pollachius virens)*	0.81	0.66	0.65
Prawn *(Pandalus borealis)*	1.13	0.87	0.08
Capelin *(Mallotus villosus)*	0.14	0.13	0.30
Herring *(Clupea harengus)*	0.21	0.21	0.60
Blue whiting *(Micromesistius poutassou)*	0.10	0.10	0.18
Greenland halibut *(Reinhardtius hippoglossoides)*	2.59	1.80	1.42

In 2015, there were also substantial changes to the basis of the fishing fee. Instead of basing the fee on a proxy measure of rents the basis became overall industry EBT profits, same as in general corporate taxation. The fee was levied on all EBT profits from fishing and respectively 5% of profits from demersal processing and 25% of pelagic processing. This change moved the fee even further away from the intention in 2012 to base the fee on rents. Also, new profit coefficients were introduced to replace the special cod-equivalent coefficients (section 3.1 in Table 2). These new coefficients were based on the estimated gross margin of fishing for different species, which is represented relative to the gross margin in cod fishing. In addition, new rules were introduced to shield smaller firms, which reduced the fee by ISK 250,000 (approximately EUR 1900) (Reglugerð um fjárhæð, 2015).

3. Important issues when setting the fee

Five major issues have arisen in association with the introduction and implementation of the fishing fee in Iceland; the base of the fee, variance in profitability, revenue transfer from fishing to processing, debt burden and difficulties in obtaining good data. Those issues were not of great importance when the fee was low but became of greater relevance and constituted problems that had to be solved after the fee was increased in 2012. This section discusses each problem and the attempts made to address them.

3.1. On the base of the levy

The first issue, which has dominated the work of the fishing fee committee, is to determine the base on which the fee should be levied. This problem has been important, especially since 2012, i.e. in phase four (see Section 2.4 above). The industry pays for the right to catch fish in Icelandic waters. Therefore, it pays a fee for an allocated quota. But how much should be paid for each species? What do you pay for a kilo of cod, haddock *(Melanogrammus aeglefinus)*, or capelin *(Mallotus villosus)*? From the time of the fee's introduction in 2004 and until 2013, it was levied on the quantity of cod-equivalent quotas allocated to the companies. The cod-equivalent coefficient used to calculate the quantity of cod-equivalent quotas is a measure of the prices of different

species relative to the price of cod. Price is, however, an unsatisfactory measure of profitability or rent.

In some species, there is a substantial difference between the profitability of catching and processing these and the cod-equivalent coefficient. The most notable examples are prawn (*Pandalus borealis*) and blue whiting (*Micromesistius poutassou*). The cod-equivalent coefficient for prawn fluctuated between 0.49 and 1.13 from 2004 to 2013 (Fiskistofa, 2015a), indicating that the ex-vessel price of prawn has been approximately half that of cod to being 13 percent higher. The cost of fishing prawn has, however, been quite high in recent years because of low stocks and high oil prices that resulted in little or no profits in the prawn fishery. Similarly, the Icelandic fleet normally must sail long distances to catch blue whiting, leading to high oil cost and low profitability. The cod-equivalent coefficient of blue whiting, therefore, dramatically overstates the profitability of catching it when compared with other pelagic species which have been very profitable to catch and process. Cod has, on the other hand, by definition, a cod-equivalent coefficient of 1.0. Catching cod is, however, very profitable and even more profitable than other demersal species. Due to the cod stock size, the catch per unit effort (CPUE) is high and has been increasing. The CPUE for cod in trawl has increased by 150% since 1991, substantially more than for other commercial demersal species (Hafrannsóknastofnun, 2016). Catching cod is, therefore, considerably cheaper than for most other species.

The solution to this problem consisted of the special cod-coefficients introduced in 2013 and profit coefficients defined in 2015. Those coefficients provide a better estimate of the profitability of catching and processing individual species than the cod-equivalent coefficient. Table 2 contains a comparison of the cod-equivalent coefficients in 2014, special coefficient for 2014, and profit coefficients for 2015. For example, the cod-equivalent of prawn was 1.13 in 2014 whereas the relative profitability of prawn fishing was only 0.87, as measured by the special cod-equivalent and only 0.08 by the profit coefficient. Thus, the profit coefficient resulted in 93% reduction in fishing fee from the cod-equivalent coefficients (1–0.08/1.13). The pelagic species, on the other hand, have considerably higher profit coefficients than the cod-equivalent one, because of the high profitability in fishing and processing pelagic species. Although the profit coefficients are an improvement on the cod equivalents, they are still criticised for being unstable and not reflecting profitability.

3.2. Variance in profitability between companies

The second issue is variance in profitability among the Icelandic fishing companies. This variation is partially caused by different species' composition of quotas. In addition, there is difference in profitability between vertically integrated companies and those only engaged in harvesting. Moreover, some firms are just more efficient and profitable than others because of better management and other factors. Finally, there are economies of scale; larger companies are more profitable than smaller ones. This issue has been especially important since 2009, i.e. in phases three and four (see Sections 2.3. and 2.4 above).

Fig. 3 presents a scatter diagram of the EBITDA (earnings before interest, taxes, depreciation and amortisation) per cod-equivalent kilo for the 23 largest companies in the Icelandic fishing industry in 2010. Those companies held approximately 69% of the total quota of the Icelandic fishing industry in 2010; thus, they truly represented the industry (Kristófersson and Gunnlaugsson, 2011). The resulting picture indicates great diversity. Ten companies had an EBITDA/cod-equivalent kilo higher than ISK 200 (EUR 1.5). However, there were two firms below ISK 100. A substantial fee, which has sometimes gone above ISK 30 per cod-equivalent kilo with respect to the companies paying the highest fees, would have a large negative impact on the least profitable companies. Conversely, a high fee would have little effect on the companies with the highest EBITDA.

Various measures were taken to overcome this diversity. One approach was to base the fee on the special cod-equivalent coefficient and profit coefficient. In addition, the deduction for indebted companies alleviated this problem to some extent, and the same applies to the small firm rebate. Clearly, a fee that is modest to one firm is high to another, and the higher the fee the more companies would be adversely affected. In an extreme case, the fee may force some companies to sell their quotas and leave the industry with unforeseen effects for rural communities. Although this type of rationalisation is a natural part of an ITQ system, adding fees is likely to increase the pressure on unprofitable firms and speed up rationalisation. This effect of the fee has been one of the main reasons for political reluctance to introduce higher fees for the industry.

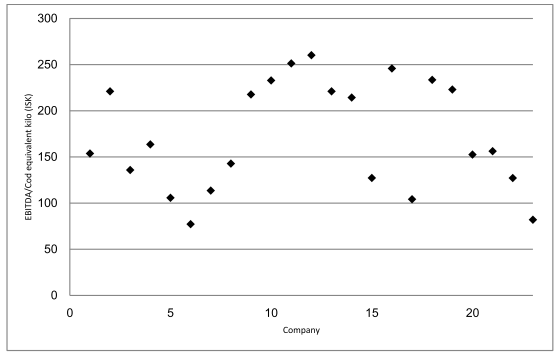

Fig. 3. Scatter diagram of EBITDA/cod-equivalent kilo in ISK of the 23 largest fishing companies in 2010. Sources: Fyrirtækjaskrá (2011) and author's calculations.

3.3. Revenue transfer between fishing and processing

The third issue is that a higher share of the profits generated in the Icelandic fishing industry has gone through the processing component of the industry than the fishing part in recent years. The majority of the largest and most important fishing companies in Iceland are vertically integrated; that is, they operate in both fishing and processing, as well as selling their own products (Knútsson et al., 2016). Landed catch is an intermediary product for these companies and pricing it is to some extent arbitrary. However, the remuneration of fishermen is determined by catch value and pricing is therefore of great importance to them. Since 1999 the ex-vessel price the most important species in intra company trade has been determined by a function that relates it to fish auction prices, determined in the collective bargaining agreement between fishermen and the fishing companies. This formula has a tendency to set prices in intra company trade 10–15% lower than in the fish auctions.

Fig. 4 demonstrates the split of EBITDA profits between the fishing and processing parts of the industry for the period 1991 to 2014. The price setting method for intra company trade leads to an underestimation of the profitability of fishing and makes estimating rent and profitability to set the fishing fee difficult. This issue has been important, especially since 2012, i.e. in phase four (see Section 2.4 above). It is worth noting that the fishing fee is added to the EBITDA of the fishing operation in Fig. 4. This is because the fee is classified as a cost item, even though it has many characteristics of a tax; thus, it lowers the 'real' EBITDA of fishing. Fig. 4 shows that fishing generated approximately 60%–75% of the EBITDA of the industry during the period 1991 to 2007, when its share was on average approximately 67%. Then, in 2008, the share of fishing in total EBITDA fell substantially. Since 2008, fishing has generated approximately 50%–60% of the EBITDA of the industry and on average 54% (Hagstofa Íslands, 2015b).

Two likely reasons are explanations for this development. The first

Fig. 4. Diagram of the fishing and processing components' share in the EBITDA of the Icelandic fishing industry from 1991 to 2014. Sources: Hagstofa Íslands (2015b) and author's calculations.

is the spectacular fall of the Icelandic krona in 2008, which resulted in a weak real exchange rate and highly favourable terms of trade for Icelandic exports. Costs denominated in Icelandic krona have been low, which benefits processing more than fishing, a development of which wages are a prime example. Although the fishers are paid catch shares that follow international fish prices, workers in processing are paid the going rate in Icelandic krona. Profitability in fishing is also more sensitive to oil prices, which have remained high during the period. Another probable explanation for this circumstance is that vertically integrated companies now hold a much larger share of the quotas than before (Knútsson et al., 2016; Saevaldsson and Gunnlaugsson, 2015). Quota consolidation and the emergence of vertically integrated companies, which cover fishing, processing and marketing, generates an ability to move profit within companies, for example, shifting it from fishing to processing.

The problem of revenue transfer from the fishing operation to processing has been considered in the development of formulas to calculate the fishing fee. Since 2012, profits in the fishing and processing component have constituted the basis for the fee, thus acknowledging and assuming resource rents are also generated in the processing component—not only in the fishing component.

3.4. Debt burden

The fourth, and one of the most crucial issues, has been the difficult financial situation, that is, a huge debt burden and considerable variations in the financial health of companies operating in the Icelandic fishing industry. This issue has been crucial, especially since 2009, i.e. in phases three and four (see Sections 2.3. and 2.4 above). In Fig. 5, the total debt of the Icelandic fishing industry is charted from 1989 until 2015 as well as the equity ratio (equity/assets) during the period. The

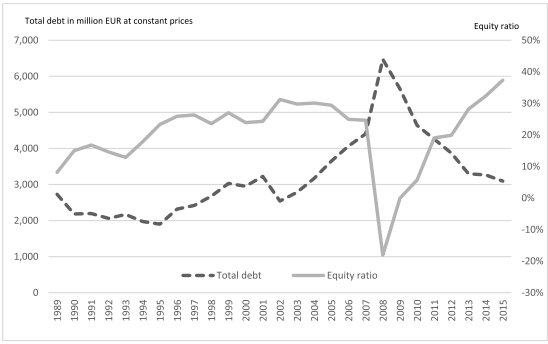

Fig. 5. The development of total debt, in constant prices (left-hand axis), and the equity ratio (equity/assets) of the Icelandic fishing industry (right-hand axis) 1989–2015. Sources: Hagstofa Íslands (2015b) and author's calculations.

picture tells an interesting story. Debt was constantly between 2 and 3 billion euros from 1989 until 2003. Next, the industry started to accrue debt, like other parts of the Icelandic economy, and its debt peaked in 2008 at 6.5 billion euros. The main reason for this increase in debt is that the industry massively invested in quotas from 2003 to 2007, and the book value of quotas in the annual reports doubled during that period (Hagstofa Íslands, 2015b). In addition, other investments, mostly in industries unrelated to fishing, increased considerably during that period. Fig. 5 also demonstrates that the equity ratio was relatively stable until 2008, when all the equity of the industry vanished and this ratio became negative. A negative equity ratio means that the value of debts is more than the book value of assets. This situation was because the Icelandic fishing companies reported huge currency losses in their annual financial statements in 2008, and that situation was mainly caused by debt being denominated in foreign currencies, whereas the accounts were in ISK. Thus, when the Icelandic krona lost half its value in 2008, the industry's financial liabilities exploded and all booked equity was wiped out (Gunnlaugsson and Saevaldsson, 2016). Since then, the situation has gradually improved. In 2015, the equity ratio of the industry was at a healthy 37%.

In 2010, a report analysed the financial health of the 23 largest firms, possessing 69% of the quotas. The findings were that more than half of them were in a difficult or extremely difficult financial position: they were heavily indebted and close to bankruptcy. These companies were, therefore, in an unfavourable financial state to take on an additional fee, which would have a substantial effect on their economic performance. The situation was even worse in 2009 when 12 of the 20 largest firms were investigated, and their balance sheets demonstrated that they were in an extremely difficult situation (Kristófersson and Gunnlaugsson, 2011).

Table 3 shows the equity ratio distribution of companies participating in the Icelandic fishing industry in 2010 and 2014. The weight of the table is the total revenue of the companies. Notably, in 2010, approximately 27% of the revenue of the Icelandic fishing industry was from companies with negative equity ratios; that is, the value of their debts was above the book value of their assets. Those companies were, therefore, in a very serious financial situation. This circumstance had improved considerably in 2014, when less than 15% of companies, weighted by revenue, were in a dire situation. The table clearly shows considerable variation in the companies' economic strength. A considerable number of companies are in a satisfactory position; that is, they have an equity ratio above 25%, especially in 2014, but many are struggling, especially in 2010.

Poor financial health, which characterised the industry from 2008 to 2011, and disparity in economic strength have been among the main reasons for the reluctance to increase the fees. When the fees were increased considerably in 2012, the solution was the reduction in the special fishing fee, granted to heavily indebted companies. As a result, most of those companies struggling with debt did not pay any special fishing fee (Table 4 in section 4).

3.5. Obtaining reliable and current data

Finally, calculating the basis for the fee has been a very difficult task. This issue has been important, especially since 2012, i.e. in phase

Table 3
The distribution of equity ratio, weighted on revenue, of the Icelandic fishing industry 2010 and 2014. Source: Hagstofan (2016).

Equity ratio	2010	2014
Negative	26.7%	14.7%
0–25%	18.8%	13.2%
25–50%	43.7%	43.4%
Over 50%	10.8%	28.7%

Table 4
Fishing fee for the fishing year 2012/2013, and its distribution between categories of size of companies, share of reduction because of difficult debt situation, and average total fee per cod-equivalent kilo. Sources: Fiskistofa (2015a) and author's calculations.

	Share of general fishing fee	Share of special fishing fee	Share of total fishing fee	Share of reduction because of difficult debt situation	The proportion of companies which receive a reduction because of debt	Total fishing fee ISK/ Cod equival. kilo
25 Largest	75.5%	88.6%	83.8%	55.8%	44.0%	28.8
26-50 Medium	10.1%	5.2%	7.0%	23.7%	76.0%	18.0
Smaller companies	14.4%	6.1%	9.2%	20.5%	7.8%	16.5

four (see Section 2.4 above). Ideally, the fee should be based on actual current rents. That would, however, require up to date information on revenues and costs, including capital costs, for all species. This is not easy. Firstly, it is both difficult to estimate and split costs by species, especially in vertically integrated firms, where determining intermediate revenue and splitting fixed costs is a real challenge. Secondly, if the fishing fee is to be general the estimation of rents can only be done when all companies have filed their taxes, about 10 months after the end of the financial year. Data on general industry profitability cannot be up to date. The Icelandic government therefore opted for a second best solution. Since 2012 the fee has been based on the most recent information available, regarding average revenue and cost.

Statistics Iceland has maintained a relatively sound collection of financial indicators for the fishing industry. These statistics are based on the data from fishing companies' tax returns (Hagstofa Íslands, 2015b). However, collecting and processing tax returns takes time, and all the data collected this manner is old and outdated. For example, the Icelandic fishing year starts in September, and the fishing fee must be set prior to that, that is, in July. The most recent tax return data available in July is between 1.5 and 2.5 years old when the fee is set, or 2 years old on average. This poses a challenge. Many factors may change in the fishing industry in 2 years. Examples of changes experienced include dramatic shifts in oil prices and the increase and decrease in prices of crucial pelagic species. Some form of adjustment is required, for example, using price indices. Problems associated with the measurement of costs and revenues in vertically integrated companies have been mentioned. Consistent measures of capital cost are also problematic. All these problems have been addressed since 2012, e.g. by using price indexes to adjust rent calculations.

4. Who has paid the fee?

What are the results of all this? Which companies have benefited from the reduction of the special fishing fee, because of a difficult financial situation? What is the relationship between size and the payment of the fishing fee? In Table 4, there is a breakdown of fishing fee payments, where companies in the Icelandic fishing industry are classified into three groups based on size. The measure of size is their quota holding in cod-equivalent kilos in the fishing year 2012/2013. This fishing year is a good example, the fee was significant, and the measures that have shielded smaller and indebted companies were in place.

Table 4 indicates that the 25 largest firms paid, and still pay, the vast majority of the fee. They paid 75.5% of the general fishing fee, which indicates they held 75.5% of the quota in cod-equivalent kilos. The largest firms paid the bulk of the special fishing fee, or 88.6% in 2012/2013. Therefore, the largest firms paid 83.8% of the total fishing fee in that fishing year. The average fishing fee per cod-equivalent kilo was highest, or ISK 28.8 per kilo, for the largest companies, who only received 55.8% of the reduction because of a difficult debt situation. Out of the 25 largest firms, only 44.0%, that is, 11 companies, obtained a reduction because of debt problems.

Companies of medium size, that is, the 26–50 largest companies, held 10.1% of the quotas and paid a corresponding portion of the general fee that fishing year. What is special about this group is that it received a disproportionately high reduction in the special fishing fee because of a difficult financial situation. More than three-quarters, or 19, of these medium-sized companies obtained this reduction. Those companies were in a much worse financial situation than the larger and smallest companies, as demonstrated by Gunnlaugsson and Saevaldsson (2016), and therefore were allocated this disproportionally high reduction. Consequently, they paid considerably less per cod-equivalent kilo in fishing fee than the largest firms. The smallest firms paid the least.

On average, all other companies than the largest 50 only paid ISK 16.5 per cod-equivalent kilo in the fishing year 2012/2013. The main reason was that most only paid ISK 9.5 per kilo (all that had quotas under 30 metric tonnes), resulting in this low fee. In addition, some of the larger firms in this group, approximately 8% of the total number, had their fishing fee reduced because of a difficult debt situation. Since 2012, there have been few changes in the distribution of payments of the fishing fee among Icelandic fishing companies from what is shown in Table 4. The 25 largest firms have been paying 83%–84% of the total fees, and the medium category have been paying almost the same proportion of the fee as they did in 2012/2013 (Fiskistofa, 2015a).

5. Discussion

The Icelandic fishing fee is now the largest experiment in the world where the fishing industry pays licence fees and resource rent taxes for access to the fishing resource. Other countries have not yet gone this far in taxing their fishing industries, and substantial fees, or true resource rent taxes, are uncommon in world fisheries. The fees imposed on the fishing industry in most countries' are normally small licence fees, which barely cover the administrative and research costs.

Why are the fees so low? Hannesson (2005) argued that user fees have mainly been introduced in fisheries where foreigners catch the majority or a substantial part of the catch (e.g. Morocco and the Falkland Islands), as governments seem much more willing to tax foreign companies than domestic ones (European Comission, 2016; European Commission, 2014; NR Fish, 2014). One can only speculate why, but market failure in the political market could be a plausible explanation. Domestic companies are viewed more favourably as general taxpayers, actors in local labour markets, and partners of government in resource management. Other considerations might be that those who buy their quota would have the basis of their business ruined if they incurred non-anticipated high fees.

Another reason may have to do with concern for the well-being of the rural communities which heavily depend on the fisheries, as those communities are often plagued with out-migration and loss of population (Corbett, 2005; Bjarnason and Thorlindsson, 2006). User fees and other taxes on the fishing industry might negatively affect those struggling communities the most, and in such cases, governments might understandably be reluctant to introduce special taxes on fisheries.

Finally, it is worth mentioning that calculating the resource rent and implementing a fair and non-distortionary resource rent tax in fisheries is difficult. The resource rent varies between species, vessels, areas, and companies, which makes calculating the tax difficult and implementation and enforcement difficult. Governments have, therefore, shied away from resource rent taxation; instead, those that have chosen to levy a tax on fisheries have opted for simple licence fees or access fees

which are simple to calculate and enforce but only cover a portion of the cost of research and management (Squires et al., 1998). Examples of this are the Atlantic provinces of Canada, Namibia, and some fisheries in the United States where the industry pays small licence fees (Sigurður Steinn Einarsson, 2014; Kirchner and Leiman, 2014; United Fishermen of Alaska, 2015). Iceland is in this respect no exception. The intention in 2012 was to base the fee on rents. That turned out to be difficult and the basis of the fee became aggregate EBT profits in fishing and a share of aggregate EBT profits processing. EBT profits have turned out to be highly varying, causing frustration in the industry. It is therefore likely that the basis of the fee will change.

All these arguments and problems have arisen in the discussion surrounding the introduction and increase of the fishing fee in Iceland. Nevertheless, despite these problems, the fee was introduced and increased and is now a significant expense for the industry. There has been significant opposition to the fee from the industry—as expected—and the political establishment. What has been crucial is the unwillingness of politicians to burden smaller companies and those struggling with debt because of the importance of the fishing industry in Iceland's rural communities. Those communities struggle with population loss; therefore, Icelandic politicians are reluctant to set fees, which would have a dramatic impact on those communities. A high fee would reduce employment in some of those communities because some firms stationed there would have to cease operations due to their inability to pay, spurring a further reduction the population and employment.

Another argument against the fee is competition. The fishing industry has argued it is unfair that it pays a significant fee when its competitors in other counties, especially in Norway, do not pay similar taxes (Kristófersson and Gunnlaugsson, 2011). The Icelandic fishing industry sell its products on the world market and thus is unable to increase prices in line with increase in costs. A higher fee would reduce competitiveness and limit the industry's ability to invest and increase efficiency and quality. Despite this opposition, the fee was introduced in 2004 and increased considerably in 2012, and it is highly unlikely it will be abolished in the future. This fee is now seen as an ingrained component of the ITQ system and necessary to pacify opposition to this controversial management system.

The experience from Iceland shows that fishing fees can generate substantial revenue for the government without substantial negative impacts on the industry. The evidence on the development of equity ratios and their distribution in the industry indicates that this has been the case in Iceland after the introduction of the fishing fee. Design of such fees is however difficult. Iceland opted for a flat rate fee determined be average profitability, unaffected by each fishing operators own profitability. This was regarded as a fair access fee with unchanged incentives to optimise own profitability. The current fee is however complicated, based on old data and unlikely to capture more than a fraction of rents. Complexity is never a good property of taxes and old data may not be very representative of current profitability in a world of ever changing prices and catches.

