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Infra-marginal rents in Norwegian fisheries

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Summary

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Content

1. Abstract

This paper examines economic rent in Norwegian fisheries 1985–2014. While several earlier studies provide estimates of total economic rent, our paper investigates different components of rent. This is important as different types of rent may be permanent to varying degrees. Modern rent theory separates total economic rent into three main components, absolute (e.g. scarcity, regulation, resource rent), inframarginal and quasi-rent. Using vessel data, we examine the composition of resource vs. inframarginal rent in the Norwegian fisheries sector. Our results suggest that the economic rent in Norwegian fisheries comes mainly in the form of inframarginal rent. This is in line with an increasing literature providing evidence that inframarginal rents are an important component of economic rent, and a category that is difficult to assess for valuation and tax purposes.

2. Introduction

Economic rent is any payment to an owner or factor of production in excess of the costs needed to bring that factor into production, i.e., all input factors are paid their opportunity cost.[1] The concept dates back to the Physiocrats and later the classic economist Adam Smith and was given a more precise definition by David Ricardo who introduced the term land rent. A number of additional sources of economic rent has been identified, such as monopoly rents, patent rents, managerial rents, regulatory rents and resource rents. The presence of economic rents gives strong incentives to other agents to enter the industry to obtain a share of the rent, and the rents can only be maintained if entry can be prevented.

In relation to fisheries, the resource rent is of particular interest. If the governance system for a natural resource facilitates optimal economic exploitation so that marginal cost equals marginal revenue without any market power being exploited, a resource rent will be generated (Gordon, 1954; Scott, 1955). However, the potential rent gives strong incentives for entry, and in the case of fisheries and other renewable resources with no restriction on access, Gordon (1954) described how entry will occur until the resource rent is fully dissipated, the economic profits are zero and the fishery has reached the open access equilibrium. This rent dissipation process with the associated decimation of the exploited natural resource is what is known as the tragedy of the commons.

However, also in the open access equilibrium economic rents may be generated, although these will typically be inframarginal as they are associated with specific factors that are unevenly distributed (Copes, 1972; Arnason et al., 2018). In the general literature, the classical example of such an

[1] Which is why in a competitive economy economic profit is zero, while accounting profit is normally positive as the accounting profits excludes the return on equity capital.

inframarginal rent is the Ricardian land rent, while in fisheries this is commonly referred to the skipper effect, a special case of what is generally known as managerial rents (Squires and Kirkley 1999; Wolff et al., 2013). The skipper effect is whatever enables some vessels or skippers to be more profitable than others due to better ability to find fish, and fish with lower costs or better handling of the fish so that one obtains a better price. Kristofersson and Rickertsen (2004) and Guillotreau and Jiménez-Toribio (2011) provide examples from auctions and Asche and Roll (2018) from landings data. Hannesson (2007) and Arnason et al. (2018) show how such rents can be generated also by interannual variation in stock size.

Homans and Wilen (1997) show that regulations that protect the stock but does not prevent a race to fish, known as regulated open access management, will create higher over-capacity than what is associated with pure open access as the protected stock yields a higher harvest. This is due to the fact that (partially) successful biological stock management lead to a larger stock and higher harvest than under open access, but the associated rents are competed away by additional entry. Valderrama and Anderson (2010) show that also in limited entry or regulated restricted entry fisheries a similar effect will occur. However, the regulations may prevent complete rent dissipation as some resource rents may be monetized as licenses become valuable. As the potential rents are higher in management systems that to some extent protects the stock this should also suggest that the potential for inframarginal rents to be realized increase.