Possible improvements to the fee include a special income tax and/or a simpler model of profitability. Special taxes are simple in the sense that they are based on the same data and methods used to calculate corporate income tax and would allow for a more aggressive taxation of resource rents. However, separating fishing operations within vertically integrated firms will be difficult and possibilities to transfer costs and revenues between fishing and processing may create an incentive to integrate companies just to lower taxes. It seems therefore unlikely that such a special tax could generate very high revenues without adverse effects. On the other hand, the most obvious simplification of the current model would be to base the fee on predicted profitability, e.g. determined by available data on input and output prices. Such a model would though be rough and would not measure rents with accuracy. A third option is a combination of fees and taxes, where the fee is deductible. Such a combination might allow substantial taxation without unjustified adverse effects.

6. Conclusion

The profitability of the Icelandic fishing industry has greatly improved since the fisheries management system was changed to ITQs. This management system has, however, always been controversial. The introduction of a fishing fee to capture a share of resource rents from the fishing industry and redistribute it to the public has been a key step in increasing public acceptance of the system. However, the introduction of this fee has been a learning process, where many emerging problems have been gradually solved. When the fee was small, as it was until 2012, these problems were of little importance, but they had to be addressed when the fee became significant. The solution chosen by the political establishment was to make the largest and most profitable companies pay the vast bulk of the fee and let the smaller or financial weaker firms pay much less.

The lessons from Iceland show that it is no small task, and has proven to be difficult and cumbersome in practice, to implement a significant fishing fee in fisheries. This fee is the next rational step after decades of ITQ management. Other countries that have managed their fishing resource with ITQ systems are likely to follow Iceland's example. They will probably incur the same or similar difficulties when setting and implementing this type of fee. Therefore, the Icelandic experience is of paramount importance.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.ocecoaman.2018.06.001.

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Paper III

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Late arrival: The development of resource rent in Icelandic fisheries

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ABSTRACT

The development of resource rent in Icelandic fisheries has been charted since the introduction of the individual transferable quota system in 1990. An estimation of the rent capture of the fishing fee, which is a form of resource rent taxation, is also presented. Two methods were applied to calculate the resource rent. One method is based on the weighted average cost of capital of the Icelandic fishing industry, and the other method involves comparing the return of the capital of fisheries to the general aggregate Icelandic economy. The findings indicate no presence of the resource rent in Icelandic fishing and processing until 2008. Since that time, the rent has been, on average, 16–19% of the export value of the fishing industry, depending on the methods that were applied. The most obvious reason for the long delay before the rent appeared is the almost continual decline of fish catches from 1990–2008. The industry was rationalized during that time, but the rationalization kept up only with the reductions in landings; thus, no resource rent was produced. The rent appeared when the catches started to increase in 2009. In addition, the exchange rate and the weakening of the Icelandic krona were major contributors to the emergence of rent after 2008. The fishing fee captured approximately 13–15% of the calculated rent from 2009. The fee has been relatively modest but was significant in 2016, when it was increased and set at approximately 26–29% of the estimated resource rent of Icelandic fisheries.

1. Introduction

According to economic theory, introducing a management system that is based on the principles of individual transferable quotas (ITQs) into an overcapitalized fishery should, over time, lead to considerable efficiency gains (Grafton, 1996a; Hannesson, 2004). This has indeed been proven, as witnessed by developments in Australia (Gardner et al., 2015; Kompas and Che, 2005; Thébaud et al., 2014), Canada (Casey et al., 1995; Dupont, 2014; Gardner, 1988), Chile (Gómez-Lobo et al., 2011; Pena-Torres, 1997), Denmark (Andersen et al., 2010; Hammarlund et al., 2018), Iceland (Arnason, 2005; Gunnlaugsson and Saevaldsson, 2016; Knútsson et al., 2016; Yagi et al., 2012), Norway (Flaaten et al., 1995; Hannesson, 2013), New Zealand (Annala, 1996; Breen et al., 2016; Dewees, 1989), Sweden (Waldo and Paulrud, 2013) and the United States (US) (Agar et al., 2014; Gauvin et al., 1994; Matulich, 2008). In all of these cases, the introduction of ITQs led to increased profits and smaller fleets. Higher profits are the product of both higher revenue and lower cost, as harvesters organize their fishing to obtain the highest value for their landings and not to maximize catches (Andersen et al., 2010; Asche et al., 2008, 2009), while aiming to catch their quota with the lowest possible costs (Arnason, 2005; Grafton, 1996a; Kompas and Che, 2005). This system facilitates the transfer of quotas from less to more efficient firms, which gradually improves economic performance (Arnason, 2008; Dupont et al., 2002).

Over time, the introduction of an ITQ system should lead to the creation of resource rent (RR) (Grafton, 1996b), which may be regarded as a special kind of economic rent. The concept of economic rent was introduced in the 19th century (Gray, 1914; Rebelo, 2009) and refers to surpluses after all costs have been paid, including the necessary return on capital, both borrowed and owned (Wessel, 1967). RR stems from the use of natural resources and occurs because of scarcity; that is, excess demand that cannot be fulfilled by the supply that depends on a scarce natural resource and, thus, has a—more or less—fixed supply. In competitive industries that do not depend on scarce resources, the excess profit the industry enjoys would attract new entrants, and the current producers would increase production if extraordinary profits were present. That phenomenon would drive down prices and profits until an equilibrium was reached wherein profits were normal and similar to profits in other industries. By contrast, profits would not evaporate in industries that utilize scarce natural resources, such as fishing, oil, and gold (Grafton et al., 2008).

Although the existence of RR in fisheries has attracted some attention, most of the studies have analyzed the scope for rent generation in unregulated or poorly regulated fisheries through management

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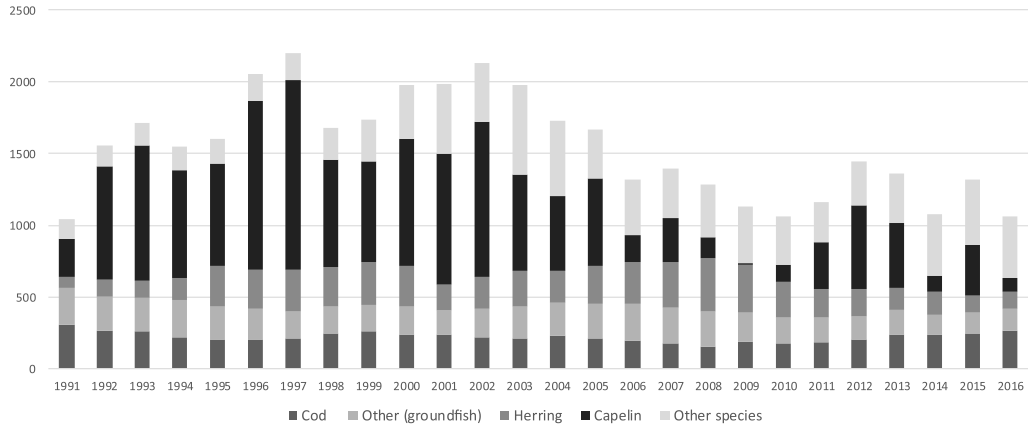

Fig. 1. Total catch by Icelandic vessels in the Icelandic Exclusive Economic Zone: 1991–2016 in thousand tonnes. Source: Statistics Iceland.

improvements. In a study on Swedish cod (*Gadus morhua*) fisheries, Eggert and Tveterås (2007) estimated that introducing individual vessel quotas could create RR amounting to 25–30% of the value of the catch. In their paper on the North Sea herring (*Clupea harengus*) fishery, Arnason et al. (2018) assessed the potential rent generation (currently, no rent is present in the fishery). The conclusion was that rent that was not dissipated because of the suboptimal stock size and the excess fishing effort could be substantial, with intramarginal profits accounting for only a small proportion of the total rent. Using a numerical optimization model, Greaker et al. (2017) estimated that substantial contrafactual RR could be generated in the Norwegian fisheries if the fishing quotas were harvested efficiently with the current available technology.

A recent example of actual rent generation in fisheries is demonstrated by Nielsen et al. (2017), whereby pelagic fisheries in the Northeast Atlantic, comprising mainly vessels from Denmark, the Faroe Islands, Iceland, Norway, and the United Kingdom, were examined. The findings were that the fisheries were well managed and profitable, and the estimated RR and producer surplus represented 32% of the landed catch value in 2007. Andersen et al. (2010) concluded that the introduction of ITQs into Danish fisheries in 2007 increased the RR, but a similar level of rent could have been generated through management by using effort restrictions.

Iceland was one of the first countries to implement fisheries management based on ITQs. Quotas were introduced in the pelagic fisheries in the 1970s and for the most important groundfish species in 1984, and a comprehensive ITQ system was initiated for almost all fisheries in 1990 (Arnason, 1993; Eythórsson, 2000; Matthíasson, 2003). Although close to 30 years have passed since the system came into effect, few studies have attempted to quantify the RR that was created in this period. Flaaten et al. (2017) estimated that the RR that was generated in the Icelandic fisheries in 2009–2013 amounted annually to 331–468 million USD, or 13.0–18.6% of the value of Icelandic fish exports. The methodology that was applied in that research had limitations; primarily, it did not consider the fishing fee, which has a significant effect on the RR. The fee is a form of RR taxation, but not a normal expense—as was presented in their research.

In 2004, the fishing fee was introduced in Icelandic fisheries, and it has always been levied on the landed catch. The catch depends almost entirely on the allocated quota; that is, the annual catch entitlement of each vessel, which is reassessed every year. The purpose of the fishing fee is twofold: to provide the Icelandic public a 'fair' share of the RR that the fishing industry is producing and to pay for the direct costs that are incurred by the government to monitor the fished resource (Gunnlaugsson et al., 2018; Matthiasson, 2008). Although the main purpose of this fee is to tax the RR of the industry, no analysis has investigated the rent capture, which is how much of the RR of the Icelandic fishing industry that this fee has collected; thus, vital information is absent in the literature regarding this important fee.

Two novel ways to calculate RR in fisheries are presented in this paper. First, by calculating the weighted average costs of capital (WACC) and the consequent financial costs, and then defining RR as the sum of earnings before interest and taxes (EBIT) and fishing fees paid to the government, less the calculated financial costs; second, by comparing the rates of the return of capital (ROC) in the fisheries and other industries and calculating RR based on that difference. The WACC method is applied to the period 1989–2016, but due to data limitations, it was possible to apply the ROC method only to the period 2002–2016. The latter methodology produces slightly higher estimates of the resource rent, but the difference is quite small for most recent years (2011–2016). In addition, the proportion of the RR that is captured by the fishing fee that is currently levied on Icelandic fisheries was estimated. The methods that were applied in this paper when calculating the RR are relatively straightforward and should, therefore, be applicable to fisheries in other countries.

2. Icelandic fisheries

2.1. Catches

The total catch of Icelandic vessels has decreased since the 1990s (Fig. 1). The catch peaked from 1996 to 1997 and again in 2002, when it exceeded 2 million tonnes, and bottomed out in 1991 at 1 million tonnes and again in 2010, 2014, and 2016, at approximately 1.1 million tonnes. The most important reason for the swings in the total catch have been the fluctuations in the landings of capelin (*Mallotus villosus*), and the total landings peaked when the catch of capelin exceeded 1 million tonnes. Cod (*Gadus morhua*) has been the most important species and was observed to have the highest catch value throughout the period. The total catch of cod by Icelandic vessels was 306 thousand tonnes in 1991 but decreased until 2008, when it bottomed out at 151 thousand tonnes. Since then, the trend has reversed, because the stock has been rebuilt: the cod catch was 264 thousand tonnes in 2016. The total catch of other important groundfish species, that is haddock (*Melanogrammus aeglefinus*) and saithe (*Pollachius virens*), as well as redfish (i.e., mainly two species [*Sebastes marinus*] and [*Sebastes mentella*]), has decreased considerably. The prawn fishery (*Pandalus borealis*) has totally collapsed. In 1991, the total prawn catch by Icelandic vessels was 38 thousand tonnes and peaked at 76 thousand tonnes in 1995. Since then, the industry has almost totally collapsed, and the total landings of

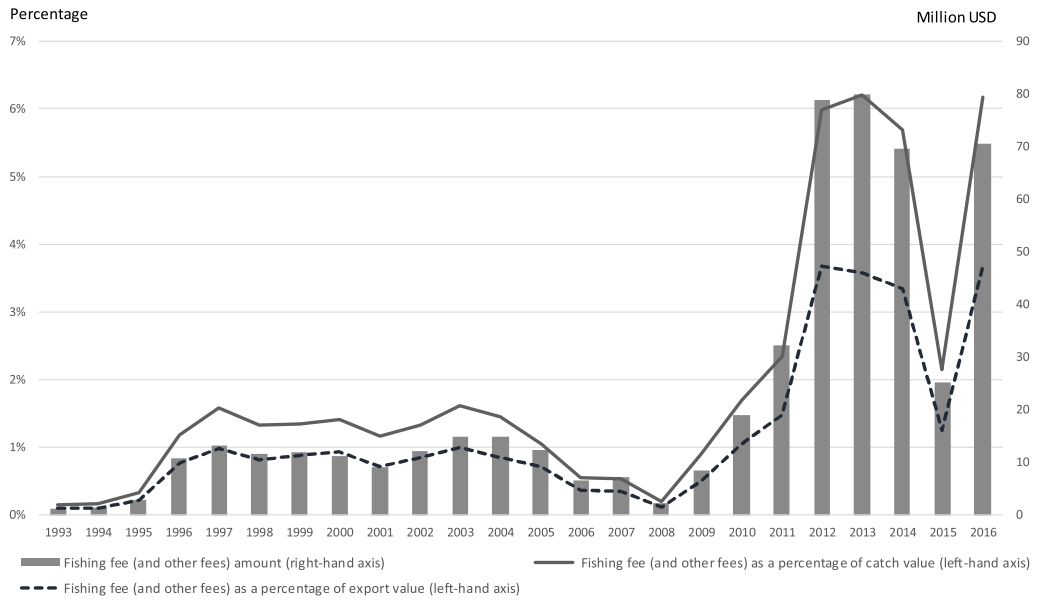

Fig. 2. Fishing fee amount and other fees (right-hand axis), and the fishing fee as a percentage of the catch and export value (left-hand axis), 1993–2016. Sources: Statistics Iceland and Directorate of Fisheries.

prawn amounted to only 5 thousand tonnes in 2016.

Fortunately, Icelandic vessels have started to fish new species, which has reduced the negative effect of the lower catches of capelin, cod, and prawn. The catch of blue whiting (*Micromesistius poutassou*) recommenced in 1995 after a long break. The landings peaked in 2003, when Icelandic vessels caught 501 thousand tonnes of blue whiting but decreased to 215 thousand tonnes in 2015. Icelandic vessels started fishing mackerel (*Scomber scombrus*) in significant quantities in 2008, when the total catch was 112 thousand tonnes. In 2015, the mackerel catch increased to 168 thousand tonnes.

2.2. Fisheries management

Iceland's experience with quota management systems in fisheries dates to the 1970s, when quotas were introduced into the herring and capelin fisheries, to be followed by quotas for the main demersal species in 1983. In the ensuing years, the demersal fisheries were managed by using a combination of quota and effort restrictions, but in 1990, a comprehensive ITQ system was introduced into almost all commercial fisheries (Arnason, 1993, 2005; Saevaldsson and Gunnlaugsson, 2015). The management regime initially included only vessels that are larger than 6 gross registered tonnes (GRT). However, smaller boats were incorporated into the management system around the turn of the millennium (Agnarsson et al., 2016). At present, the ITQ system applies to almost all Icelandic fisheries, or approximately 98% of the landed value (Flaaten et al., 2017). Exempt from the ITQ management system are coastal fisheries and catches of lumpfish (*Cyclopterus lumpus*).

The consequences of the ITQ system have been varied and are significant. The number of active vessels has decreased. Profits that were measured as earnings before interest, taxes, depreciation, and amortization (EBITDA) have become more sustainable, and the overall debt level of the industry has risen, not the least of which was due to quota transactions (Gunnlaugsson and Saevaldsson, 2016). Quota ownership has also become more consolidated, and the harvesting firms have become larger (Agnarsson et al., 2016). In 1995, the five largest companies had 17% of the quotas, which were measured in terms of the cod-equivalent tonnes. A cod-equivalent tonne is defined as the unit value of each species relative to the unit value of cod, which is the most important fishery. The cod-equivalent coefficients (which are used to calculate the cod-equivalent tonne) were calculated for each fishing year (September 1 – August 31) on the basis of the average unit value of the landings of each species to that of cod, which always has the cod-equivalent coefficient of 1.0 (Gunnlaugsson et al., 2018). By 2018, the share of the quota held by the five largest firms had grown to 30% in cod-equivalent tonnes. The past 25 years have also witnessed the gradual emergence of vertically integrated companies that are involved in fishing, processing, marketing, and selling their products (Knútsson et al., 2016). These large, vertically integrated companies currently hold the majority of Icelandic fishing rights.

2.3. Fishing fee

Following the suggestions of a special Parliamentary resource committee (Auðlindanefnd), an act that introduced a special fishing fee was passed in 2002. The fishing fee replaced various fees that were levied on harvesting but was also intended to pay for the management of the fished resources and return a share of the RR to the public. The fishing fee came into effect during the fishing year 2004–2005 but has since been revised and set for each fishing year. The fee is levied on the landed catch, and it varies between species, with the most valuable species, such as cod and Greenland halibut (*Reinhardtius hippoglossoides*), taxed higher than less valuable species, such as capelin or saithe (*Pollachius virens*) (Gunnlaugsson et al., 2018).

Prior to the introduction of the fishing fee, the Icelandic fishing industry paid relatively small fees for management and monitoring in the form of license fees (Fig. 2). The fees were levied on annual catch entitlements, which were paid annually and were small; that is, they were always under 16 million USD and were less than 1.7% of the catch value. The main purpose of those fees was to pay for the direct costs that were incurred by the Icelandic government for monitoring and management of the fished resources. These fees were all abolished when the fishing fee was introduced in 2004. The fishing fee was initially low: 1.5% of the catch value in 2004, and 0.2% (the lowest value) in 2008, which was approximately 2 million USD. Iceland was

Table 1
The IFRS principles, the WACC method, and problems when calculating the RR.

		IFRS	Problems when calculating the RR	WACC method
	Revenue	Income from fishing and processing.	Income from fishing and processing; however, income from leasing fishing rights should be excluded.	Income from fishing and processing.
−	Operating costs	Wages, raw material, oil, gear, insurance, maintenance, administration, operating costs, and fishing fee.	Fishing fee should be excluded. Cost from leasing fishing rights should be excluded. If fishers receive part of the rent, because their wages are higher than their opportunity cost, their share of the rent should be estimated.	All cost items except the fishing fee are recognized. No attempt was made to assess the part of RR fishers receive because of wages greater than estimated opportunity cost.
=	EBITDA	EBITDA		EBITDA + fishing fee
−	Depreciation	Assets are depreciated based on original purchase price by using the straight-line method.	Depreciation may not represent the replacement value of the assets. Depreciation of fishing rights (quotas) should be omitted.	Depreciation was used as a measure of the replacement value of assets.
=	EBIT	EBIT		EBIT + fishing fee
−	Financial charges	Financial cost and currency difference on all debts.	Financial cost calculated on debts and equity. The cost should represent the opportunity cost of the capital, without quota holdings.	Financial cost was calculated by estimating WACC for the industry on the basis of all assets, except for quota holdings.
−	Taxes	Corporate taxes	Corporate taxes were omitted	Corporate taxes were excluded.
=	Profit	Profit		Estimated RR

hit hard by the financial crisis in 2008, which saw the value of the Icelandic currency, the krona, plummet and the export earnings of the fisheries, measured in krona, rose sharply. In the aftermath of the crisis, a new left-wing government was elected, which was more willing to heavily tax the fishing industry. The rising fees then became an important expense for the harvesting sector. In 2012 and 2013, the fee exceeded 6% of the catch value, approximately 3.6% of the export value, and approximately 80 million USD. By then, the fee had become a significant cost for the vessel owners and operators. Following the parliamentary elections in 2013, a new center-right government came into power, which was less keen than its predecessor to tax the fishing industry. The fee was, therefore, lowered in 2015, with fees in that year amounting to 25 million USD, or 2.1% of the catch value. Next, a new government was elected, and the fee increased considerably in 2016: the fee was 70 million USD and 6.2% of the catch value. The literature presents a description of the Icelandic fishing fee (Gunnlaugsson et al., 2018) in greater detail, i.e., with specifics regarding historical accounts and problems that occurred while setting the fee.

3. Materials and methods

3.1. Calculating resource rent

Measuring the RR that was generated in fisheries can be very problematic, with the first issue being the definition of RR. In general, rent may be defined as the profit remaining after the total assets have been compensated based on the opportunity cost. There may be, however, more than one source of rent in fisheries, for example, intramarginal rent, and distinguishing between these different types of rent may prove to be virtually impossible (Thébaud et al., 2014). Intramarginal rent exists because vessels are, in reality, heterogeneous in terms of capital and labor (Coglan and Pascoe, 1999; Copes, 1972). Some vessels will, therefore, be more cost efficient than a marginal one that earns no profit. A second issue concerns the calculations of input costs, in particular, the opportunity costs of capital and labor. Whereas operating accounts will usually record the correct costs, that is, the opportunity costs, of all intermediate inputs, the same may not hold for capital and labor. The costs of using capital and labor must, therefore, be adjusted to consider the fact that operating accounts reveal only the accounting costs of using these inputs, but not the true economic costs (Flaaten et al., 2017). Finally, the reinvestment necessary to maintain the operations of the industry must be assessed (Flaaten et al., 1995, 2017; Wessel, 1967). All of those problems occurred while measuring the RR that was generated in Icelandic fisheries. Because of this uncertainty, two new methods were applied in this study to increase the accuracy. The first method estimates rent based on the estimated cost of capital, which in this study is referred to as the weighted average cost of capital (WACC) method. The second method estimates the RR based on the difference in the return of capital (ROC) between the fishing industry and the average ROC of enterprises that operate in the Icelandic economy, excluding the fishing industry and the financial sector. This second method is referred to as the ROC method.

The financial accounts, that is, the profit and loss accounts, balance sheets, and cash flow statements (Curtis et al., 2013; Zhang and Zheng, 2011), of Icelandic fisheries firms follow the international financial reporting standards (IFRS). As shown in Table 1, earnings before interest and depreciation (EBITDA) are, according to the IFRS, calculated as revenue from fishing and processing less the operating costs (wages, raw material, oil, gear, insurance, maintenance, administration and the fishing fee). Earnings before interest (EBIT) are then calculated as the EBITDA less depreciation, and subtracting financial charges and taxes yields a measure of the profits. While the RR may be calculated in a similar manner, there are several adjustments that may be needed (Table 1).

The first adjustment is that revenue should include only income from harvesting and processing fish and other marine species and not

income from leasing fishing rights. However, Icelandic harvesters can only sell quotas to one another and not to entities outside the fishing sector or abroad; the revenue from leasing fishing rights is a revenue for one company but is an expense for another company. Because of this, there is no need to adjust how EBITDA is measured in the firms' accounts. The second adjustment is the fishing fee. The fee is classified as a normal cost that is similar to, for example, the wages and the cost of oil, but not as a tax according to the principles of the IFRS. The main purpose of this fee is to tax the RR of the Icelandic fishing industry; the fee is, therefore, added to the EBITDA in this study.

The third issue concerns fisher's wages. Ideally, the wages paid to fishers should reflect their opportunity cost of labor and, in cases where wages are higher, this should be considered when calculating the RR (Bulte et al., 1995; Flaaten et al., 2017). In Iceland, fishers are most often paid more than average wages. This top-up is necessary, because their job often involves substantial discomfort, long hours and absences from home, and danger, although fatalities in Icelandic fisheries have declined considerably in recent decades. However, attempting to estimate the opportunity cost of Icelandic fishers is fraught with difficulties, and in this study, no attempt was made to do so. Therefore, the calculations of RR presented in this study could be somewhat lower than they would have been if the share of RR were adjusted to include wages paid to fishers.

The fourth issue is depreciation. The purpose of depreciation is to match the cost of productive assets to the revenues that are earned from utilizing these assets, which reflect the cost and replacement value of the capital stock. In the annual reports of Icelandic fishing companies, depreciation is estimated by using the straight-line method. Real estate is normally depreciated in increments of 25–30 years, equipment in increments of 5–15 years, and ships in increments of 25–30 years. In this study, the values of the assets of companies of the whole Icelandic fishing industry are measured at book value. Although it is always possible that depreciation rules for tax purposes exaggerate real depreciation, this is of minor concern in this study. That is, because the straight-line depreciation rules that are used by Icelandic fishery companies tend to be well aligned with the economic life of the assets. By contrast, the accelerated deprecation method that is often applied in the U.S. has led to assets being depreciated faster than that which corresponds to their true loss of value. It is, therefore, reasonable to assume that the book value of total assets is a satisfactory estimate of the real value of the total capital in the Icelandic fishing industry.

Since 2005, there has been an insignificant depreciation of fishing rights in the financial statements of Icelandic companies, because of their permanent nature. However, up to 2005, the charged depreciation may have overestimated the replacement value of assets, because depreciation includes the depreciation of purchased fishing rights. As purchased quotas composed only a small part of the total assets, on average 18% from 1997 to 2004, this does not have serious consequences for this study. Only later did fishing rights become a significant part of assets. Since 2007, the book value of fishing rights (quotas) has been approximately 38–43% of the book value of total assets of the Icelandic fishing industry.

The fifth—and most crucial—issue concerns the calculation of the financial cost. According to IFRS principles, the financial cost in annual reports comprises interest expenses and currency charges on all debts. No allowance, however, was made for the cost of equity; the opportunity cost of capital is completely omitted, according to the IFRS. A second bias stems from the fact that, according to the IFRS, the financial cost includes the costs of servicing all debt, including financial costs that result from investments in fishing rights (quotas). However, the cost of acquiring quotas should be excluded, as the cost of capital should be calculated without quota holdings (Bulte et al., 1995; Flaaten et al., 2017). This is precisely the path that is taken under the WACC method, as shown in Table 1 and Section 3.3, below.

3.2. Data

The data that are used in this study come primarily from three Icelandic public sources, namely, Statistics Iceland, the Directorate of Fisheries, and the Central Bank of Iceland. The fisheries data that were collected by Statistics Iceland consists of both the aggregate data on catches, the fleet size, markets, and exports, as well as the financial data of the fishing industry based on the tax returns of a representative sample of fisheries firms. The accounting data are fairly disaggregated and include information on the costs, revenues, and profits, as well as assets and liabilities, including equity. Good financial data have existed only since 1997, with earlier data being less aggregated. Statistics in Iceland base its information gathering on other sectors and almost entirely on the tax returns of representative samples in each branch of economic activity. The data that were collected are similar to that which were collected for fisheries firms.

The Directorate of Fisheries is a government agency that is charged with monitoring the Icelandic fisheries and the daily administration of the fisheries management in Iceland, including levying fishing fees on Icelandic harvesters.

Data on interest rates were obtained from the Central Bank of Iceland. For the period 1997–2016, the cost of capital was estimated as the Reykjavik Interbank Bid Rate (REIBID) plus 2.5%, which is a common margin of corporate borrowing in Iceland. REIBID is the rate at which Icelandic banks make deposits with each other, and it is regarded as a satisfactory guide for the annual interest rate and basic cost of borrowing. For the earlier period, 1989–1997, the capital borrowing cost was estimated as the general term deposit rate plus 2.5%.

3.3. The WACC method

The weighted cost of capital shows the full cost of capital by calculating both the cost of borrowing and the opportunity cost of equity (Luehrman, 1997). Formally, WACC is defined in the following manner:

$$WACC_t = W_{d,t} K_{d,t} (1 - tax_t) + W_{e,t} K_{e,t} \quad (1)$$

where $W_{d,t}$ is the proportion of the capital stock in the whole fishing industry, which was funded by borrowing in year t, and $W_{e,t}$ is the proportion that was funded by equity. $K_{d,t}$ is the cost of borrowing and is assumed to have been REIBID, plus 2.5% from 1998 in this study; before that, it was estimated at the rate of general term deposits, plus 2.5%. $K_{e,t}$ is the opportunity cost of equity, and tax_t is the corporate tax rate.

In an ideal world, the market value of both debt and equity should be used for these calculations. While the book value of the debt of Icelandic fishing firms is sufficiently close to the market value, the same does not hold for the market value of equity, as only very few Icelandic fishing firms have been registered on the Icelandic stock market since 2007. Furthermore, it is likely that the present value of the RR would make up most of the market value of the equity, and equity should, therefore, be adjusted accordingly. In view of these difficulties, it was decided that the book value of equity should be used, but with the value of fishing rights (quotas) subtracted from this book value. The book value of assets was adjusted in a similar manner, as shown in Eq. (2) as follows:

$$W_{e,t} = \frac{Equity_t - Value\ of\ \ fishing\ \ rights_t}{Assets_t - Value\ \ of\ \ fishing\ \ rights_t} \quad (2)$$

$W_{d,t}$ was then calculated using Eq. (3) as follows:

$$W_{d,t} = 1 - W_{e,t} \quad (3)$$

The cost of equity $K_{e,t}$ was calculated by applying the capital asset pricing model (CAPM) each year that this study spans. Although this model is the cornerstone of modern finance (Jensen et al., 1972; Lintner, 1965), it does have its shortcomings. The most important is that the relationship between return and risk is not what the model

predicts; that is, high systematic risk does not give a sufficiently high return when the model is tested with real data (Fama and French, 2006; Gunnlaugsson, 2007). In addition, there are factors other than systematic risk that explain returns; for example, the market-to-book ratio, firm size, and company risk (Fama and French, 1992). The CAPM model is defined as follows:

$$K_{e,t} = R_{f,t} + \beta(R_m - R_{f,t}) \quad (4)$$

where β is calculated using the following:

$$\beta = \frac{Covar(R_{i,t}, R_{m,t})}{Var(R_{m,t})} \quad (5)$$

where $R_{f,t}$ represents the risk-free rate, $R_{m,t}$, represents the return of the market, and β is a numeric value that measures the fluctuations of a stock to changes in the overall stock market. The average company with average risk has a β coefficient of 1.0. When calculating the beta coefficient, the OMXI8 index, which is an index of the eight largest firms on the Icelandic stock market by market capitalization, was used as a proxy for the market. Using the average monthly returns of HB-Grandi, the only fishing firm registered on the stock market for the period April 2014 to December 2017, yielded a β coefficient of 0.5. Accordingly, this value was used for all of the years.

The Icelandic stock market has a relatively short history. It took a terrible beating during the market crash of 2008, when the market was down 94.4%. As a result, the risk premium ($R_m - R_{f,t}$) of the Icelandic stock market has been negative, on average, since its inception in 1993. Rather than relying on uncertain Icelandic data, it was, therefore, decided that the calculations of the risk premium should be based on U.S. data for the period 1928–2017. The risk premium was estimated by using the average return of the S&P 500 stock index, which is an index of the 500 largest firms on the U.S. stock market, in excess of the risk-free return, which was represented by the return of U.S. 3-month T-bills. This method yielded an average risk premium ($R_{m,t} - R_{f,t}$) of 6.3%, which was used for every year of this study. This risk premium is in line what has been observed over long periods on European stock markets (e.g., Sweden, Finland, Norway, France and Germany; Dimson et al., 2003) and may, therefore, be regarded as a satisfactory approximation of the risk premium for Icelandic equities.

The calculated financial cost in year t, CFC_t, was then calculated as follows:

$$CFC_t = WACC_t(Assets_t - Value\ of\ fishing\ rights_t) \quad (6)$$

where assets are defined as the sum of debt and equity. The calculated financial cost (CFC_t) was estimated by multiplying $WACC_t$ by the total assets less than the book value of fishing rights (Eq. 6) for each year that this research covers. Thus, this cost represents the cost of capital and the opportunity cost of owned capital for all assets, except for fishing rights (quota).

$$RR_t = EBIT_t + Fishing\ fee_t - CFC_t \quad (7)$$

The RR was finally calculated for each year from 1989 to 2016 using Eq. (7). RR was estimated to be the reported EBIT (earnings before interests and taxes) in fishing and processing, plus the fishing fee for the particular year, less the calculated financial cost (CFC). Thus, Eq. (7) aggregates all of the previous calculations and estimates the RR of the whole Icelandic fishing industry during the period studied.

3.4. The ROC method

The second method, which was referred to as the return of capital (ROC) method, estimates the RR by using the ROC of the aggregate Icelandic economy and compares that to the ROC of the fishing industry. This analysis starts in 2002, because the data that are necessary to calculate the ROC of the aggregate economy were not available before that time. Eq. (8) has typically been applied to calculate the ROC, where EBIT is divided by assets. The ROC shows how much profit the capital is generated by the business generates. Obviously, a higher ratio indicates that more profits are generated by the amount of capital employed. This ratio is a good measure of how effectively a company or an industry uses its capital. The ROC should always be greater than the borrowing cost; if not, the companies are losing money.

$$ROC_{A,t} = \frac{EBT_t + Financial\ cost_t}{Assets_{A,t}} = \frac{EBIT_t}{Assets_{A,t}} \quad (8)$$

$$ROC_{F,t} = \frac{EBIT_t + Fishing\ fee_t}{Assets_{F,t} - Value\ of\ fishing\ rights_t} \quad (9)$$

$$RR_t = (ROC_{F,t} - ROC_{A,t})(Assets_{F,t} - Value\ of\ fishing\ rights_t) \quad (10)$$

The $ROC_{A,t}$, which is the aggregate ROC of all firms operating in the Icelandic economy except for fisheries, financial institutions, and pharmaceuticals, was calculated by using Eq. (8) for each year of the study. Then, $ROC_{F,t}$, which calculates the ROC of the fishing industry, was calculated using Eq. (9). $ROC_{F,t}$ is EBIT plus the fishing fee divided by all assets except for the book value of fishing rights. Finally, Eq. (10) was applied, and the RR was estimated for every year during the period 2002–2016. By using Eq. (10), the difference in ROC between the fishing industry and the aggregate economy was estimated ($ROC_{F,t} - ROC_{A,t}$). This difference was then multiplied by the total assets of the fishing industry ($Assets_{F,t}$) less the book value of fishing rights, and the annual RR was estimated.

The ROC method is based on the assumption that excess ROC in fisheries, i.e., an ROC greater than the average of other Icelandic industries, represents the RR, but a question remains regarding the veracity of the methodology. An extensive investigation of the U.S. stock market concluded that ROC was stable over time but was variable between industries. The ROC was highest in industries with high barriers to entry, such as patents and brands, which reduced competition and led to a high ROC (Jiang and Koller, 2016). The Icelandic fishing industry has high barriers to entry. However, those barriers are primarily caused by the ITQ system. The ITQ system results in very expensive fishing rights (quotas), which makes entry into Icelandic fisheries for new entrepreneurs difficult (Chambers et al., 2017; Gunnlaugsson and Saevaldsson, 2016). That system is the reason for the RR in the industry, and without the ITQ system, the fishing industry would probably have a similar ROC to the aggregate economy.

Capital-intensive sectors and highly competitive sectors tend to generate low ROCs. The fishing industry in Iceland is relatively highly capital-intensive compared with most other industries in Iceland, which should lower the ROC. In addition, the Icelandic fishing industry is competitive with hundreds of companies, and more competitive than almost all other parts of the Icelandic economy. Finally, a notable consideration is that the Icelandic economy is small, and in many major industries, for example, retail, transport, or media, there are only two to four major players. Therefore, there is little competition in many parts of the Icelandic economy, and monopoly rent is probably widely present, which should lead to a higher ROC than in a fully competitive society. After considering all this information, the capital intensity and competition reduced ROC in Icelandic fisheries, and little competition increases the ROC in most other parts of the Icelandic economy. A fair assumption is that the difference in ROC between the fishing industry and the aggregate economy (except for fishing, financials, and pharmaceuticals) is a satisfactory and conservative estimation of the RR in Icelandic fisheries.

4. Results

Fig. 3 presents the estimated RR for the period 1989–2016 according to the WACC method and for the period after 2002 for the ROC method as a percentage of the export value of Icelandic fisheries. Almost all Icelandic fish products are exported; thus, this measure is a good measure of the revenues of the industry. The export value

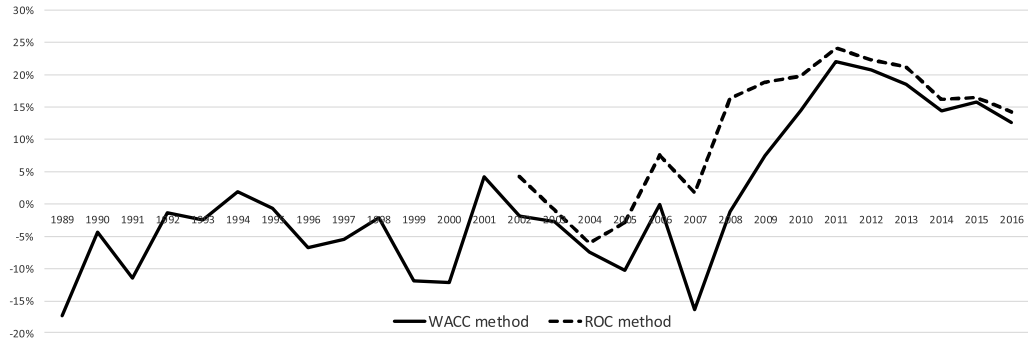

Fig. 3. Resource rent as a percentage of the export value in Icelandic fisheries, 1989–2016. Sources: Statistics Iceland and the author's calculations.

automatically cancels out the revenues that are sold by fishing to processing firms; thus, double counting of revenues is avoided. By showing the share of RR as a percentage of the export value, its portion is shown to remain at constant prices, because the inflation affects the RR and export value equally. Fig. 3 charts a clear and interesting story. There was no RR present in the Icelandic fishing industry for the first years of the ITQ system, and RR was not visible until 2009, according to the WACC method. Notably, exceptions were observed: there was a small RR of 1.8% in 1994 and a more significant RR of 4.2% in 2001. The RR in 2001 was most likely caused by the fall of the Icelandic krona that year, which resulted in good profitability of the industry. From 1989–2007, the average RR was -5.8% of the export value according to the WACC method; thus, a fair assumption is that the industry did not produce RR during that period. The year 2008 is a "game changer" and no RR was observed. However, starting in 2009, the rent was, on average, 15.7% of the export value according to the WACC method.

The ROC method provides similar estimates of the RR, but slightly higher, as the average RR was 19.1% of the export value from 2009–2016. The difference between the two methods is greatest in 2007 and 2008. The most likely reason for the difference in those years are the high interest rates during that period, which led to a high CFC and reduced the estimated RR by the WACC method. The ROC method estimates the rent by using the difference in ROC between fisheries and other parts of the economy; thus, its estimate is not sensitive to interest rates. The two methods have provided remarkably similar results since 2010. The likely reason for this similarity is that since 2010, the profitability of the industry has been consistent and satisfactory. Moreover, the Icelandic economy, at that time, was relatively stable, with reasonable interest rates, and relatively little change in the exchange rate was observed. This similarity in the estimated RR based on those two methods strengthens the assumption that these calculations are reliable and precise.

A safe assumption is that the ROC method would not have shown any RR generated in the fishing industry from 1989 to 2001, even if the data on the average ROC for the aggregate Icelandic economy were available. The only exception would perhaps have been 2001, when the ROC for the fishing industry ($ROC_{F,t}$) was 12.9%. The reason for this assumption is that $ROC_{F,t}$ was, on average, low from 1989 to 2001, which was 5.6%, and is unlikely to be higher than the estimated $ROC_{A,t}$ if the data were available to calculate it. Since 2008, the $ROC_{F,t}$ was, on average, 18.5% and generated the RR because the average $ROC_{A,t}$ was only 4.1% at that time.

Table 2 shows the fishing fee and its portion of the estimated RR according to the WACC and ROC methods, and the estimated amount of the RR according to both methods. The fee was modest from 2009–2011. When the fee increased in 2012 to approximately 79 million USD, it represented approximately 16–18% of the calculated RR. The fee decreased considerably in 2015 and increased again in 2016, when it was 70 million USD and was estimated to be approximately 26–29% of RR. On average, the fee was 15% of the RR according to the WACC method from 2009 to 2016, and 13% by the ROC method.

5. The mystery of the absent resource rent

The broad picture is clear; no RR was produced in the Icelandic fishing industry until the 2008–2009 period. What was the reason for that phenomenon? Why did the fishing industry and ITQ management system in Icelandic fisheries require almost two decades to rationalize and yield a significant RR? The explanations for these questions are numerous. The most important explanation is the almost continual reduction of the catch of Icelandic fishing vessels from 1989 to 2008. During that time, the catch in cod-equivalent tonnes decreased by 48.2%. Fig. 4 presents the development of the catch, employment, and estimated RR according to the WACC method. The industry was rationalizing during the whole period. Factories were closed, boats were scrapped, and firms merged, with many ceasing operations. However, the industry's rationalization caught up only with a reduction in the total catch. That phenomenon is evident when the number of full-time jobs are charted. Full-time jobs are the total number jobs in fishing and processing. The number of jobs decreased by 51.0% from 1989 to 2008 (Fig. 4), just to keep up with the reduction in the catch. It is not until landings started to increase in 2008 that the industry started to produce significant RR. Since 2008, the catch increased by 52.4%, whereas the number of fishers and others working in the processing industry increased by 6.8%. The rationalization of the industry paid off with a significant RR.

Another important reason for the change in 2008, and the emergence of RR, is the spectacular fall of the Icelandic krona that year, when it lost almost half of its value. At the start of 2008, the Euro was 92.4 Icelandic kronas and ended the year at 171.5. The real exchange rate, which was measured by consumer prices and the estimated RR in proportion to the

Table 2
Fishing fee, RR, the fishing fee's share of estimated RR, 2009–2016. Sources: Statistics Iceland, Directorate of Fisheries and author's calculations.

	2009	2010	2011	2012	2013	2014	2015	2016
Fishing fee (million USD)	9	19	32	79	80	70	25	70
RR (WACC method) (million USD)	124	262	477	447	414	300	315	241
RR (ROC method) (million USD)	317	356	523	479	470	337	330	274
Fishing fee/RR (WACC method)	7%	7%	7%	18%	19%	23%	8%	29%
Fishing fee/RR (ROC method)	3%	5%	6%	16%	17%	21%	8%	26%

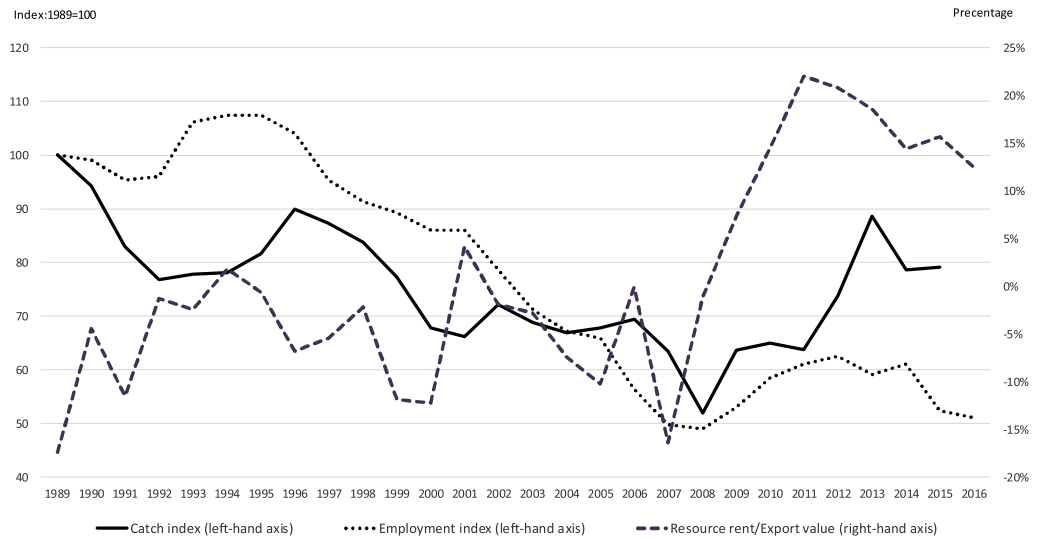

Fig. 4. Time-series of the catch index (cod-equivalent tonnes), employment index, and the estimated RR/export value according to the WACC method, 1989–2016. Sources: Statistics Iceland, Directorate of Fisheries and author's calculations.

export value, is shown in Fig. 5. The real exchange corrects the exchange rate to the price level of the average consumption basket. An increase in the real exchange rate of the Icelandic krona means that the prices in Iceland have increased compared with that of other countries that were measured in foreign currencies, if the exchange rate did not change. The Icelandic fishing industry benefits from the weakening of the real exchange rate for the Icelandic krona, because almost all of its products are exported and paid for in foreign currencies. However, a significant portion of costs are in Icelandic kronas. Therefore, a weakening of the Icelandic krona increases revenues in the local currency, and costs do not increase proportionally. Fig. 5 shows a significant negative relationship between the real exchange rate and the RR during the observed period. The correlation coefficient is estimated to be -0.76. The y-axis is inverted in the picture; thus, when the real exchange rate of the Icelandic krona falls, which occurred during the period 2007–2009, when the average real exchange rate decreased from 99 to 64; it is represented by an upward movement on the graph. Fig. 5 shows that the RR has followed the real exchange rate very closely, and a weaker Icelandic krona is one of the fundamental reasons for the improved RR generation of the industry from 2008.

Finally, the ITQ system requires time to yield its full benefits. One of the benefits of ITQ systems is the long-term vision that is provided to quota holders. The quota holders can optimize production, fishing, processing, and marketing. However, the optimization to materialize these benefits takes time and requires a learning process in which the staff and managers grasp how to apply better technology, improve quality, and produce better and higher-paying markets. The development of the Icelandic pelagic industry is a good example of this. In the 1990s, approximately 90% of Icelandic pelagic catches were processed for animal feed, that is, in fishmeal and oil. Improved processing technology, automation, better access to markets, and more advanced

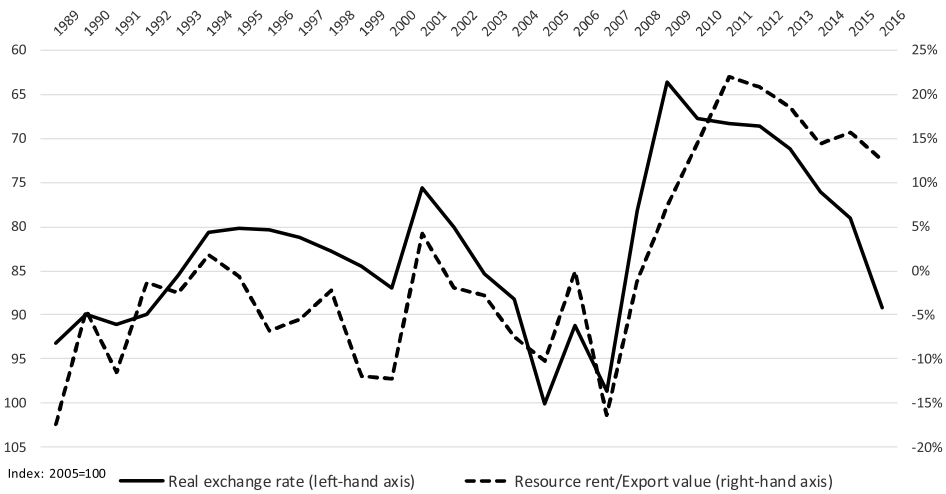

Fig. 5. Time-series of the real exchange rate and RR/export value according to the WACC method 1989-2016. Sources: Statistics Iceland, Central Bank of Iceland and author's calculations.

quality control has enabled the industry to process more of these species for human consumption. In addition, different species compositions of the pelagic catch, with more mackerel and herring, which are better than capelin for human consumption, has led to a higher proportion of the pelagic catch being processed for human consumption. Because of this phenomenon, approximately half of the Icelandic catch of pelagic species has been processed for more valuable human consumption. The ITQ system has been a major contributor to this development by providing the quota holders with a sufficient incentive to invest and maximize value instead of catch quantity (Saevaldsson and Gunnlaugsson, 2015). A similar development has been evident in the demersal fisheries. Today, an important portion of catches of valuable groundfish species is processed in Iceland and flown fresh to supermarkets in Europe. The ITQ system has been a main contributing factor in making this situation possible, because it allows quota holders to manage fisheries, processing, and marketing, and makes regulating an even supply to supermarkets possible. This regular supply and strict quality control has given the Icelandic fishing industry a competitive edge over its competitors (Knútsson et al., 2016).

6. Discussion

Iceland is a world leader in fishing and fisheries management. The Icelandic fishing industry is now very profitable and produces significant RR. However, this success required two decades under fisheries management according to ITQ principles for this rent to appear. Are these results unique to Icelandic fisheries? Would other countries attain similar profitability and RR in fisheries when managing them effectively with an ITQ system? The answer to these questions are no and yes, respectively. An ITQ system provides the quota holder with an incentive and long-term vision to maximize profitability and, thus, rent. The system should increase the catch value, because managers organize fishing to increase revenue and profits. In addition, the system leads to the transfer of fishing rights from less efficient firms, which sell their quotas to more efficient firms, which increases the profitability of the industry. All of this is universal and should apply to every fishery—not only Icelandic fisheries. Therefore, this Icelandic experience clearly demonstrates how much RR that well-managed fisheries can produce.

A question remains as to who has received the RR. A significant portion of the rent produced in Icelandic fisheries was grandfathered when the original quota receivers sold their fishing rights to those that are still operating in the fishing industry. These purchases have increased the debt burden of the industry and reduced its profitability. The quantity of this portion is difficult to assess and warrants further study. However, it is significant. The fishing fee has captured some of the rent, which is an estimated 13–15% on average of the RR from 2009 to 2016, according to this paper. In addition, the Icelandic government has received a portion of the rent through corporate taxes. Finally, the remainder of the RR was received by those operating in the industry.

An important contributor regarding the emergence of RR in Icelandic fisheries, which was not covered in this research, is the impact of the rebuilding that important fish stocks has had on profitability. The cod stock, which is by far the most important species in Icelandic fisheries, is a good example of this. In 1990, the biomass of Iceland's fishable stock (cod that is 4 years old or older) was estimated at 844 thousand tonnes, but conservation and reduction in catches resulted in the fishable stock increasing to 1393 thousand tonnes in 2016. In 1990, the cod catch was approximately 335 thousand tonnes. As a result, the harvest ratio (catch/fishable stock) was 40%. However, in 2016, the catch was 251 thousand tonnes, and the harvest ratio was only 18%. A result of this has been increased efficiency in Icelandic fisheries and a significant improvement in catch per unit effort (CPUE). During the period 2000–2016, the CPUE almost tripled, from 500 kg/hour to 1400 kg/hour, on average, when fishing with a bottom trawl, which is the method that was used to harvest the majority of cod. This has lowered the cost of fishing considerably and is one of the main contributors to the production of RR in Icelandic fisheries.

In this study, the assumption was made that RR was produced both in the harvesting and processing sector of the Icelandic fishing industry. In general, RR should only be generated in the harvest sector based on the exclusive rights to fish stocks. Therefore, the processing sector should not generate rent unless they have monopsony power that enables the processing component to capture RR from the harvest sector. The majority of the Icelandic fishing industry is vertically integrated (i.e., involved in fishing, processing as well as selling their own products), which results in both revenue and profit being shifted from the harvesting component of these companies to the processing part. The price of the landed catch is an intermediary product for these vertically integrated companies, and the pricing of the catch is in some way arbitrary. Importantly, the wages of the fishers are determined by the catch value (normally approximately 35% of the value), and the pricing of the catch is, therefore, of great importance to the vertically integrated companies. Hence, their profit increases if the pricing of the landings is lowered. Price setting in intracompany trade may lead to an underestimation of the real profitability in fishing, overestimate profits in the processing component and shift some of the RR generated in harvesting to the processing part. Both of the methods presented here apply assets and EBIT to the fishing sector as a whole, in both the processing and fishing components of the industry. This may lead to some bias. The calculated ROC may, for instance, be too low, as the capital component that is used in the calculation contains assets from processing, not just from fishing. However, for this bias to be substantial, the "real" EBIT in processing (i.e., the real profit without excess profit transferred from the fishing component) would have to be less than the necessary ROC, which is less than the cost of capital. If that is the case, is impossible to estimate, but it might present some bias to this study.

There is always the possibility that the value of fixed assets (boats, plant and equipment) is lower than the real replacement value because of inflation. According to IFRS standards, fixed assets are valued and depreciated based on historical costs. Over time, inflation could, therefore, erode the value of capital, thus leading to overestimation when the RR is calculated by the WACC method, as the capital could be undervalued. However, this should have little effect on the RR that is calculated according to the ROC method, as that methodology is based on the difference of the ROC between the fishing industry and that of the general economy, and the impact of inflation on capital stock can be assumed to be similar in fisheries and in the general economy.

A possibility of overestimation always exists when the intramarginal rent is included in the estimated RR. The WACC method estimates the cost of capital for borrowed and owned capital. In the CFC, intramarginal rent should be included, because it provides the necessary return for owners' equity, which should include intramarginal rent; if that is so in reality, it is difficult to assess. However, a safe assumption is that the ROC method does not have any intramarginal rent as part of the estimated RR in this research. That is, because it is unlikely that a significant difference was observed in the intramarginal rent between fisheries in Iceland and in other parts of the economy. The method estimates the RR in Icelandic fisheries by the difference in the ROC between the fishing industry and other parts of the economy. The ROC includes intramarginal rent, but what is notable in this study is the difference, and if it is similarly distributed in all Icelandic industries, no intramarginal rent should be presented as the RR in this study.

7. Conclusion

The economics literature has asserted that fisheries that are managed using an ITQ system should, over time, generate excessive profits, which have been termed the resource rent. However, few empirical studies have been conducted to ascertain whether this holds in reality. In 1990, Iceland introduced a comprehensive ITQ management system into almost all of its fisheries. Therefore, ample time should have passed for the resource rent to occur. The evidence presented here indicates no presence of resource rent in Icelandic fishing and processing until 2008; since that time, the rent has been significant. The most obvious reason

for the long delay, before the rent appeared, is the almost continual decline in fish catches from 1990–2008. The industry was rationalizing during that time, but the rationalization only kept up with the reductions in landings; thus, no resource rent was produced. When catches started to increase, starting in 2009, the rent appeared. In addition, the exchange rate and the weakening of the Icelandic krona were major contributors to the emergence of rent after 2008. Therefore, this study shows that an ITQ system can indeed generate economic returns in excess of those found in other industries that do not rely on natural resources, but it may take time for the resource rent to appear. Patience and long-term planning are, therefore, needed in abundance.

The taxation of the resource rent has been moderate in Icelandic fisheries. Since 2009, the fishing fee has captured, on average, around one-sixth of the resource rent that was generated. The fee has become an important part of the ITQ system, as it clearly shows that some of the profits in the fisheries are distributed to the general public. The fee has been criticized, though, both by those who regard it as an excessive burden and those who believe the industry is getting away with too low taxation. More than anything, however, the taxation shows that well-managed fisheries can generate rent and become a source of income for the government.

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Paper IV

Resource Rent and its Distribution in Iceland's Fisheries

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ABSTRACT

This article provides an estimate of resource rent creation and its distribution in Icelandic fisheries, which have been administered by an individual transferable quota (ITQ) management system for almost three decades. This study examined the period from 1997 to 2017. Little rent was produced in the first years; however, since 2008, rent has been significant, averaging 380 million USD per year, which is around 17% of the export value of the fishing industry. Approximately 20% of the rent went to the public due to a special fishing fee and through corporate taxes. The remainder was evenly split between those who originally acquired their fishing rights by grandfathering but have cashed in their windfall gains and traded their quotas, hereinafter referred to as quota sellers, and the companies working in the fishing industry, each receiving around 40% of the rent.

Key words: Resource rent, transitional gains trap, rent distribution, rent taxation, fishing fee, ITQ, Icelandic fisheries.
JEL Codes: Q22, Q28.

INTRODUCTION

For centuries, the fishing industry in Iceland has played an important role in the nation's economy. It remains one of the main employers and the biggest source of export revenue, surpassed only by tourism in 2015. Annual average catches over the past 20 years have been around 1.5 million metric tons, of which pelagic species account for 60–70% and demersal species 25–30%. Iceland is ranked among the world's 20 major fishing nations and among the 10 major demersal fishing nations (FAO 2017). Although the importance of the fishing industry has declined considerably with growth in the production and service sectors, seafood products still make up more than 40% of the nation's total value of exported goods. Consequently, the development of this important industry and the management of its resources have always been of utmost importance to the nation.

Iceland has been managing most of its fisheries with individual transferable quota (ITQ) systems since 1990. Iceland's fisheries are, therefore, an excellent example to illustrate the development in fisheries regulated by this key management system. A consensus has emerged in the academic literature that quota systems, or more importantly ITQ systems, are ideal for producing profits in fisheries, as the implementation of ITQ management ends the race to fish and promotes efficiency (Annala 1996; Arnason 2012). Economic performance improves as fishers attempt to

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catch their quota in a way that maximizes their profits (Grafton 1996a; Kompas and Che 2005; Arnason 2005; Andersen, Andersen, and Frost 2010; Asche, Bjørndal, and Gordon 2009; Kroetz et al. 2017). Quotas are transferred from less efficient firms to more efficient ones, improving economic performance (Arnason 2008; Asche et al. 2008; Dupont et al. 2002). When the ITQ system matures, it should lead to the creation of resource rent (RR) in fisheries under its auspices (Grafton 1996b). RR is defined as the excess profit that arises when natural resources (e.g., diamonds, gold, fish, and forests) are utilized in economic activity. Because of resource scarcity, it is impossible to saturate demand in the market, and this excess demand drives up prices and, therefore, profits. In most industries that do not depend on scarce natural resources, excess profit would lead to current producers stepping up their level of production and new firms entering the industry, leading to increased output, lower prices, and dissipating rents. This does not happen in industries that utilize scarce natural resources, so RR production is possible in those industries (Bulte, Folmer, and Heijman 1995; Grafton et al. 2008; Asche, Bjørndal, and Gordon 2009). Formally, RR may be defined as excess profit after all costs have been accounted for, including return on capital, both borrowed and owned (Wessel 1967).

The allocation of fishing rights when ITQ or quota systems have been introduced has most commonly been based on historical participation in the fishery (Shotton 2000; Anderson, Arnason, and Libecap 2011). This grandfathering, or first possession (Rose 1985; Lueck 1995), was the favored distribution mechanism when fishing rights were granted in the Icelandic fisheries. The allocation was usually based on catches in the previous three years (Arnason 1993), but the period under consideration has sometimes included up to the six previous years in some Icelandic fisheries (Saevaldsson and Gunnlaugsson 2015). As the ITQ system matures, more of the initial quota allocation is traded. This article refers to those who received their quota originally by grandfathering but have sold their quotas and left the fishing industry as "quota sellers." The amount received from selling quotas represents the quota-sellers' share of the future RR created in the fisheries, because those transactions are mostly financed by borrowing. They increase the debt of the fishing industry, and the borrowing cost represents a financial cost that goes indirectly to the quota sellers (Flaaten, Heen, and Matthíasson 2017). Hannesson (2017) stated that if quota trade is unrestricted, the return on capital in an ITQ-managed fishery should become the same as in other industries, with an appropriate allowance for risk. Therefore, the gains for the industry as a result of an ITQ management system will be transient, and the excess profitability, often referred to as RR, will take the form of capitalized fishing rights, quotas, or intangible assets on the balance sheet of firms in the industry. This is one of the critiques Copes (1986) made about the ITQ system, which he referred to as a transitional gains trap, a term originally used by Tullock (1975) to describe the effects of handing transferable privileges to limited groups in society. According to this argument, most—perhaps even all—the RR ITQ systems generate should accrue to the quota sellers.

A few articles have explored rent in North Atlantic fisheries, focusing on estimating potential rent if fisheries management was improved, quota systems introduced, and stocks rebuilt and utilized efficiently. Arnason et al. (2018) assessed the potential rent generation of the North Sea herring (*Clupea harengus*) fisheries, concluding that the RR could be substantial, but it is currently squandered by excess fishing effort, which, in combination with suboptimal stock size and ineffective fishing effort, eliminates profits. Therefore, at present, the herring fisheries produce no RR. A Swedish study estimated that introducing individual vessel quotas (IVQs) in the cod (*Gadus morhua*) fisheries could, in combination with optimal utilization of the fish stock, result

in a potential RR of 25–30% of the catch value (Eggert and Tveterås 2007). Finally, the World Bank's well-known *Sunken Billions* report estimated that global losses in RR due to overexploitation of fish stocks and overcapitalized fishing fleets amounted to 50 billion USD per year (The World Bank 2009).

A number of studies has analyzed actual RR production in fisheries. Andersen, Andersen, and Frost (2010) estimated the RR generated in Danish fisheries and concluded that the introduction of ITQs into Danish fisheries, initiated partially in 2003 and fully in 2007, increased RR. Merayo et al. (2018) however, arrived at different results and concluded that rents did not increase in the Danish demersal fisheries after the introduction of ITQs due to exogenous factors, such as lower catches and fish prices. Greaker, Grimsrud, and Lindholt (2017) estimated that the RR in Norwegian fisheries was negative in the 1980s and 1990s, but economic performance has since improved, and that the RR had been around zero in recent years. Norway's fisheries management is complicated and mostly based on IVQs (Hannesson 2013). A new paper studying fisheries management in the Northeast Atlantic pelagic fisheries involving vessels from the Faroe Islands, Denmark, Norway, the United Kingdom, and Iceland, concluded that the fisheries were very profitable and producing significant RR (Nielsen et al. 2017). Those fisheries are mostly managed by IVQs or ITQs.

To our knowledge, no studies have been published examining the distribution of rents between major stakeholders in ITQ-administered fisheries. Flaaten, Heen, and Matthíasson (2017) stated that RR in fisheries managed by an ITQ system would accrue to six groups of stakeholders. Some of the rent would accrue to former quota holders who sold their grandfathered fishing rights (i.e., the quota sellers) and some could accrue to current quota owners. Processors might acquire a share of the RR through transfer pricing of raw fish. The government would receive part of the RR through corporate taxes on profits and special RR taxes. A portion of the rent would go to financial institutions, as sellers of fishing rights might deposit their financial surpluses in these institutions. Finally, fishers might collect some of the RR if their wages are above their opportunity cost. This study assumes that there are three stakeholders that have received the RR. They are the government, companies that still operate in the industry (processors and harvesters are calculated together), and quota sellers. The financial institutions only provide a service that is not specific to receivers of rents. Therefore, there is no reason to assume any additional benefits to them from managing rents. It has been argued that fishers collect wages above their opportunity cost (Guillen et al. 2015). In their paper, Griffin, Lacewell, and Nichols (1976) argued that when labor salary was proportional to catch, rents would accrue to crews as well as to vessel owners under limited-entry fisheries management. Fishers in Iceland have historically been well paid and their wages are significantly above the national average. (Flaaten, Heen, and Matthíasson 2017; Nielsen et al. 2018a). However, the hours are long, the job is hard, and fishers are absent from friends and family. Their job is dangerous and uncomfortable (Kaplan and Kite-Powell 2000). All this complicates the estimation of opportunity cost and fishers' share of RR. There are usually no waiting lists for crew membership on Icelandic vessels, which indicates that the wages are in accordance with the fishers' opportunity cost. Hence, this research assumes that the crews' share of RR is close to zero. If this assumption is false, it will result in an underestimation of rents, but not in estimation errors of the amount of rents shared by other groups.

The literature contains two papers estimating the RR in Icelandic fisheries, neither of which addresses the issue of RR distribution. In their paper, Flaaten, Heen, and Matthíasson (2017) estimated that annual RR in Icelandic fisheries between 2009 and 2013 amounted to between 331

and 468 million USD per year, which was around 13–19% of the export value of Icelandic fisheries. Another study, covering the period from 1989 to 2016, revealed that no RR was present until 2008, but that since then, annual rent averaged between 250 and 500 million USD per year, which was around 10–19% of the export value of the fishing industry (Gunnlaugsson and Agnarsson 2019).

In this article, the development of RR in Iceland's fisheries is charted from 1997 to 2017. More importantly, we show how RR has been distributed among the three major stakeholders since 1997: the government, quota sellers, and enterprises operating in the industry. Iceland's fisheries are ideal when examining an ITQ-administered fishing industry, and this study is based on extensive data covering the entire industry for a long period. Therefore, the development of RR and its distribution in Icelandic fisheries presented in this research, is of substantial significance to all interested in fisheries management, policy, and economics.

ICELANDIC FISHERIES

HISTORY

Fishing around Iceland used to be open access with the participation of foreign nations until the 1950s. The Exclusive Economic Zone (EEZ) was extended in three steps between 1952 and 1976. Finally, in May 1976 Icelanders won full jurisdiction over the 200-mile EEZ, thus fully controlling their fishing grounds (Hannesson 2004). Icelandic pelagic catches increased rapidly with the herring (*Clupea harengus*) fisheries in the 1950s and 1960s, reaching a peak of 690 thousand metric tons in 1966. However, only two years later, the herring stocks collapsed. Part of this fleet then turned to capelin (*Mallotus villosus*) and demersal fisheries (Nielsen et al. 2018b). The years between 1995 and 2005 were record years in terms of pelagic catches. Figure 1 charts this development. Since then, the pelagic catch has been almost halved in the wake of reduced capelin quotas.

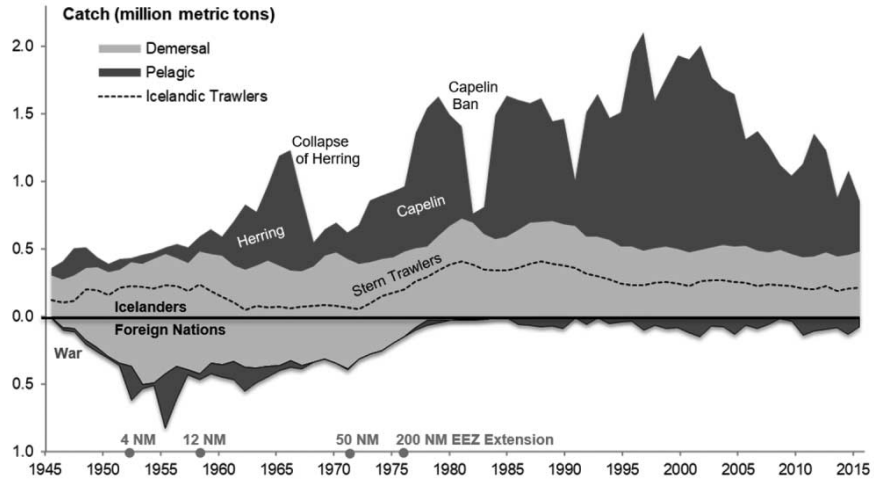

Figure 1. Catch of the Icelandic Fleet and Foreign Nations in Icelandic Waters since 1945 and the EEZ Extension

Note: The area under the dotted line represents Icelandic trawlers part of the demersal catch; that is, sidewinder trawlers, until the introduction of stern trawlers in the 1970s. The EEZ Extension is represented by gray dots on the x-axis.

Source: Statistics Iceland (2019) and ICES (2019).

Pelagic companies have adjusted to these changes; thus, almost half of the vessels and fishmeal factories have been scrapped since 2005 (Saevaldsson and Gunnlaugsson 2015).

Demersal catches around Iceland increased after WWII with a renovated fleet of smaller boats and newly built sidewinder trawlers. Between 1950 and 1970, annual average demersal catches in Icelandic waters amounted to 770 thousand metric tons, of which foreign harvests were almost half. The first Icelandic stern trawlers began operating in 1970, when they replaced a former fleet of sidewinder trawlers. In 1975, there were 58 stern trawlers fishing in the EEZ, but by 1985, this number reached 100. Their fishing effort with expanding vessel and engine sizes increased sharply, and, within a few years, their proportion of the total demersal catch surpassed 50% (Nielsen et al. 2018b). Since 1990, the demersal catch has been almost halved in terms of quantity, remaining at around 450 thousand metric tons for the past 20 years. The fleet's excess capacity and overcapitalization issues were gradually solved with the consolidation of quotas and scrapping of vessels and factories, affecting a number of occupations in the industry (Gunnlaugsson and Saevaldsson 2016).

FISHERIES MANAGEMENT

The collapse of the Atlantic herring fishery in 1968 sounded an alarm to the nation (Arnason 2005). Consequently, the management of pelagic species was initiated in 1969 with a total allowable catch (TAC) of Icelandic herring. In 1975, the government announced individual quotas (IQs) and issued them for capelin in 1980 (Matthíasson 2003). Initial allocations were divided between vessels participating in the fisheries during the previous year. When the nation gained control over Iceland's 200-mile EEZ in 1976, serious concerns were raised that demersal stocks were being overfished. From 1977 to 1983, effort limitations were in force. In 1983 effort limitations were abolished, as fishing effort and fleet capacity had been rising while the number of days at sea kept falling. Then, Iceland's Althing (national parliament) voted on and accepted a demersal management system; vessel allocation was based on catch performance between 1981 and 1983. The initial demersal quotas were allocated in 1984 to vessels above 10 gross registered tonnage (GRT), not including small boats that mainly target demersal species. This caused their numbers to escalate. The initial quotas were partly transferable by authority of the Ministry of Fisheries. Between 1985 and 1987, an effort option was in effect that offered vessel operators an opportunity to boost their share of the initial allocation (Arnason 1993; Runolfsson and Arnason 2001a).

Vessel renewals or enlargements were integrated into the 1984 demersal ITQ quota regulations. All fishing vessels above 10 GRT in Icelandic waters in 1983 received fishing licenses that indicated their GRT. New licenses were not issued unless a vessel of similar size in GRT was decommissioned. Restrictions controlling total fleet capacity were abolished in 1999; then, the renovation and/or new building of vessels could be carried out without additional cost (Runolfsson and Arnason 2001b). Since then, the fleet has been gradually modernized with the import of both newly built and used vessels.

CURRENT MANAGEMENT SYSTEM

The structure of the Icelandic ITQ system remains similar to the initial uniform ITQ system implemented in 1990. The uniform ITQ system allowed the majority of ITQs to be almost freely transferable, which led to consolidation. Since 1990, the number of vessels and companies has gradually decreased. The authorities did not centralize these adjustments, but mostly left them to the companies (Saevaldsson and Gunnlaugsson 2015). Fisheries legislation was reformed in

2006, resulting in the current *Fisheries Management Act* No. 116/2006. According to the *Fisheries Management Act*, the TAC is issued annually by regulation of the Minister of Fisheries, having obtained recommendations from the Marine Research Institute. The TAC is valid for one fishing year, a 12-month period commencing September 1 every year. All species subject to the system are issued an annual TAC, but prior to the issuance, the authorities deduct and retain 5.3%. This proportion is then utilized as temporary support to coastal region communities. Finally, the Directorate of Fisheries issues the annual vessel catch quota (harvesting right), based on a vessel's permanent quota share (i.e., TAC minus 5.3%, then multiplied by the vessel quota share). The annual and permanent quotas for each species are divisible and transferable among vessels with fishing licenses (Nielsen et al. 2018b).

All participants in commercial fishing in the Icelandic EEZ need a fishing permit. The permits are split into two types: a general catch quota and a hook-and-line catch quota. The hook-and-line catch quotas were issued in steps from 1996 to 2004, when they were fully fledged. Since then, all segments of the Icelandic fleet have been issued with ITQ quotas and later (in 2009) an open-access costal jigging system was installed. Restrictions are valid in quota trade between vessels with general catch quotas and vessels with hook-and-line catch quotas. In general, hook-and-line catch quotas may only be used for longline and handline fishing. The catch from vessels with hook-and-line catch quotas is made up of demersal species. In recent fishing years, vessels with general catch quotas have been allocated about 90% of the demersal quotas, calculated in cod-equivalent kilos (Nielsen et al. 2018b). The cod-equivalent is a special conversion factor used within the system to assess all species at the same value as cod, which always equals one; the Directorate of Fisheries thus calculates all species and the results are issued annually (Gunnlaugsson, Kristofersson, and Agnarsson 2018). For example, if the cod-equivalent kilo of capelin is 0.13, it means that 7.70 kilos of capelin equal 1 kilo of cod (1/0.13), or the value of capelin is 13% of the cod value.

In 1998, a maximum quota share was introduced, thus restricting a company's quota allowance. This was commonly named a "quota ceiling," whose objective was to reduce the consolidation of ongoing quotas and to prevent a handful of firms from controlling all the fishing in the country. The current maximum quota share is 12% of the total quota issue in cod-equivalent kilos. For individual species, the ceiling is normally 20%, although for certain species it reaches 35% (Nielsen et al. 2018b). A notable development in Iceland's fisheries is the fishing fee. The fee was introduced in 2004 and it replaced previous fees. The fee was small in the beginning. However, in 2012, it increased and has since been a significant expense for the fishing component of the industry. The fee is levied on landed catch and, hence, is directly related to the allocated quota. The fee is a form of RR taxation, as its main purpose is to tax the RR produced in Icelandic fisheries. The fishing fee generated around 0.5–1.5% of the total revenue of the Icelandic government from 2012 to 2017. The literature contains a detailed description of the fee, its amounts, and the problems arising when setting the fee (Gunnlaugsson, Kristofersson, and Agnarsson 2018).

MATERIAL AND METHODS

DATA

Statistics Iceland provided most of the data used in this analysis. The agency publishes yearly data showing the development of individual components of the profit and loss account and balance sheet for the entire Icelandic fishing industry. The data used in this study are an estimation of the profit and loss account of fishing and processing separately and the balance sheet of the entire fishing industry. These numbers give an overall weighted average sum of the industry, treating

the whole industry as one company. These are the official Icelandic records and the best available source of data for analysis. The data are based on annual reports and tax returns on a very large sample (around 70–90%) of firms operating in Icelandic fisheries and, therefore, are accepted as reliable. Good data have existed only since 1997; the data before that time were less detailed, and most importantly, an estimation of capitalized fishing rights was not presented for years prior to 1997. In addition, data from Statistics Iceland, which show the balance sheet and profit and loss account of other industries, were used. They were compiled in a similar manner as the data on fisheries (from annual reports and tax returns). These data have been available only since 2002. Data from Íslandsbanki, one of the largest banks in Iceland, and Deloitte, which is the agency that audits the financial statements of most companies in Iceland's fisheries, were used to show the corporate tax payment of the fishing industry. These data show the total corporate tax payment of the entire industry every year from 2001 to 2017. These numbers are based on the data supplied by the Icelandic tax authorities and, hence, founded on tax statements of all firms operating in Iceland's fisheries.

CAPITALIZED FISHING RIGHTS

Icelandic companies use international financial reporting standards (IFRS) when compiling their financial statements. In accordance with IFRS principles, Icelandic fishing businesses register the value of fishing rights (quotas) in their capital accounts when permanent quota shares are purchased (Chalmers et al. 2012). Permanent quota shares that were grandfathered are not registered on the balance sheet. For the past three decades, a significant proportion of quota purchases have been conducted through company acquisition; that is, when one company buys another company completely, (i.e., buys all the shares) and then normally merges the newly acquired company with itself. Next, the fishing rights are generally booked at an estimated market value. Permanent quota shares traded and quotas purchased by company acquisition are reported as other assets (aðrar eignir) in Statistics Iceland's reports, and almost all other assets are capitalized fishing rights. These estimates are used to assess the value of capitalized fishing rights in Icelandic fisheries in this research, as they represent a reasonable estimation of the cumulative sum the quota sellers received for the permanent quota share they sold.

The estimates are, however, not flawless. They include some risk of overestimation due to quotas purchased from companies still in operation. These quota deals do not represent rents leaving the industry, since the sellers are still operating within it. No reliable information is available as to the ratio of these transactions still booked in the balance sheet of the Icelandic fishing industry. On the other hand, depreciation of fishing rights was customary in the financial reports of Icelandic companies before 2005, and occasionally until 2009, leading to an underestimation of capitalization. The quotas were linearly depreciated (Ben-Shahar, Margalioth, and Sulganik 2009). Before 1996, capitalized fishing rights were normally depreciated over five years (i.e., 20% per year). From 1996 on, fishing rights were depreciated over 10–20 years (Michaelsen 2009). The result is a considerable depreciation of capitalized permanent quota shares traded from 1989 to 2004, and a minor depreciation from 2005 to 2009. Correcting for this is quite difficult and is not attempted here. As a result, it is likely that the RR calculated in this article is, to some extent, underestimated—especially before 2005. This also leads to underestimation of the cumulative sum of fishing rights that were traded and the amount the quota sellers received. Although these two issues affect the estimation of the RR share the quota sellers received, they tend to cancel each other out, at least partially, when calculating the quota sellers' share. This is because the depreciation of

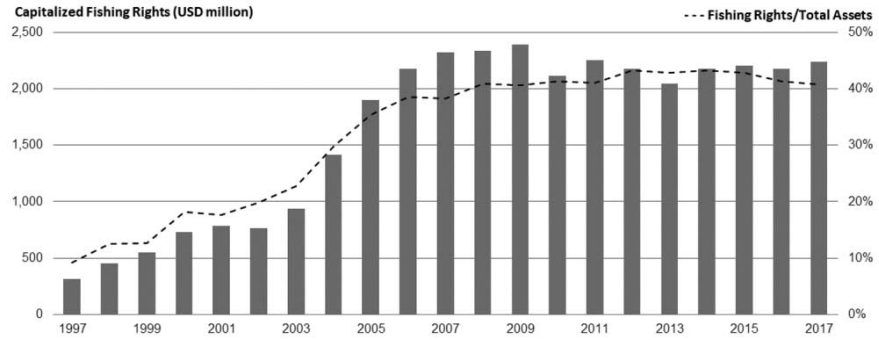

Figure 2. Development of Fishing Rights as a Percentage of Total Assets (right axis) and the Amount of Capitalized Fishing Rights in USD at Constant Prices (left axis) in Icelandic Fisheries from 1997 to 2017
Source: Statistics Iceland (2018).

fishing rights leads to an underestimation of the amount quota sellers received, and the unknown capitalized trading between companies still operating in the industry leads to an overestimation of the quota-sellers' share of the RR. However, it is likely that the depreciation of fishing rights was higher than the trading between companies that are still active in the industry. Therefore, the book value of capitalized fishing rights (used in this study) is probably an underestimation of the permanent quota share sold by the quota sellers; hence the quota-sellers' RR share is possibly slightly underestimated in this study.[1]

Figure 2 (specifically, the left axis) shows the development of estimated capitalized fishing rights (book value) from 1997 to 2017. No estimation of capitalized fishing rights before that time is available. The amounts are in USD and adjusted for inflation. In addition, the right axis in figure 2 shows the development of the book value of fishing rights as a proportion of the total assets of Icelandic fisheries. The graph shows that quotas were booked at around 300 million USD in 1997. There was a gradual increase in this value, and in 2003 it had reached 940 million USD. Then, the value increased rapidly, and, in 2007, capitalized fishing rights stood at 2,300 million USD. The main reason for this increase was cheap and plentiful credit on the eve of a bank crisis that made funding the purchases of fishing rights inexpensive and easy (Gunnlaugsson and Saevaldsson 2016). Therefore, many quota holders cashed in and sold their fishing rights, becoming quota sellers. The fishing industry went through a reconstruction during this period and fishing rights were rapidly consolidated (Agnarsson, Matthiasson, and Giry 2016). Since 2008, the book value of capitalized fishing rights has remained relatively stable. The development of the book value of fishing rights as a proportion of total assets tells a similar story. This ratio was around 9% in 1997. Thus, in that year, 9% of the book value of all assets of the Icelandic fishing

1. Supporting this statement is the fact that Statistics Iceland estimated the total capitalized book value of quotas in the Icelandic fishing industry at around 2.3 billion USD in 2017. This is the total sum accruing to quota sellers according to the methodology of this study. The estimated market value of all fishing quotas in Iceland at that time was around 7.5 billion USD, indicating (without proof because the price in the permanent quota trading is unknown) that 31% (2.3/7.5) of all quotas were cashed in and sold permanently; that is, traded and capitalized on the balance sheets of the fishing industry. In 1996, the 30 largest companies had a combined share of around 54% of overall fishing rights. In 2017, 16 of these 30 firms had exited the industry. Those 16 companies held 20% of the quotas. Therefore 37% (20/54) of the fishing rights of the largest companies had been sold, and the owners of those fishing rights had exited the industry. Because a higher proportion of smaller firms exited the Icelandic fishing industry, this strongly supports that the book value of capitalized fishing rights is probably a conservative estimate of fishing rights that were traded permanently, and the quota sellers' share of the estimated resource rent is probably underestimated.

industry was quotas. In 2003 it stood at 23%, and it was 38% in 2007. Since then, this ratio has remained very stable, just above 40%.

RESOURCE RENT ESTIMATION

According to classical economic models, no rents exist in open-access fisheries in equilibrium, with constant cost per unit of effort and one-dimensional homogeneous effort (Gordon 1954; DuPont 1990). A simple alteration to the model, for example by introducing heterogeneous effort, opens it to the appearance of rent, especially intra-marginal rent (IMR) in open-access equilibrium (Manning and Uchida 2016). In this equilibrium, the marginal vessels break even. However, other vessels with lower costs may earn IMR (Arnason et al. 2018). Disentangling IMR and RR may be difficult (Thébaud et al. 2014). Pure RR should not exist in open-access fisheries regimes; however, IMR should exist (Copes 1972). In this study, managed fisheries governed by an established ITQ system were examined in which rent should appear and, hence RR. To distinguish between RR and IMR, extensive data are necessary. To do so perfectly in this research, it would have been necessary to have profit and loss accounts, as well as balance sheets from 1997 to 2017 for every company in the Icelandic fishing industry. These data are not available; hence, a second-best solution was chosen.

The methodology applied was to compare the return of capital (ROC) in fisheries to the return of capital in other segments of the Icelandic economy (i.e., all companies except for financial institutions, pharmaceuticals, and companies involved in fisheries). Most companies in Iceland are operating in competitive industries and should not have excess profitably that comes from utilizing a scarce natural resource, as the fishing industry does. Therefore, excess ROC in fisheries (i.e., higher ROC than the weighted average of other industries in Iceland) is a good measure of RR. ROC is defined by equation (1). It states that ROC is simply EBIT (earnings before interests and taxes) divided by assets. (For a better explanation of EBIT, see table 1.) Because assets are

Table 1. Overview of IFRS Principles and Explanation of RR Calculations Applied in this Research

	Financial Statements (IFRS)	RR Calculation
Revenue	Income from fishing and processing and revenue from the leasing of fishing rights.	All income from fishing and processing. Note that the leasing of fishing rights has no effect on EBIT, because the lease payments constitute revenue for one firm and an expense for another, cancelling each other out for the whole industry.
– Operating costs	Insurance, raw material, wages, fuel, gear, fishing fee, maintenance, administration.	All costs except the fishing fee are recognized. Fishers' share of RR was not measured.
– Depreciation	Assets are depreciated based on original purchase price by using the straight-line method.	Depreciation was used as a measure of the replacement cost of assets.
= EBIT	EBIT	EBIT + fishing fee.
– Financial charges	Financial cost and currency difference on all debts.	Financial cost was set at 4.6% and charged on all assets except capitalized fishing rights.
– Taxes	Corporate taxes	Corporate taxes were excluded because they are simply a transfer of RR from the industry to the government.
= Profit	Profit	Estimated RR.

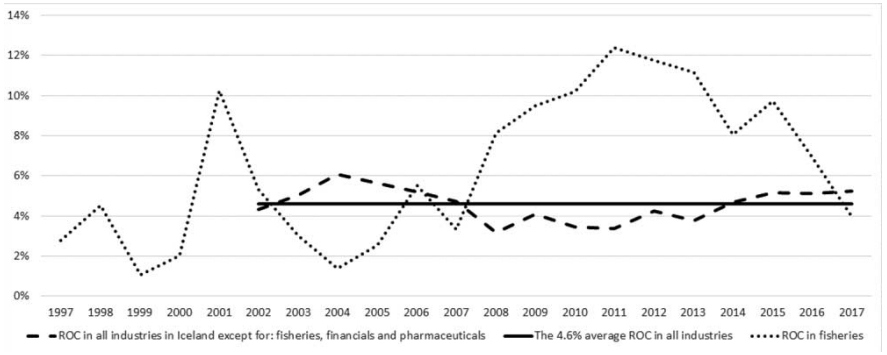

Figure 3. Weighted Average Return on Capital (ROC) in all Industries in Iceland and ROC in Fisheries
Sources: Statistics Iceland (2018) and author calculations.

equal to debts plus equity (equation (2)), this ratio shows how much profit the capital invested in the business generates for both borrowed and own capital. A higher ratio shows more profit. This ratio must be higher than the cost of borrowing and the opportunity cost of equity; if not, the companies are not making any economic profit:

$$ROC_t = \frac{EBIT_t}{Assets_t}. \quad (1)$$

This methodology (i.e., to assume that excess ROC in fisheries represents RR) should exclude IMR rent in the calculation, because the IMR of companies, in general, is part of their ROC. It is also likely that the scale of IMR in fisheries is similar to that of other industries, and RR causes a higher ROC in fisheries.[2] The weighted average ROC of all companies in the Icelandic economy (except for fisheries, financials, and pharmaceuticals) was 4.6% for the period 2002 to 2017. The data for all sectors of the economy is available only from 2002, whereas data for the Icelandic fisheries is available from 1997 (figure 3). The ROC was quite stable during the period 2002 to 2017 and was at its highest in 2004, 6.1%, and lowest in 2010, 3.4%, with a standard deviation of only 0.8%. By contrast, the average ROC in fisheries amounted to 6.4% during the years 1997 to 2017 with a standard deviation of 3.7%. ROC in fisheries has, on average, been higher—but at the same time more volatile—than in other industries in Iceland, indicating a presence of RR.

In addition, a sensitivity analysis was performed of to evaluate the effects changes in the cost of capital had on RR and its distribution in Iceland's fisheries. The base cost of capital was set 4.6% in

2. This methodology is based on the assumption that excess ROC in fisheries is a good measure of RR. However, a question remains about the certainty of that assumption. Results for various industries in the US reveal that ROC has been stable over time, but varied between industries. ROC was highest in industries with little competition, which was mainly due to the brand or to patents held by firms in the industries in question, and lowest in industries that were relatively capital intensive (Jiang and Koller 2016). The Icelandic fishing industry has high barriers to entry. However, these barriers are caused by the ITQ system, as it is necessary to buy expensive fishing rights to enter the fisheries. Without these barriers, entry would be cheap and easy, thus eliminating all rents and probably generating ROC on par with the average in the Icelandic economy. The Icelandic fishing industry is relatively more capital intensive than the average of other industries in Iceland, mostly due to the capitalized fishing rights, which have amounted to 40–43% of the total assets of the industry for the last decade. If the fisheries were open access (and therefore with no need to buy expensive quotas to enter the fisheries), no fishing rights would be capitalized. Therefore, it is likely that the amount of necessary capital in Iceland's fishers would be on par with the average of other industries. This leads us to conclude that the higher ROC in Iceland's fisheries compared to other industries is because of the RR produced in the industry.

this study, as it was the average ROC in other industries. The sensitivity analysis ranges from a minimum cost of capital of 4.0%, which been used in the literature when measuring rent in Norwegian fisheries (Greaker, Grimsrud, and Lindholt 2017). The maximum cost of capital was set at 6.0%, as this is the ratio normally used when measuring RR in Icelandic fisheries (e.g., Flaaten, Heen, and Matthíasson 2017; Nielsen et al. 2017), and it is also the same ratio that Statistics Iceland applies when calculating profitability according to the "annuity method" (árgreiðsluaðferðin). The sensitivity analysis was performed because it is impossible to completely dismantle IMR from RR. That is because the IMR of companies, in general, is part of their ROC. By changing the cost of capital, it is possible to analyze if RR is present, even when the cost of capital is altered. A higher cost of capital assumes that more IMR was produced and, hence, less RR, and a lower cost of capital means lower IMR was present and, therefore, higher RR.

One of the characteristics of the Icelandic fishing industry is that it is dominated by vertically integrated companies (Knútsson, Kristófersson, and Gestsson 2016). Those companies own quotas, boats, and factories. They catch the fish, process it, and sell their own products. The monetary value of the catch is an intermediary product, and the pricing mechanism for the catch of those companies is partially arbitrary. The tendency in those companies is to maximize revenues and profit in the processing portion at the cost of the fishing component (Flaaten, Heen, and Matthíasson 2017; Gunnlaugsson, Kristofersson, and Agnarsson 2018;Byrne, Agnarsson, and Davidsdottir 2019). This is because fishers in Iceland are paid wages proportional to the value of the landed catch. Their wages are usually approximately 35–40% of the catch value. Therefore, earnings of the vertically integrated companies increase if fish prices are lowered in intra-company trade as fishers' wages are reduced. However, a government institute, the Fresh Fish Price Directorate (Verðlagsstofa skiptaverðs), monitors intra-company pricing. It sets guiding prices in intra-company trade and audits all contracts to enforce fair pricing in all intra-company transactions. Nevertheless, RR is probably produced in both the processing and fishing components of the Icelandic fishing industry, instead of being confined to the harvesting component, as would be the likely outcome if all the fish were sold on a fully competitive market. The path taken in this study was to estimate the RR in both the fishing and the processing components of the industry. Hence, EBIT from fishing and processing were used when calculating the RR and its distribution, as well as all assets of the entire Icelandic fishing industry.

The data used in this study are based on the IFRS accounting standards and need adjusting when calculating the RR, so some alterations were necessary. The only changes made in this study were regarding the fishing fee and the cost of capital. Table 1 provides an overview of IFRS principles and an explanation of the RR calculations applied in this research.

The fishing fee is classified as a normal operating cost (e.g., wages, cost of fishing gear, and cost of oil) according to IFRS guiding principles (De George, Li, and Shivakumar 2016). However, this fee is a form of RR taxation (Gunnlaugsson, Kristofersson, and Agnarsson 2018). Industry taxes should not be included in operating costs in a measurement of the RR, because they are simply a transfer of RR from the industry to the government (Greaker, Grimsrud, and Lindholt 2017). As a result, the fishing fee was added to the EBIT in this study when measuring RR.

An adjustment was also made to financial cost. According to IFRS principles, costs in financial statements comprises interest expenses and currency charges on all debts. However, the cost of equity; that is, its opportunity cost, is not charged in the profit and loss account according to IFRS principles (Florou and Kosi 2015). In addition, because the IFRS calculates financial costs on all debts, a significant adjustment must be made when calculating the RR. Consequently, financial

costs resulting from any investments in fishing rights (quotas) should be excluded, as they represent a financial cost that goes indirectly to the quota sellers (Flaaten, Heen, and Matthíasson 2017). This research set the financial cost at 4.6% every year, for all assets except for capitalized quota holdings (fishing rights), effectively setting a financial cost of capital 4.6% for all, both debt and equity. This was the average ROC of the Icelandic industry from 2002 to 2017.

An adjustment is sometimes made for depreciation in RR estimations. The purpose of depreciation is to match the cost of productive assets to their duration (Jeanjean and Stolowy 2008). In the case of a mismatch (e.g., depreciation exceeding the cost of assets), an alteration might be required to calculate RR (Greaker, Grimsrud, and Lindholt 2017). Icelandic companies use the straight-line method when calculating depreciation in their fiscal accounts. This method is well aligned with the economic life and value of real assets (ships, equipment, plants, etc.). Therefore, the book value and depreciation charges are a good estimation of the real value of assets and the cost of replacing those assets. However, as previously mentioned, there was considerable depreciation of quotas capitalized between 1989 and 2004, and a minor depreciation from 2005 to 2009. Consequently, before 2009 and especially before 2005, depreciation may have overestimated the replacement cost of assets, as depreciation charges on fishing rights were part of the total depreciation charges during that period. Here, it was assumed that depreciation appropriately matched the replacement cost of assets and no adjustments were made, but this might lead to an underestimation of RR from 1997 to 2009.

By definition, assets (A) at time t equal debt (D) and equity (E) (equation (2)). Therefore, applying financial cost to assets gives the opportunity cost for both debt and equity. The RR was estimated for each year from 1997 to 2017 by using equation (3). By applying the equation, RR was estimated to be the reported EBIT in both fishing and processing plus the fishing fee (FF) minus c times the difference between the book value of total assets (A) of the whole fishing industry and the booked value of capitalized fishing rights (V), (i.e., c(A-V)). The coefficient c represents the cost of capital, both the cost of debt and the cost of equity:

$$A_t = D_t + E_t. \tag{2}$$

$$RR_t = EBIT_t + FF_t - c(A_t - V_t). \tag{3}$$

RENT DISTRIBUTION

This study assumes that the RR produced in Icelandic fisheries has benefited three stakeholders: the government (RR_g), the firms still active in the industry (RR_a), and the quota sellers (RR_s). Total RR in time t may then be defined as:

$$RR_t = RR_{gt} + RR_{at} + RR_{st}. \tag{4}$$

As stated in equation (5), the government has accrued its share of the RR through fishing fees (FF) and excess corporate taxes (ET):

$$RR_{gt} = FF_t + ET_t. \tag{5}$$

The FF is RR tax paid by the fishing component of the Icelandic fishing industry for access to the fishing resource, while excess corporate tax represents taxation over and above normal corporate taxes and is a direct result of the RR, produced by utilizing the fishing resource. Estimating this

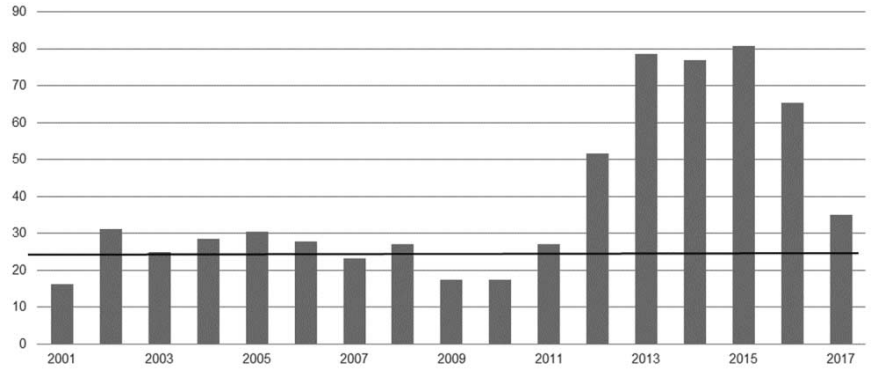

Figure 4. Corporate Taxes Paid by the Icelandic Fishing Industry from 2001 to 2017 (million USD) at Constant Prices

Note: The solid line is the average from 2001 to 2010 (i.e., 24.2 million USD).

Source: Íslandsbanki (2017) and Deloitte (2018).

proportion of total corporate taxes paid by the Icelandic fishing industry is fraught with difficulties, because in an open-access fishery no RR is present. However, the industry would pay corporate taxes even under an open-access regime without yielding any extraordinary profits. This is because the better-run companies, with lower costs than the marginal companies, would make a profit (i.e., IMR). In addition, the opportunity cost of equity is not recognized as a cost, according to IFRS accounting standards. Therefore, a company that does not earn any economic profit might pay corporate taxes levied on profits, because the opportunity cost of owners' equity is not a base for cost when corporate taxes are levied. In this article, it was decided to define "excess corporate taxes" as taxes paid above a certain historical average. Figure 4 charts the payment of corporate taxes in the Icelandic fishing industry from 2001 to 2017. During the period 2001 to 2010, these payments ranged from 16 to 31 million USD, with an average of 24.2 million USD, but have since increased substantially, mostly due to higher RR. As shown in the results section, the Icelandic fisheries did not really start to produce any RR until 2008. The higher profits of the industry are, however, not immediately transformed into a larger income tax base, as firms often carry losses from previous years that may be deducted from current year profits and, thus, decrease the base on which income tax is levied. Consequently, the improved financial performance of the fishing industry since 2008 is not reflected in higher tax payments until 2011. In this study, it was consequently assumed that all corporate taxes above 24.2 million USD per annum each year from 2011 to 2017 were excess corporate taxes (ET_t) and the result of RR.

This article assumes that capital gains taxes caused by quota trading were negligible.[3] As stated in equation (6), some of the rent has accrued to enterprises still operating in the fishing industry.

3. The booked profit in quota trading was mostly taxed as corporate taxes levied on profits but not as capital gains taxes and is, therefore, part of corporate taxes. Capital gains taxes were small in other instances because various laws and regulations made postponing tax payments possible. Additionally, the capital tax percentage was low (only 10% from 1997 to 2008) when most of consolidation happened and quotas were traded. Further, much of the money the quota sellers received was lost in the financial bubble in Iceland and its crash, when the Icelandic stock market lost 95.4% of its value in 2008 to 2009. In the financial crash, corporate bonds and bond issued by Icelandic banks became almost worthless, and owners lost almost all their investments. Finally, it is likely that some (how much is impossible to assess) part of the money quota sellers received when fishing rights were traded was stored in various offshore tax shelters, where little or even no taxes were paid. All of this leads to the assumption that capital gains tax payments were insignificant, and they are omitted in this research.

The share of firms still active is calculated as EBIT both in fishing and processing minus the cost of capital (c) times the book value of assets (A) and minus excess corporate taxes (ET). Therefore, those operating in the industry pay the fishing fee, which lowers the EBIT. They pay the excess corporate taxes and bear the full cost of all capital invested in the Icelandic fishing industry:

$$RR_{at} = EBIT_t - cA_t - ET_t. \tag{6}$$

What is left of the RR is allocated to the quota sellers. Therefore, RR accruing to the quota sellers equals the total RR minus the share of the RR accruing to the government and the fishing firms still active in the industry (equation (7a)). As shown in equation (7b), the share of the quota sellers can also be defined as the opportunity cost of capitalized fishing rights:

$$RR_{st} = RR_t - RR_{gt} - RR_{at}. \tag{7a}$$

$$RR_{st} = cV_t. \tag{7b}$$

RESULTS

RESOURCE RENT ESTIMATION

Figure 5 illustrates the development of RR in Icelandic fisheries from 1997 to 2017 as calculated by using equation (3) and setting the cost of capital (c) at 4.6%. The figure shows RR both in million USD (at constant prices) and as a share in percentages of the export value of the catch. Because almost all fish caught by Icelandic vessels is exported, the export value is a good measure of revenue of the Icelandic fishing industry. The figure reveals that the Icelandic fisheries yielded limited RR until 2008, with the exception of the year 2001, when the rent was around 280 million USD or 13% of the export value of the industry. Since 2008, rent has been significant, averaging 380 million USD per year, which is around 17% of the export value.

It took the Icelandic fishing industry almost two decades to rationalize under the ITQ system and yield a significant RR, as rent has only been produced consistently since 2008. Gunnlaugsson

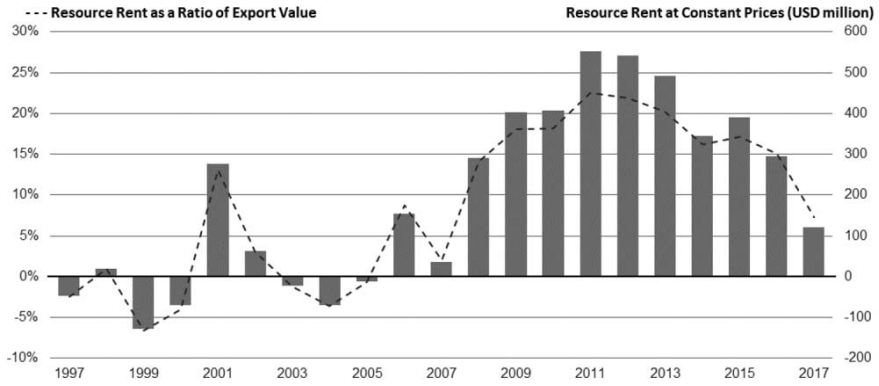

Figure 5. Development of the Estimated Amount of Resource Rent (million USD) at Constant Prices (right axis) and Resource Rent as a Percentage of Export Value (left axis) from 1997 to 2017

Source: Statistics Iceland (2018) and author calculations.

and Agnarsson (2019) mention that the main reason for this long delay was lower catches. From 1989 to 2008, the catch in cod-equivalent kilos was almost halved, which led to the late arrival of RR in Iceland's fisheries. The fishing industry was rationalizing during that period, closing down factories and scrapping boats. However, the rationalization merely kept up with lower catches, so no rent was produced. When catches started to increase in 2008, RR emerged. The second factor affecting RR creation in Iceland's fisheries was the exchange rate. The Icelandic fishing industry benefits from a weaker exchange rate of the Icelandic krona, because almost all its products are exported and paid for in foreign currencies. The fall of the Icelandic krona in 2008, when it lost almost half its value, was also a very important contributor in the emergence of the RR in the following years.

The RR peaked between 2011 and 2013, mainly because of an exceptionally weak Icelandic krona that immensely benefited the industry. Catches were also good at the time, landings started to increase in 2009, and prices were relatively high—especially for pelagic species. An interesting RR development was in fall of 2017, caused mostly by a strengthening of the Icelandic krona. The Icelandic economy has been booming because of expanding tourism since 2012. This led to a stronger currency in the period 2015 to 2017, with the Icelandic krona being exceptionally strong in 2017. As a result, the profitability of the Icelandic fishing industry suffered.

RESOURCE RENT DISTRIBUTION

The estimated RR in the Icelandic fisheries and the distribution of rent between the three stakeholder groups during the period 1997 to 2017 is shown in table 2. The cost of capital (c) was set at 4.6% when calculating the findings presented in the table. The periods of the research were divided into three seven-year periods, as RR generated varied considerably between periods. In the first period (i.e., from 1997 to 2003), RR amounted to only 0.1 billion USD. The government's share was zero during that time, because there was no fishing fee and excess corporate taxes were paid by the fishing industry. The quota sellers received more than all the RR, as their share was 225%. Hence, those active in the industry had a share of –125%, reflecting the fact that the industry was experiencing only limited profits for most of the period, and even significant losses in some years. The middle subperiod (i.e., 2004 to 2010) was eventful. Most of the permanent quota shares were traded during this period. The profitability of the industry increased significantly; especially in the last two years of this period, and the total RR amounted to 1.2 billion USD. The government's share was only 6% of the rent during this period, as the fishing fee was low, and no excess corporate taxes were paid. The quota sellers received more than half of the RR, and the companies active in the industry received around 40% during this period.

Most of the RR generated was created in the last subperiod, (i.e., 2011 to 2017), as this period was characterized by high profitability. Half of the 2.7 billion USD produced accrued to those still

Table 2. Resource Rent and its Distribution to the Three Stakeholders (1997 to 2017)

	1997 to 2003	2004 to 2010	2011 to 2017	1997 to 2017
RR (billion USD adjusted for inflation)	0.1	1.2	2.7	4.0
Government share of RR	0%	6%	25%	19%
Quota-sellers' share of RR	225%	55%	25%	39%
Active-companies' share of RR	–125%	39%	50%	42%

Source: Statistics Iceland (2018) and author calculations.

operating in the industry, and the rest was evenly distributed between the government and the quota sellers. Finally, the table shows that total RR during the entire period (1997 to 2017) was estimated at 4.0 billion USD. The government's share was around 19%. Of the government's share of the rent, around 69% came from the fishing fee and 31% was excess corporate taxes (ET). The quota sellers and the firms active in the industry received a similar portion of the rent, or 39 and 42%, respectively, during those 21 years.

SENSITIVITY ANALYSIS

A sensitivity analysis was performed to measure what effects changes in the cost of capital (i.e., c in equations (3) to (7)) had on the RR and its distribution. The results are presented in table 3. The most likely cost of capital and the rate this article is based on is $c =$ 4.6%. At that cost, the results are the same as presented in table 2 as the RR for the whole period. The minimum cost of capital in the sensitivity analysis was set at 4.0%. This rate gives a slightly higher RR of around 4.4 billion USD than if the cost of capital had been set at 4.6%. An increase in RR leads to more of it going proportionally to those operating in the industry—slightly more than half. However, the quota-sellers' share decreases and the government's share remains the same; even though it decreases proportionally. When the cost of capital is set at 6.0%, which is the maximum, the estimated RR created decreases. However, it is still significant, as it is estimated at 3.1 billion USD. The share of those operating in the industry becomes smaller when the financial cost is set so high (i.e., only 10%). At such an elevated cost of capital, the opportunity cost of capital is high and, therefore, the quota sellers receive most of the RR.

The sensitivity analysis clearly demonstrates that significant RR has been produced in Iceland's fisheries. Changing the cost of capital does not have a substantial effect on the RR created, as significant RR was present even though the financial cost was set at the highest, at 6.0%. The sensitivity analysis also demonstrates that all three stakeholders received a significant portion of the RR. Almost certainly, the quota sellers and those operating in the industry received most of the rent, and the government's share was slightly less than the share of either of the other two stakeholders.

DISCUSSION

The ITQ system has managed Iceland's fisheries for almost three decades. Initially, the ITQ system did not lead to RR creation. However, as the necessary rationalizing materialized, factories were closed and vessels were scrapped, and RR appeared. This rent became significant after 2008, when landings, especially of cod, the most important species (e.g., in 2016 around 44% of the value of all landings was cod), started to increase. It is likely that the rent appeared mostly because of better utilization of input factors (i.e., labor and capital). An important reason leading to the

Table 3. Sensitivity Analysis of Resource Rent and its Distribution (1997 to 2017)

	$c = 4.6\%$ (the base case)	$c = 4.0\%$	$c = 5.2\%$	$c = 6.0\%$
RR (billion USD adjusted for inflation)	4.0	4.4	3.6	3.1
Government share of RR	19%	17%	21%	24%
Quota sellers' share of RR	39%	31%	49%	66%
Active companies' share of RR	42%	52%	30%	10%

Source: Statistics Iceland (2018) and author calculations.

better utilization of these factors is the effects that rebuilding of important fish stocks have on costs and, therefore, profitability. The cod stock is a prime example of this. In 2000, the size of its fishable stock (i.e., cod four years old and older) was estimated at only 600 thousand metric tons. Conservation and reduction in catches led to this stock increasing in size to 1,400 thousand metric tons in 2016. The effect of this increased size was an increase in the catch per unit effort (CPUE). In 2000, the average catch per hour for cod when using a bottom trawl, which is the method most widely used; was around 550 kilograms. This increased to 1,400 kg per hour in 2016. This has resulted in considerably less capital (ships) and labor (fishers) being used now than were used previously per unit of catch. The size of the cod has also increased. In 2000, around 25% of cod caught (by weight) by bottom trawl was longer than 80 cm; however, in 2016, this ratio had reached 50% (Hafrannsóknastofnun 2019). Bigger fish cost less to catch and process, because less labor is needed per every kilogram. Therefore, better utilization of the fishing stocks and the end of overfishing are important contributors to the emergence of RR in Iceland's fisheries. A similar development has occurred in Iceland's processing industry. Increased utilization of technology leading to more automation and higher productivity have all resulted in better use of labor and capital (Knútsson, Kristófersson, and Gestsson 2016; Gunnlaugsson and Saevaldsson 2016).

It is unlikely that the RR will disappear from Iceland's fisheries. For that to happen, a significant decline in catch or an extreme appreciation of the value of the Icelandic krona would be necessary. Because the catch is composed of many species, this reduces the risk of overall decline in catches. As often happens, an increase in the catch of one species coincides with a decline of another. An exception to this is the cod stock, because of its significance. A substantial decline in cod catch could not be compensated fully by a greater catch of other species. Because the cod stock is well managed and in a healthy state, the species has an average length of lifespan and the stock is composed of many cohorts. A significant fall in the cod catch is unlikely. Looking at the second factor, the Icelandic krona has been strong for the last few years. Even as the krona was exceptionally strong in 2017, and fishers went on strike for almost two months, which lowered profitability, the fishing industry produced RR that year. However, active companies received none of the RR in 2017, as the government and the quota sellers received more than all of it. As companies active in the industry are the last in line of the three stakeholders presented in this study, their economic performance can be unsatisfactory even though limited RR is produced, as happened in 2017. Their share of the RR can be negative, as the quota sellers and the government (through the fishing fee) can receive all the RR—and even more. History has shown that the Icelandic fishing industry has been quick to adjust to negative developments. Therefore, unsatisfactory economic performance results in further consolidation of fishing rights, closure of fishing plants, and scrapping of boats. This would ultimately improve economic performance and lead to improvement in the economic performance of the industry and a "fair share" (at least not an economic loss, which occurs when the active companies' share of the RR is negative) of the RR for those companies active in the industry. All of these arguments lead to the conclusion that it is unlikely a situation will arise in the near future where no RR is present in Iceland's fisheries.

Pinkerton and Edwards (2009) conducted extensive research on the Pacific halibut (*Hippoglossus stenolepis*) fisheries in British Columbia (BC), Canada. Since 1999, a fully free ITQ system has been used in the management of the local halibut fishery. Few restrictions have been placed on quota ownership (except for a 1% quota ceiling of the TAC), and there has been no obligation for quota owners to fish for halibut on their own vessels or even to possess vessels at all. Therefore, enterprises and individuals not participating in the fishing industry now own most of the fishing

rights (quotas). Consequently, a significant percentage of those vessels fishing halibut now own very little halibut quota, or even none. As a result, fishing boats normally lease the quota, and lease payments amounted to 78% of catch value in 2008 for those vessels that leased their quota entirely. Therefore, crew wages were only around 1–5% of the revenues of those boats from which the entire quota was leased, whereas this ratio was 10–20% of revenues before the introduction of the ITQ system. Thus, BC's halibut fishery is an extreme case wherein undoubtedly most of the RR produced in the industry is now taken by those owning quotas and leasing them out to the industry.

A similar development to the BC halibut fishery has not occurred in Iceland. That is because the quota has always been allocated to vessels, so owning a vessel has always been necessary to own a quota. Since 1998, complex rules have stated that each vessel has to catch at least half of its quota. The current rules are that each vessel is now obliged to catch at least half the allocated quota, on average, every two years. More importantly, all Icelandic fishers are members of a worker's union. Their wages are determined by a collective agreement whereby fishers receive a fixed proportion of the catch value (around 35%, on average). Hence, the lease value cannot push down fishers' share of the catch value, as happened in the BC halibut fishery. All of this has prevented Icelandic fisheries from developing in the way of the BC halibut fishery. This is because almost all Icelandic fishers are well paid, and the current quota holders own vessels and are active participants in the fishing industry.

Hannesson (2017) predicted that the return on capital in ITQ-managed fisheries would become like other industries with similar levels of risk. That is because an ITQ system would lead to a bigger balance sheet on which a significant amount of the assets were capitalized fishing rights. As these costs are included in the capital base in the financial accounts of firms operating in the fishing industry, the return of their total capital should decline. Therefore, almost all the RR would fall to the quota sellers and little to companies operating in the industry. Similar arguments were previously presented by Flaaten, Heen, and Salvanes (1995). Our research does not support this prediction; at least this has not yet happened in Iceland's fisheries. Hence the so-called "transitional gains trap" has not become apparent in Iceland's fisheries, even after almost three decades under an ITQ management regime, as active firms in the industry receive a considerable share of the RR. What is the reason for this? There are many probable explanations. The most likely is that the bulk of quota trading occurred from 1997 to 2007. During that time, the Icelandic fishing industry was not profitable and not producing RR. However, there was plenty of cheap credit flowing in the Icelandic economy. Financing quota purchases was, therefore, easy and quota trading was blooming. However, there is a limit to how much debt can possibly be placed on an industry. As the industry was not very profitable, an imaginary debt ceiling was probably reached in that era, as reports at that time estimated the debt situation was unsustainable (Gunnlaugsson and Saevaldsson 2016). This changed when the Icelandic banking system collapsed in 2008. Trading in permanent quota shares almost stopped (as well as mergers and acquisitions) for a few years because credit dried up at exactly the same time as the profitability of the fishing industry improved immensely. Therefore, it is possible that the size of the balance sheet (i.e., capitalized fishing rights financed by borrowing) has not yet adjusted to the improvement of the economic performance of the Icelandic fishing industry for the past decade. Nevertheless, it is unlikely that that debt levels will become unsustainable and improbable that active firms in the Icelandic fishing industry will not receive any part of the RR in the near future. There are many reasons for this prediction. One is that the current return on capital is high in Iceland's fisheries and there is

no need for capital to leave the industry, as there is little opportunity for higher returns in other industries or in other forms of investments in the current low-interest environment.

A question of validity is bound to arise concerning research of this kind, as it is based on a few simplifying assumptions that inevitably affect the results. This article starts by estimating the RR produced in Icelandic fisheries from 1997 to 2017. The estimated RR is similar to amounts calculated by Flaaten, Heen, and Matthíasson (2017) from 2009 to 2013 and also akin to the estimate presented by Gunnlaugsson and Agnarsson (2019), wherein the RR was assessed from 1989 to 2016. However, this article's main contribution to the literature is the calculation of RR distribution among major stakeholders. This estimation is based on a few assumptions and is, therefore, not flawless. The exact distribution of RR among these three stakeholders in Icelandic fisheries is, therefore, difficult or nearly impossible to assess. Nevertheless, the broad picture presented in this study is clear. All three of the stakeholders have received a significant share of the rent, with the government's share of the rent being the smallest.

CONCLUSIONS

This article shows the estimated RR in Iceland's fisheries and its distribution since 1997. The methodology applied in was to assume that excess return on capital in fisheries compared with other industries in Iceland was a good measure of the RR. The rent was divided among three major stakeholders: the government, which received a share of the rent through higher corporate taxes and the fishing fee; the quota sellers, who sold their fishing rights and received a share of the rent; and, finally, companies still active in the industry that obtained their share of the rent after the two other stakeholders received theirs. The findings are that substantial rent was produced. Since 2008, the rent has been significant, averaging 380 million USD per year, or around 17% of the export value of the industry. The rent distribution has been fairly even. A substantial proportion (around 20%) was allocated to the Icelandic government. A significant portion has accrued to quota sellers (around 40%). Finally, harvesters still active in the fishing industry received a portion of rent similar to the quota sellers.

As the economics literature predicted, this article clearly shows that a quota system, especially an ITQ system, ultimately leads to RR production in fisheries. The Icelandic government received a significant portion of the RR produced in Icelandic fisheries. The fishing fee is a major contributor to this development. The fee is now an important part of the ITQ system and a clear indication of the profits in fisheries distributed to the public. Higher taxes are also a substantial and overlooked part of the government's share of the rent, as around 30% of the government's share of the RR was collected by higher taxes on profits. The quota sellers have not received all of the RR, as some had predicted. Nevertheless, the windfall gains the quota sellers received when they sold their fishing rights and cashed in their quotas are among the key aspects of a negative perception of the ITQ system in Icelandic politics. This, however, is an almost unavoidable part of ITQ management.

The results presented in this study have profound policy implications. The lessons learned from Iceland are that ITQ management in well-governed fisheries will lead to RR creation. However, it took a long time (almost two decades) for the rent to appear. The most likely reason for the long delay was the almost continual decline in fish catches from 1990 to 2008. The industry was rationalizing during that time, but the rationalization only kept up with the reductions in landings; therefore, no resource rent was produced. When catches started to increase, the rent appeared. In addition, the rebuilding of the cod stock was a major contributor to the arrival of rent

in Iceland's fisheries. Thus, patience and long-term planning is needed. The rent should be taxed, and the taxes and fees collected should at least cover the government's cost of managing the fishing resource. Iceland has chosen to tax the rent accruing to companies currently operating in the industry—albeit moderately. The taxation is low because higher resource rent taxes could discourage investments, lead to loss of employment, and reduce the competitiveness of the industry. However, the quota sellers have not paid any form of RR taxation in Icelandic fisheries. In our opinion, Iceland should have considered implementing this form of taxation. As quota sellers will always receive a significant portion of RR in the fisheries, they should not be exempt from RR taxation. Applying a special form of RR taxation specially aimed at quota sellers should normally be considered when ITQ systems are introduced. This would lead to higher government revenue, and, more importantly, wider political acceptance of ITQ systems.

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Paper V

Derby versus ITQ: Iceland's coastal fisheries explained and compared to its ITQ-managed fisheries

Abstract

Iceland adopted a derby fishery; open for all vessels in 2009. This paper refers to these fisheries as coastal fisheries (strandveiðar), in which small vessels, mostly catch cod (*Gadus morhua*) during the summer. This article describes the coastal fisheries, and their results are compared to those of other fisheries in Iceland, which are all manage by an ITQ (individual transferable quota) system. The profitability and the rate of accidents was examined. According to experience from numerous fisheries around the world, the coastal fisheries should be much less profitable than other fisheries in Iceland – indeed, nonprofitable – because of the derby nature of the fisheries. The findings of this study are in accordance with this experience; the coastal fisheries have been on average generating losses, while other fisheries in Iceland have been profitable. The derby management system of the coastal fisheries might lead to the rate of accidents in the coastal fishers being higher than in other fisheries in Iceland. That is because of incentives generated by the race to fish, which could result in coastal fishers disregarding safety. The findings did not support this; accidents in which a person was injured were uncommon in the coastal fisheries and were relatively less frequent than in other fisheries. However, reported incidents without personal injuries, which were mostly caused by mechanical failures, occurred comparatively more often in the coastal fisheries than in other Icelandic fisheries.

1. Introduction

Iceland adopted an open-access derby fishery for small coastal vessels in 2009. This paper refers to these fisheries as coastal fisheries (strandveiðar), in which small vessels mostly catch cod (*Gadus morhua*) during the summer. An open access fishery is a fishery that is open to all. A derby fishery is a fishery where fishers race to fish during a limited season. All Icelandic fishing vessels can enter the coastal fisheries, given certain restrictions on daily catch, gear and vessel ownership. Economic constraints (i.e., a low daily catch limit) and other regulations (e.g., that fishing is only allowed by using a jigging reel) result in these fisheries being only conducted by smaller vessels. All other fisheries in Iceland are managed by an ITQ (individual transferable quota) system. ITQ are management system where the regulator does set a species-specific total allowable catch (TAC). It is typically set by weight for a given time period. A specific portion of the TAC, called quota share, is allocated to the quota holders. The quota shares can normally be leased, bought and sold if the quota shares are fully transferable. Iceland was one of the first countries in the world to introduce an ITQ management system in its fisheries. It was introduced in late 1970s in important pelagic fisheries and in the 1980s in demersal fisheries as a reaction to declining catches, low profitability and overcapacity (Arnason, 2005). A significant milestone was reached in 1991 when ITQ system became a fully functional management system encompassing almost all aspects of the fishing industry (Hannesson, 2004),(Matthiasson, 2008),(Arnason, 2008). The fact that these two management systems coexist in Iceland, provides a unique opportunity to examine open-access derby fisheries and compare them to fisheries managed with ITQs. Fisheries economics theory and empirical evidence suggest that there should be a stark difference in economic performance, and that we might expect other differences, such as in the frequency of accidents. The study presented

in this paper, compares profitability and rate of accidents on-board in coastal fisheries, to that of all other Icelandic fisheries.

Open-access derby fisheries lead to excess capitalization and rent dissipation. This is due to competitive fishing activities causing an excessive fishing effort to enter the industry (Gordon, 1954),(Bjørndal and Conrad, 1987). In cases where entry is not limited, vessels will enter the fishery if average revenue per unit effort is greater than the marginal cost of effort and, conversely, exit the fishery if revenue is less than cost. The expected results are low or no profit. The literature has ample examples of low profitability, overcapitalization, and rent dissipation in open-access fisheries. For example in Belize (Rogers et al., 2018), Canada (Dupont, 2014), Denmark (Andersen et al., 2010), the Faroe Islands (Danielsen and Agnarsson, 2018), Iceland (Arnason, 2005),(Matthíasson, 2003). In the North Sea (Arnason et al., 2018),(Holt and Raicevich, 2018), Norway (Standal and Aarset, 2008),(Greaker et al., 2017), Papua New Guinea (Hair et al., 2016), Sweden (Waldo and Paulrud, 2013), the US (Agar et al., 2014),(Warlick et al., 2018),(Hsueh and Kasperski, 2018) and Taiwan (Liao et al., 2019). All those fisheries used to be open access but later fishing management in most of these countries was changed to various forms of catch share systems.

ITQs as a management system were first introduced partially 1976 in the Netherlands (Chu, 2009). As time has passed, more and more countries have introduced this system to their fisheries. New-Zealand was the first country to implement a major ITQ program in 1986 and Iceland was a close second (Annala, 1996). In 2007, around 250 species in 18 countries were managed by ITQ principles (Chu, 2009). The outcomes of ITQ systems have been documented in various fisheries around the world. Such as in Argentina (Bertolotti et al., 2016), Australia (Kompas and Che, 2005),(Thébaud et al., 2014),(Gardner et al., 2015), Canada (Gardner, 1988),(Casey et al., 1995),(Herrmann, 2000),(Dupont, 2014). In Chile (Pena-Torres, 1997),(Gómez-Lobo et al., 2011),(Kroetz et al., 2017), Denmark (Andersen et al., 2010),(Hammarlund et al., 2018), New Zealand (Dewees, 1989),(Annala, 1996),(Mace et al., 2013),(Breen et al., 2016), Norway (Flaaten et al., 1995),(Hannesson, 2013),(Hannesson, 2017),(Standal and Asche, 2018),(Flaaten et al., 2017),(Zhang et al., 2018), Peru (Kroetz et al., 2019), Sweden (Waldo and Paulrud, 2013),(Blomquist and Waldo, 2018) and the USA (Gauvin et al., 1994),(Matulich, 2008),(Agar et al., 2014),(Thunberg et al., 2015),(Hsueh and Kasperski, 2018). The main results have been similar in all cases: excess capitalization in labor and capital has been reduced or eliminated, and the economic performance of the industry has improved considerably.

Competitive fishing behaviors under derby fisheries elevate the risk of on-board incidents and accidents. Even when the weather is bad, fishers have an incentive to go fishing, as they would lose the race to fish if they stayed home while their competitors went fishing. This is in stark contrast to catch share management systems, in which fishers can choose when they fish their quota. Evidence of high risk-taking in open access derby fisheries was provided in an extensive study on fisheries off the US West coast where the likelihood of fishers going fishing in bad weather decreased considerably when catch shares were introduced to various fisheries (Pfeiffer and Gratz, 2016). As expected, several studies have concluded that higher wind speeds are associated with greater accident probability in fisheries (Jin et al., 2002),(Jin and Thunberg, 2005),(Laursen et al., 2008). The anticipated outcome is, therefore, a considerably higher accident frequency in derby fisheries than in fisheries managed by an ITQ system (Lincoln et al., 2007).

The purpose of this paper is to explain the Icelandic coastal fisheries and compare them to other ITQ managed fisheries in Iceland. In addition to describing the coastal fisheries, this paper answers two main questions. The first is: “How has the profitability of coastal fisheries developed, and how does it compare to other fisheries in Iceland?” The second is: “Are coastal fisheries more

prone to accidents than other fisheries in Iceland?" The contribution of this paper to the existing literature is substantial. This paper is the first to explain the management principles and outcomes of the Icelandic coastal fisheries. In addition, even though the profitability and rent dissipation of open-access fisheries has been studied before in various fisheries around the world. The literature lacks the synchronous comparison of profitability between ongoing open-access derby fisheries and fisheries managed by an established ITQ system. This paper addresses this issue. Finally, the paper addresses the complete nonexistence in the literature of a synchronous comparison between the rate of accidents in derby fisheries and that of fisheries managed by a catch share system. Therefore, this paper is of importance to all interested in fisheries and fishery management and policy.

2. Data

The data used in this study comes from three sources. The data on the number of vessels, catch and quota was obtained from the Directorate of Fisheries, a government institution whose task is to monitor Icelandic fisheries and the daily administration of the fisheries management system. Data on profitability and costs of the coastal fisheries and other fisheries was obtained from Statistics Iceland. Every year, this government agency publishes data online, where the financial development of the Icelandic fishing industry is reported. This data is based on a large sample of tax returns and financial statements of companies operating in the Icelandic fishing industry, and is therefore considered reliable. The data shows the development of the main component of the profit and loss account of the coastal fisheries as well as other segments of the Icelandic fishing industry. Data showing the rate of accidents was obtained from the Icelandic Transportation Safety Board, a government agency that, among other projects, collects data about accidents in aviation, traffic, and fisheries. Every accident in Iceland's fisheries should be reported to this institution. This data is, therefore, comprehensive and provides thorough information on every reported incident in Iceland's fisheries.

3. The coastal fisheries

3.1. Vessels

The coastal fisheries vessels are normally small, cheap and old. The average size of the vessels was 5 gross tonnage (GT) in 2018 and the average length of vessels was 8 meters. The size of the engines was, on average, 121 kW. The average insurance value of each vessel was around 90 thousand USD and the age of the vessels was around 30 years on average (Statistics Iceland, 2019a). The vessels' major hull material is now normally synthetic fibers instead of the wood previously used as building material. The cruising speed of an old-fashioned mainstream motorized wooden vessel is 7–10 nautical miles per hour. This portion of the coastal fishing fleet is this therefore slow. However, a cruising speed of 20– 25 nautical miles per hour is common in the coastal fisheries. This is because of redesigned hulls and more powerful engines. A portion of the coastal fishing fleet belongs to this type of vessels. The equipment used to catch the fish in the coastal fisheries is the electronic jigging reel, invented in the 1980s, which greatly improved productivity in fishing. One man can now easily operate many jigging reels, as the fisher only needs to release the fish from the hook and then push a button for the reel to start fishing again.

3.2. Management

The coastal fisheries were introduced in 2009 and made permanent by law a year later. There were two main reasons for introducing coastal fisheries into the Icelandic fishing industry, according to the original directive. The first was to facilitate recruitment of newcomers into the fishery. The Icelandic ITQ system, fully established in 1991, has always been controversial and under constant political debate and scrutiny (Eythórsson, 2000),(Saevaldsson and Gunnlaugsson, 2015),(Chambers et al., 2017),(Kokorsch et al., 2015). One of the consequences of the Icelandic ITQ system is that fishing quotas have become extremely expensive (Arnason, 2008),(Oostdijk et al., 2019). Buying a quota is necessary to enter fisheries managed by ITQ. For a young person without significant capital, competing on the quota market with the largest fishing companies in Iceland is difficult (Gunnlaugsson and Saevaldsson, 2016),(Chambers et al., 2017). Consequently, it is hard for new recruits to enter the fishing industry, as buying a vessel, and especially the needed quota, is simply too challenging and expensive (Chambers et al., 2017). This lack of recruitment is an important issue for many opponents of the Icelandic ITQ system (Eythórsson, 2000),(Saevaldsson and Gunnlaugsson, 2015). The new coastal fisheries were intended to answer the concerns of the opponents of the ITQ system, as here the fishing rights are free and entry is therefore relatively easy. The second reason was to support rural development and employment. The declining employment in fisheries in vulnerable rural communities, which has been almost constant for the past three decades, has been one of the most negative developments in the industry (Kokorsch and Benediktsson, 2018),(Gunnlaugsson and Agnarsson, 2019). The ITQ system was often blamed for this predicament as it has led to rationalization and concentration of fishing rights (Saevaldsson and Gunnlaugsson, 2015),(Kokorsch, 2018). The coastal fisheries were supposed to halt this decline – or even reverse it – by increasing small-scale fisheries (University Centre of the Westfjords, 2010),(Fisheries Center, 2017).

The management principles of the coastal fisheries are simple, and the main rules have not changed markedly since the initiation of the fisheries in 2009. The coastal fisheries are limited to the summer months from May to August. All vessels can participate in the coastal fisheries even if they are part of the ITQ system. A low daily catch limit and other regulations (mainly the fishing method allowed i.e., the jigging reel) effectively restrict coastal fisheries to smaller vessels. It is possible for vessels within the ITQ system to leave the ITQ system and enter the coastal fisheries for the duration of the coastal fishing season. When the coastal fisheries season ends in August, those vessels can rejoin the ITQ system again and catch their quota from September until the end of April. The entrance fee for participating in the coastal fisheries has been relatively low, around 600 USD in 2019 (Directorate of Fisheries, 2019), and therefore has not discouraged participation.

As referred to above, coastal fishing is limited to the jigging reel, which is almost always electronic and automatic. No more than four jigging reels are permitted per vessel. The vessels are only allowed to be operated by the owner, and they must be locally registered. Each vessel that partakes in the coastal fisheries can catch up to 650 kilos of gutted quota species in cod-equivalent kilos per fishing trip, equivalent to 770 kilos of ungutted fish. A cod-equivalent kilo is a measurement in which the value of species is compared to the value of gutted cod (Gunnlaugsson et al., 2018). Each vessel is only permitted to fish for a maximum of 14 hours per day. The authorities register the time of departure and arrival. The coastal fisheries are only open in the beginning of the week for four days, from Monday through Thursday, from May through August. The fisheries are also closed for five public holidays.

From 2009 to 2017, the management principles of Iceland's coastal fisheries remained unchanged. During that period, the fisheries were managed by setting a TAC, allocated for the whole coastal fisheries, and dividing it geographically into four areas, as shown in Figure 1. Vessels participating in the coastal fisheries were not allowed to move from one area to another. The

allowable catch for the fleet was set in each area and divided onto four months (May – August). Area A, the most important one, received 33% of the total quota from 2009–2015 and 38% from 2016– 2017. Areas B and C received around 23–25% of the coastal fisheries' quota. The smallest quota was allocated to Area D, 14–18% each year (Fisheries Center, 2017). As a result, there were 16 "windows" where the vessels competed for the catch. When the total allocated quota was finished in each zone in one of the months, the fishing was stopped in that area. The fishing then resumed the following month and was stopped again when the total quota for that zone was again completed. Thus, this was an example of a classical derby fishery system, with sixteen different races – four races going on each month, restarting every month, from the beginning of May to the end of August.

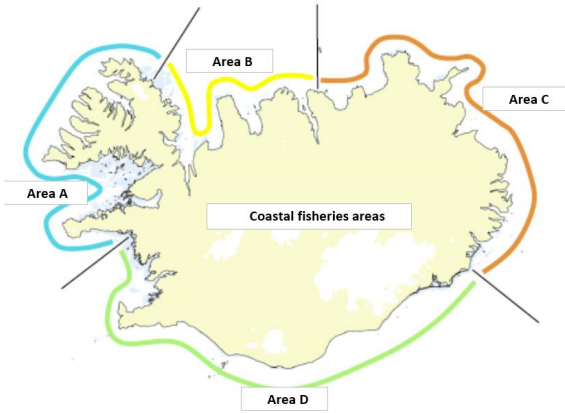

Figure 1. The division of Iceland's Exclusive Economic Zone (EEZ) into four areas in the coastal fisheries. Source: (Directorate of Fisheries, 2019).

In 2018, a significant amendment was made to the management system of the coastal fisheries. The main principles remained the same (i.e., the 650-kilo daily catch limit and the 14-hour maximum time per trip). However, each vessel could now go fishing for 12 days every month (from May to August) and choose the days (except for Fridays to Sundays and the five public holidays), until the total quota allocated to the coastal fisheries was completed in August. The division of the country into four areas was in reality (but not on paper) abolished, as the total quota for coastal fisheries was set for the country as a whole but not for individual areas (Directorate of Fisheries, 2019). Simultaneously, to make these changes easier, the quantity allocated to the coastal fisheries was increased slightly. The main purpose of this adjustment was to reduce or eliminate the race to fish. By having 12 days to fish at the fishers' choice, the fishers were expected to be less likely to go fishing in bad weather. Here, the purpose was to reduce the risk of accidents in coastal fisheries. One fatality had occurred in 2016, and this was one of the reasons for these changes. Another reason was to balance the supply on Iceland's fish markets. Most of the supply of fish caught by the coastal fisheries, especially from Area A, occurred during the first two weeks of the four months that the fisheries are operational. This led to a drop in fish price in these weeks. By having the fishers choose the days they fish, a more even supply was anticipated, leading to higher prices. Another important change made in 2018 was that the fishing of saithe (*Pollachius virens*) was made free for the coastal fishing vessels. The catch of saithe was, therefore, not

included in the daily 650-kilo catch limit set by the authorities. This was partly aimed at reducing incentives to high-grade; that is, limit catches to the more valuable cod.

Figure 2 shows the number of accumulated open (fishing) days from 2009–2018 for each area. The maximum possible permitted days (if the fishing was not stopped) would be around 65–67 days per year, except for 2018, when the allowable days were 48 for all areas. To best understand the picture, we focus on Area A, the most important sector and the one with the fiercest race to fish. Here, coastal fisheries were normally open for only 20–35 days during the season, until 2018 when the system was changed. Therefore, for most months, the fisheries would be closed in Area A before the middle of the month. Areas C and D had the least fierce race to fish. In those areas, the coastal fisheries were usually open for 50–65 days from 2009–2017, close to the maximum possible opening of 65–67 days per year. It is obvious from looking at the picture that the amendment in 2018 hugely benefited Area A, as the number of open days increased significantly for that area. Accordingly, the average catches of vessels in Area A increased considerably in 2018 from the previous year – going up from 16.3 to 21.5 metric tons (MT) – but the average catch per vessel showed little change in the three other areas (Directorate of Fisheries, 2019).

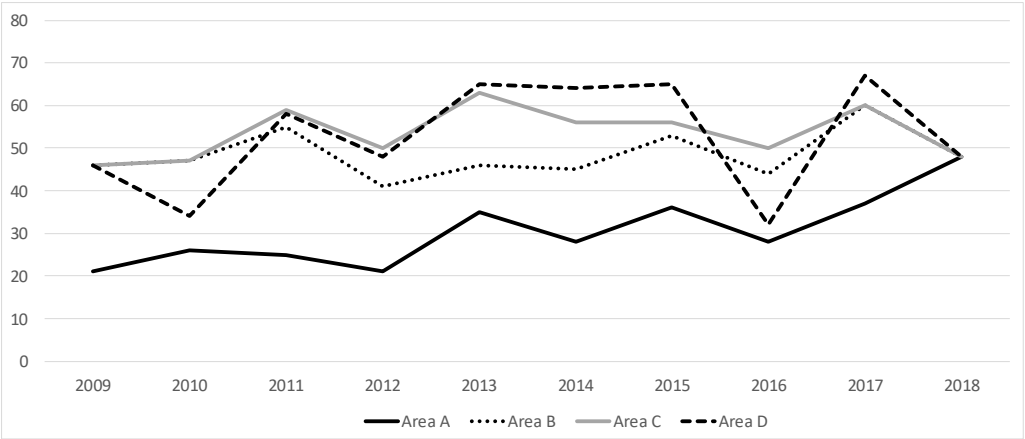

Figure 2. The number of "open days" in the four areas in Iceland's coastal fisheries 2009–2018. Sources: (Fisheries Center, 2017),(Directorate of Fisheries, 2019).

3.3. Numbers

The development of the Icelandic coastal fisheries is outlined in Table 1. The table shows that the total quantity, or TAC, allocated to coastal fisheries was set at 4,000 MT in the beginning but reached 6,000 MT the following year. The TAC was stable from 2011 to 2016 but was increased in 2017 and again in 2018, when it was 10,200 MT. The reason for these increases was mainly a rise in the overall TAC for cod in all Iceland's fisheries; this went up by 72% from 2009 to 2018. Political pressure from the coastal fishers' resulted in an additional rise to the coastal fisheries. As the table shows, the catch has been in line with the set TAC but sometimes a little higher. The number of vessels has fluctuated slightly (between 549 to 761 vessels) since the initiation of the fisheries in 2009. It is noteworthy that the average catch per vessel has increased significantly. From 2009 to 2018, it went up from 7.3 MT per vessel to 17.8 MT. Therefore, the increased TAC allocated to the coastal fisheries has not resulted in an added number of vessels; instead, it has led

to a rise in average catch per vessel. The table indicates the value of the catch, showing an increase from 2009 to 2012, when it reached a peak of around 20 million USD. Since then, it has fluctuated between 17 and 20 million USD. Finally, the table shows the average revenue of vessels participating in the coastal fisheries. From 2011 to 2017, the revenue was relatively stable, from 26 to 30 thousand USD per vessel. It peaked in 2018, when it was around 37 thousand USD. The fish caught by the coastal vessels has mostly been cod, around 87.5% of the weight on average. The second most-caught species was saithe, with a 10.6% share. Other species comprised less than 2% in total (Fisheries Center, 2017).

Table 1. The TAC in the coastal fisheries, catch, and catch value. The number of vessels, average catch per vessel, and average value of landings per vessel for the Icelandic coastal fisheries 2009–2018. Sources: (Directorate of Fisheries, 2019),(Statistics Iceland, 2019b).

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
TAC MT	3,955	6,000	8,499	8,600	8,600	8,600	8,600	9,000	9,760	10,200
Catch MT	4,028	6,363	8,544	8,749	8,666	8,701	8,568	9,145	9,800	9,786
Catch value (million USD)	6.68	13.82	19.45	20.17	17.47	19.92	17.23	18.81	17.73	20.13
Number of vessels	554	741	686	761	676	649	631	665	594	549
Catch/vessel (MT)	7.3	8.6	12.5	11.5	12.8	13.4	13.6	13.8	16.5	17.8
Catch value/vessel (thousand USD)	12.1	18.6	28.4	26.5	25.8	30.7	27.3	28.3	29.9	36.7

4. Profitability

Experience from various fisheries around the world, suggest that open-access derby fisheries, such as the Icelandic coastal fisheries, should be less profitable than ITQ managed fisheries – and indeed, unprofitable on average. Figure 3 shows the development of the EBITDA margin (ratio of earnings before interest, taxes, depreciation, and amortizations), which is defined as EBITDA/Revenue. The figure shows; firstly, the coastal fisheries; secondly, the smaller vessels (i.e., 10–200 GT, not including vessels participating in the coastal fisheries); and, thirdly, the weighted average of all fisheries in Iceland 2009–2017. This ratio is a good indicator of profitability, as it shows what is left as a percentage of revenue after most costs (e.g., wages, fuel, maintenance, insurance, etc.). The only costs left when estimating the EBITDA are financial costs, depreciation, and corporate taxes levied on profit.

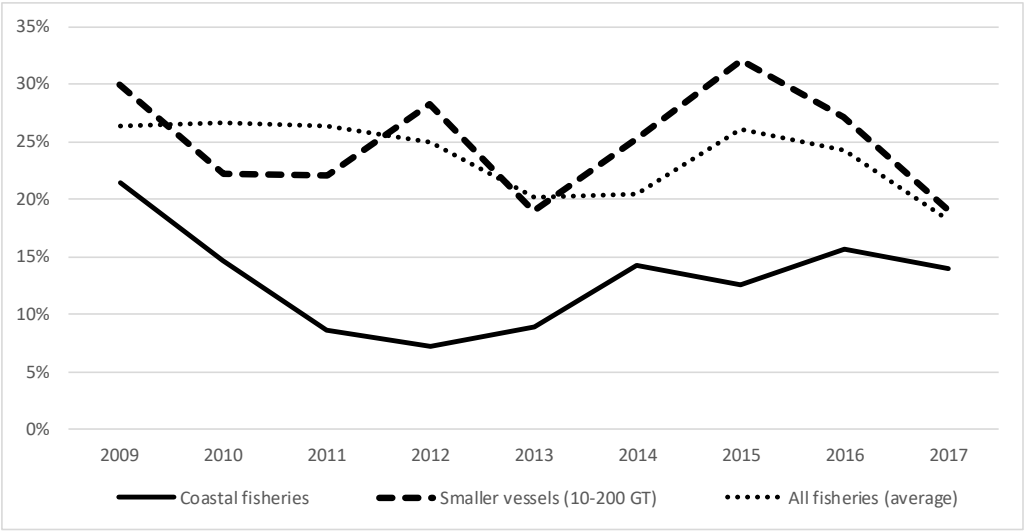

Figure 3. Development of EBITDA margin (EBITDA/Revenue) of Icelandic coastal fisheries, smaller vessels (10–200 GT excluding vessels participating in the coastal fisheries), and an average of all fisheries 2009–2017. Source: (Statistics Iceland, 2019b).

As the figure shows, coastal fisheries have had considerably lower EBITDA margins than the average of all fisheries and, moreover, a significantly lower margin than other small vessels. On average, the EBITDA margin of coastal fisheries was 13.0% from 2009–2017; for other small vessels, the same average was 25.0%, and for all Icelandic fisheries it was 23.7%. The coastal fisheries were much less profitable than the ITQ fisheries in all years. The development of the ratio in coastal fisheries was interesting. When the coastal fisheries started, this margin was around 21.4%. It went down during the following years and reached a low in 2012, when it was only 7.2%. The margin increased steadily to 2014. It has been, on average, around 15% since that year.

The development of profitability is shown in Figure 4. The figure illustrates the development of the relative profit margin, defined as EBT (earnings before taxes)/Revenue. The graph shows the coastal fisheries, smaller vessels (10–200 GT excluding vessels participating in the coastal fisheries), and the weighted average of all Icelandic fisheries. As the picture indicates, coastal fisheries have been unprofitable for almost the whole period the fisheries have been operating. There was a slight profitability in the beginning; however, from 2011, every year except for 2016, coastal fisheries were run at a loss. On average, the profit margin for coastal fisheries was -2.7% from 2009 to 2017. For smaller vessels, this ratio was 14.9%, and the average of all Icelandic fisheries was 14.4% during this period.

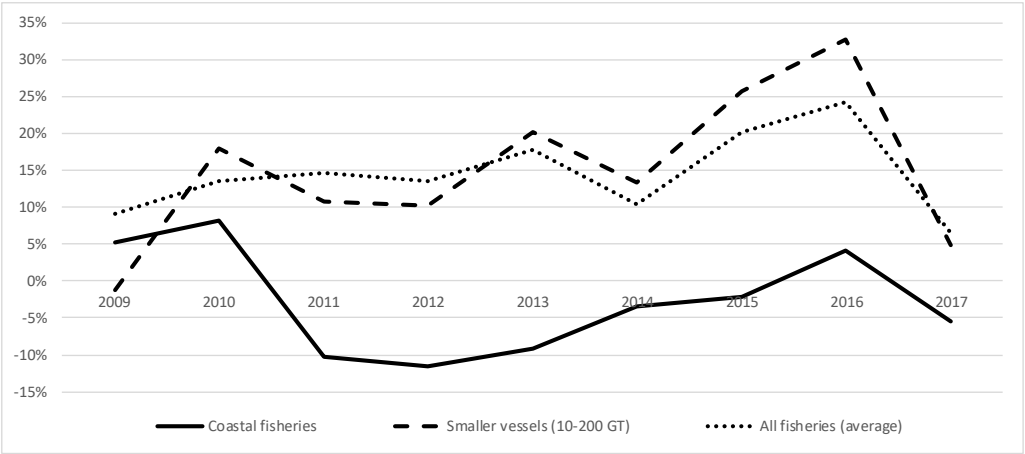

Figure 4. Development of profit margin (EBT/Revenue) of Icelandic coastal fisheries, smaller vessels, and a weighted average of all fisheries 2009–2017. Source: (Statistics Iceland, 2019b).

Table 2 compares the cost structure of coastal fisheries to smaller vessels and the average of all Icelandic fisheries in 2017. The table shows the most important items from the profit and loss accounts. The table presents each item as a share of revenue. The biggest costs for Icelandic fisheries are wages. The coastal fisheries have a clear cost advantage. Fishers' wages were 37.0% of revenue for the whole fishing industry (average) but only 24.1% in the coastal fisheries. The explanation for lower wages in the coastal fisheries is mainly that fishers in most fishing vessels in Iceland receive a share of the catch value as wages. This share is a fixed percentage and is often around 35%. Owner operated coastal vessels are not bound by this. The coastal fishers are almost always the owners of the vessels. Therefore, the coastal fishers control their wages, to a certain extent, and they are unlikely to pay themselves high wages if the operation of the vessel is running a loss. The wages paid are often what is left when all other operating costs have been covered and are significantly below other Icelandic fisheries as a percentage of revenue. Additionally, if there is a profit, owners of coastal fisheries' vessels are likely to pay themselves dividends from the profit instead of higher paychecks, as dividend income is taxed at a lower rate than wages. The owners of the vessels might also build up equity in their enterprise instead of paying high wages or dividends, consequently reducing the wages accruing to their business. The coastal fisheries also have an advantage in the cost of fishing gear. The method applied for fishing (i.e., using automated electronic jigging reel) is relatively cheap in operation and upkeep compared to longlines and trawls. The cost of fishing gear was only 1.1% of revenue for coastal fisheries in 2017, compared to a 3.4% average in all fisheries in Iceland.

The second biggest cost item in Icelandic fisheries is fuel. There is not a substantial difference in the cost of fuel between coastal fisheries and other fisheries. It was 9.2% of revenue for coastal fisheries in 2017; for smaller vessels, it was 5.3%; and around 7.5% of revenue for the average of all fisheries. One would expect coastal fisheries to have low energy costs because coastal fisheries are conducted with jigging reels near the shore. Therefore, the vessels normally do not travel long distances to fishing grounds. However, the boats sail into harbor every day, unlike most other vessels, which stay fishing for a few days. As a result, considerable time is spent traveling and not fishing, leading to relatively high fuel costs, even though the method used to catch the fish is not fuel-intensive (Statistics Iceland, 2019b). It is also possible that the vessels are run at

uneconomical speeds, to maximize fishing time, as this is limited to 14 hours per day, port to port. Other costs, including fishing fees, transportation, office costs, and insurance, were significantly higher as a proportion of revenue for coastal fisheries, in addition to the cost of maintenance, which was almost triple that of the smaller vessels. The outcome of all this was an EBITA margin (EBITDA/Revenue) of 13.9% in 2017 for coastal fisheries, whereas the average for Icelandic fisheries was 18.2% and 19.1% for smaller vessels.

Financial costs and depreciation were higher as a percentage of revenue for coastal fisheries than the average of all fisheries. This is not surprising, considering that the coastal fisheries only operate four months out of twelve, and the vessels are often idle for the remainder of the year. However, this only applies to those vessels that do not participate in the ITQ fisheries when the coastal fisheries are not operating. Almost all other segments of Icelandic fisheries utilize the investment better and catch fish the whole year. Therefore, as expected, their financial costs and depreciation are relatively lower. The results of all this were that the profit margin (EBT/Revenue) for coastal fisheries was -5.4%% in 2017, which is a significant loss and an unsatisfactory outcome. This margin was a profit of 4.8% of revenue for smaller vessels, and the average profit margin for all of Iceland's fisheries was 6.6% in 2017.

The underlying explanations for high costs and low profitability in the coastal fisheries appear to be economies of scale, adverse incentives and the underutilization of investment. On average, the vessels only fish 15–20 MT, and the average revenues are normally less than 30,000 USD. This is simply not enough to cover costs. Many costs are not linearly related to the value of the catch such as for example financial costs, depreciation, insurance, maintenance, and even the cost of fuel. The vessels are idle for a significant period, even during the four months the coastal fisheries are operating. Hence, the investment is underutilized. This is in stark contrast to fisheries conducted under the ITQ regime, as the nature of an ITQ system is to facilitate the maximum utilization of capital. Therefore, the coastal fisheries are unprofitable and significantly less economically viable than other fisheries in Iceland.

Table 2. Costs as a percentage of revenues of Icelandic coastal fisheries, small vessels (10–200 GT) and an average of all fisheries in 2017. In addition, EBITDA ratio and profit margin. Source: (Statistics Iceland, 2019b).

	Coastal fisheries	Smaller vessels (10-200 GT)	All fisheries (average)
Revenue	100.0%	100.0%	100.0%
Wages	-24.1%	-35.8%	-37.0%
Fuel	-9.2%	-5.3%	-7.5%
Fishing gear	-1.1%	-1.7%	-3.4%
Maintenance	-11.5%	-4.0%	-6.6%
Other costs	-40.3%	-34.1%	-27.3%
EBITDA	13.9%	19.1%	18.2%
Depreciation	-12.8%	-5.4%	-5.9%
Financial cost	-6.4%	-8.9%	-5.7%
Profit margin	-5.4%	4.8%	6.6%

5. Accidents and incidents

This research defines accidents as all reported occurrences in fisheries when a person was injured or died. Incidents are all reported occurrences in fisheries filed at the Icelandic Transportation Safety Board, excluding events leading to personal injuries or death. Fishing is one of the most dangerous occupations there is. The hours are long, the work is hard, and there are many ways for injuries and even fatalities to befall fishers (Kaplan and Kite-Powell, 2000). Injuries

are more common in fisheries than almost all other professions (Chauvin and Le Bouar, 2007),(Zytoon, 2012). The Icelandic coastal fisheries were time limited until 2018, creating an incentive to go fishing regardless of the weather. Those fishers that did not go fishing lost the race, negatively affecting their revenue and profits. The literature does suggest that the frequency of accidents and incidents should be higher than in fisheries managed by an ITQ system, wherein fishers can choose when to fish and stay home when the weather is bad. Evidence for this is provided by an extensive study performed by Pfeiffer and Gratz (2016) analyzing fisheries in the US West Coast from 1994 to 2012. The findings were that fishers' probability of taking a fishing trip in high wind conditions decreased by 82% after catch share systems were implemented as management systems. This was compared with only a 31% decrease in open-access races to fish in fisheries. Overall, catch share management systems caused the average annual rate of fishing on windy days to decrease by 79% compared to open access fisheries (Pfeiffer and Gratz, 2016).

Table 3 presents the number of accidents and incidents. In addition, the table shows the number of fatalities. The table shows statistics for coastal fisheries separately and all fisheries in Iceland excluding the coastal fisheries. Before looking at the table, it is worth noting that the Icelandic coastal fisheries were, on average, 1.5% of the total of all Icelandic fisheries measured by catch value. Therefore, the coastal fisheries should represent an insignificant proportion of all accidents and incidents in Icelandic fisheries, according to the scale of the fisheries measured by this criterion.

Table 3. Number of fatalities, incidents and accidents in Icelandic fisheries and coastal fisheries 2009–2018. Source: (Icelandic Transportation Safety Board, 2019).

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total (2009–2018)
Number of fatalities (all fisheries except for the coastal fisheries)	1	1	0	4	2	0	1	1	0	1	11
Number of fatalities (coastal fisheries)	0	0	0	0	0	0	0	1	0	0	1
Number of incidents (reported incident without personal injury) in all Icelandic fisheries except for the coastal fisheries	93	65	68	72	65	46	59	31	62	76	637
Number of incidents (reported incident without personal injury) in the coastal fisheries	3	33	17	17	52	10	19	20	33	27	231
Number of accidents or deaths in all Icelandic fisheries except the coastal fisheries	55	61	69	48	53	42	51	52	41	54	526
Number of accidents or deaths in the coastal fisheries	0	0	0	0	0	0	0	1	0	0	1

The table shows that loss of life was uncommon in Icelandic fisheries during this period. Twelve fishers lost their lives fishing in all of Iceland's fisheries during the period the table spans. This is a noticeable achievement when the overall annual catch of between 1 and 1.5 million MT is taken account. For the past five decades, the number of deaths has been in steady decline in Icelandic fisheries. During the 1970s, on average, 20 fishers died fishing each year; in the 1980s, this figure was 12. A further reduction occurred in the 1990s, when on average 7 fishers died per year. However, since 2000, this number has been on average 1.5 per year, and there are a few years in which no fisher has died fishing. Since the inception of coastal fisheries in 2009, sadly, one death has occurred in that setting (Icelandic Transportation Safety Board, 2019).

The results presented in the table show contradictory results. This is because incidents, which are all reported incidents without personal injury, were very common in the coastal fisheries. However, accidents; that is, when a person was injured, were almost nonexistent in the coastal

fisheries. In total, there were 231 reported incidents in the coastal fisheries over the period the table spans. In all other Icelandic fisheries, there were 637 reported incidents. Thus, 868 total incidents were reported, and out of those, the share of coastal fisheries was 27%. A chi-squared test of independence was performed to examine the relationship between the rates of minor incidents, comparing the rate in the coastal fisheries to all other Icelandic fisheries. The null hypothesis was that incidents in coastal fisheries should be 1.5% of the total incidents in all fisheries, as this was the scale of the fisheries measured as catch value. The relation between these variables was significant, and the null hypothesis was rejected, X^2 (1, N = 868) = 3,711, $p < 0.00001$. Therefore, the rate of incidents was statistically significantly much higher in the coastal fisheries than in other Icelandic fisheries. However, 64% of these incidents involved engine failures. The vessels lost engine power and were towed to the nearest port. Thus, these occurrences were generally trivial even though they were reported.

There was only one reported accident in the coastal fisheries. It happened in 2016; the vessel capsized, and the fisher died. However, there were 526 reported accidents in all Icelandic fisheries, except the coastal fisheries, during the period observed. A chi-squared test of independence was performed. The null hypotheses was that accidents would be 1.5% of total accidents in all Icelandic fisheries. The null hypotheses was rejected at a significance level of 0.05. X^2 (1, N = 527) = 6.2, p = 0.013. Coastal fisheries were therefore relatively underrepresented in accidents (where a person was injured) contrary to what would be expected.

The anticipated outcome according to the literature was that derby fisheries such as the Icelandic coastal fisheries would have higher occurrences of accidents than fisheries managed by the ITQ system. The results presented here do not fit these expectations. Accidents in which a person has been injured are almost unheard of in the coastal fisheries. However, like expected, reported incidents that are mostly engine failure are much more common in coastal fisheries than in other Icelandic fisheries. It is worth noting than the management system changed in 2018. From that year, the coastal fisheries are still open-access, but the derby nature of the fisheries was reduced, as each vessel could choose the 12 days it would fish each month. The expected result was fewer accidents and reported incidents. This did not happen; the number of incidents was like what it had been in the previous years.

6. Discussion

Iceland has now been conducting open-access derby fisheries (i.e., the coastal fisheries) for a decade. The purpose of these fisheries was to help new people to enter the fishing industry and to stop (or reduce the speed of) the rural decline that has plagued many fishing communities in the country. What effect the coastal fisheries have had on rural development, has been difficult to access and warrants an extensive study. No such study has been undertaken, so the effect coastal fisheries have had on this development is unknown.

A recent comprehensive report addresses the role of costal fishing in recruitment into the fishing industry. The findings were that, in 2017, around 64% of fishers in coastal fisheries were 51 years or older, and surprisingly, more than 7% were older than 71 years old. Only 5% of the fishers were 30 years old or younger (Fisheries Center, 2017). Another older report had examined the coastal fisheries in 2009 and shown an almost identical age structure of the fishers that year as it was in 2017 (University Centre of the Westfjords, 2010). Therefore, middle aged or old men dominate the Icelandic coastal fisheries. As women were only 1.5% of coastal fishers in 2017 and young fishers are a small minority. The background of the persons entering the coastal fisheries was also examined in the report. The findings were that most of the fishers (around 2/3) were

involved in the fishing industry during the rest of the year when coastal fisheries were not operating. The remainder had various other professions (Fisheries Center, 2017).

The coastal fisheries are small in scale and do not offer full-time employment. In their paper, Chambers and Carothers (2017) studied why the coastal fisheries did not attract newcomers and young people. Their findings were that coastal fishers did not make enough money to attract young people and that the fisheries were merely a part time job for the summer. They concluded that high cost and little flexibility (hence little profitability) would lead to coastal fisheries being best suited for individuals who are already engaged in fishing or are financially established in other professions – in other words, not newcomers in rural communities (Chambers and Carothers, 2017). This is line with the findings in this paper. The results presented here are that the coastal fisheries are not profitable and therefore not likely to attract new people to the industry. Thus, this mode of fishing is better suited as a source of additional income, supplementing another main profession, during the summer.

The surprising findings in this paper are that derby-style fisheries do not necessary lead to higher accident rates than fisheries managed by the ITQ system. This is not what was expected. There are five probable explanations for these findings. The first explanation is that the coastal fisheries operate during the summer, the season of best weather. Iceland is windy. In Iceland, the wind speeds are on average 20%–80% higher in winter than in summer (Nawri et al., 2014). Therefore, fewer accidents should happen in coastal fisheries than in other fisheries conducted throughout the year when the weather is worse. The second is that the fishing gear used in coastal fisheries (i.e., the jigging reel) is relatively safe and easy-to-use. It is less prone to serious accidents than other methods used in Icelandic fisheries, such as the trawl, gillnet, or longline. The third is that coastal fishers are probably less likely to report minor accidents than other Icelandic fishers are, because they own the vessel and are their own masters, unlike most other fishers in Iceland, who are employed by a company. Hence, they do not receive the same benefits as other fishers when injured, such as sick leave, and thus have little incentive to report a minor accident. The fourth is that the race to fish in Iceland's coastal fisheries is not as fierce as expected. The income for the fisheries is normally supplemental income, and hence the fishers are likely to be sensible and refrain from fishing when the weather is bad. The fifth and probably the most important explanation is extensive surveillance of fisheries in the Icelandic EEZ and mandatory crew safety training. All fishing vessels need to have Automatic Identification System Monitoring Equipment installed. Therefore, each vessel is constantly monitored by the Center of Maritime Traffic. All fishers need to attend a safety course at the Maritime Safety and Survival Training Centre, which issues a safety certificate, with mandatory retraining every fifth year. This has without doubt reduced the number of accidents in Iceland's coastal fisheries.

The most likely reason for many incidents (mechanical failures without any injuries to the fishers) in coastal fisheries is the sheer number of vessels that participate in the coastal fisheries. The catch per vessel is small. It would be possible to bring in the entire catch of the coastal fisheries' 500–700 vessels using only one trawler. Therefore, it is easily explained that mechanical failures were much more common per unit of catch for coastal fisheries than other fisheries in Iceland, which are much more productive. There are simply many more engines that can fail, vessels that can leak or burn, and other misadventures that can happen to 500–700 vessels than to one trawler. In addition, fishers participating in the coastal fisheries are often nonprofessional fishers, and they have other jobs during the winter. They are, therefore, more likely to mishandle the machinery. On larger vessels, the fishers are professional. Only specialized mechanics are licensed to attend to and monitor the engines on larger vessels. The likely result is considerably fewer occurrences of

mechanical failure and loss of engine power on larger vessels than smaller vessels that participate in the coastal fisheries. The age of some of the coastal vessels might also play a role.

The results presented that the coastal fisheries are not profitable and significantly less economically viable than other Icelandic fisheries are not surprising. These findings are in accordance with fisheries economic theory. Iceland's coastal fisheries are derby style so everyone can participate. The lack of entry barriers would keep attracting new vessels if it were profitable to enter the fisheries. It is not, so the numbers of vessels remains stable. The low profitability (or loss) of the coastal fisheries is in stark contrast to other fisheries in Iceland.

The coastal fisheries do not make economic sense, because it would be much cheaper to catch the fish using vessels already within the ITQ system. It is worth noting that most of the catch in coastal fisheries is cod (around 88% of the catch). In almost all of Icelandic fisheries, catching cod is highly profitable, much more so than fishing for nearly all other species (Gunnlaugsson et al., 2018), because the price of cod is high. More importantly, Icelandic trawlers have little difficulty in catching their cod quota and often avoid fishing for cod when seeking their quota for other species. Fishing cod by long-line or bottom trawl is very profitable. Therefore, the coastal fisheries are economically wasteful. The magnitude of the economic loss, while unknown, is, nevertheless, significant and does warrant further study.

7. Conclusion

The Icelandic open coastal fisheries have been in place for around a decade. The fisheries are a classic case of derby fisheries where fishers race to fish. The expected outcome was that these fisheries would be unprofitable on average and more prone to accidents than the ITQ managed fisheries in Iceland. The findings in this study partially fit these expectations. The coastal fisheries are on average unprofitable, as would be expected. Moreover, they are much less economically feasible than other fisheries in Iceland. As anticipated, mechanical failures are much more common in the coastal fisheries than other fisheries in Iceland considering their scale. However, accidents wherein a person is injured are relatively less frequent in the coastal fisheries than other fisheries managed by the Icelandic ITQ system –contrary to what was expected. The coastal fisheries have not been the source of recruitment predicted by their advocates. Instead, middle aged or older fishers, already involved in the fishing industry, mostly attend them.

The coastal fisheries are now important in many rural fishing communities. These fisheries give life to rural villages and harbors and provide additional employment. The coastal fisheries have revitalized some of those communities and their ports, at least during the summer when the fisheries are operating. The coastal fisheries are here to stay. Politically, they have solid backing, and it would be impossible to abolish them, especially since the coastal fishers and other owners of smaller vessels are an important lobby group. The authors of this paper, therefore, predict that the coastal fisheries will be a part of Iceland's fisheries, parallel to other fisheries managed by the main ITQ system, for the foreseeable future.

The lessons learned from Iceland's coastal fisheries are that open-access derby fisheries can coexist parallel to fisheries managed by an ITQ system. If conducted sensibly, derby fisheries do not necessarily lead to a higher rate of accidents causing injuries. However, open-access fisheries will always be unprofitable, as the Icelandic experience of coastal fisheries has clearly demonstrated.

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