Fisheries management has in recent decades improved significantly in many countries (Hilborn et al., 2020). While the main focus has been on protecting stocks, limitations on participation in the fishery has also allowed economic rents to be created. An early example is Flåten, Heen and Salvanes (1993), who show that the license for large Norwegian purse seiners obtained value in the mid-

1970s. The introduction of individual fishing quotas (IFQs) has further facilitated the monetization of rents as the quota gets value (Asche 2001; Newel et al., 2005). However, this includes both an element that is (a part of) the resource rent and an inframarginal element as more efficient fishers buy quota from less efficient ones (Arnason, 1990). The regulatory system also impacts how much of the rent can be monetized. Kroetz et al. (2015) provides a good example in showing how restrictions on transferability of quota between vessel groups allows more rent to be generated in the more efficient vessel group relatively to the others. That implies that a part of the rent being generated is a resource rent, while the difference in rent generation between vessel groups becomes an inframarginal rent caused by the regulatory system.

The gradual implementation of IFQs and the gradual introduction of transferability into the system makes the Norwegian management system an interesting case with respect to rent generation, particularly as there are still no attempts by the government to collect any of the potential resource rent (Standal and Asche, 2018). Until the introduction of IFQs basically no rents were monetized with the large purse seiners as an exception (Flaaten, Heen and Salvanes, 1995). Asche, Bjørndal and Gordon (2009) show that no rents were realized for the cod trawlers in the late 1990s following the introduction of IFQs in this fleet and attributes this to the significant over-capacity. Steinshamn (2010) examines all the main segments of the Norwegian fishing fleet and find that the large purse seiners are the only vessel group where rents where monetized. The introduction of IFQs with an increased degree of transferability has facilitated the generation of more rents, and Byrne et al. (2019) provide estimates of these rents.

Profits and rents – The schizophrenic nature of economic rents in the literature

Empirical investigation of potential and generated rents is difficult as one first has to estimate the excessive profits, and then attribute it to specific sources. As a consequence, the definitions and estimation of profit and rent in the fisheries literature are often specific to the individual studies (Arnason, 2006; 2011; Flaaten, Heen and Matthiasson, 2017; Greaker et al., 2017; Arnason et al., 2018). The reason for this conceptual ambiguity is that economic rent theory has a long and complex history which has resulted in a multitude of definitions that include classical Ricardian land rent, Marshallian rents, scarcity rents, monopoly rents, entrepreneurial rents, quasi-rents, locational rents, investment rents, market rents, resource rent and pure rents (Luckert, 2007; Sanderson and Winter, 2002; Lewin and Phelan, 1999; Schwerhoff et al., 2020).

Profits, rents, and producer surplus are often used interchangeably, contributing to the confusion. In general, profits and rents are not the same, and rents can, depending on the size of fixed costs and the curvature of the profit function, be larger or smaller than profits (Arnason, 2006; Arnason and Bjørndal, 2020). Arnarson (2006) shows that the variable portion of profits will always be greater or equal to rents if the profit function is at least weakly concave. The concepts of surplus vs. rents are discussed in Mishan (1968), Currie et al. (1971) and Jensen et al. (2019).

Even in a simple model of land rent, several types of economic rents can be attributed to the use of the land. For instance, land might be scarce from the nature perspective, which gives rise to a scarcity rent. Land might be scarce due to regulation, for instance by protecting land from economic use, resulting in a regulation rent. Moreover, land can have different qualities, which result in the classical Ricardian differential rent. Investment in technology might lead to a technical change that improves the quality of land, resulting in an investment rent.

Economic rent is therefore more appropriately seen as an umbrella term comprising different forms of more basic types of rent. In the simplest models rent is a result of scarcity of a single factor of production. In more complicated models the profit function is dependent on a vector of variables, such as technology, capital, entrepreneurship, natural resource stocks, expectations, prices, etc., and total economic rents depends on all the rents associated with the individual variables (Arnarson and Bjørndal, 2020). In this case, it can be very challenging to isolate the effects on rent from any single factor. Moreover, some of the variables consist of discrete subsets that have heterogenous productivity, resulting in differential rents and inframarginal rents.

Since the supply curve is less elastic in the short-run than in the long-run, this generates temporary rents in the short-run, known as quasi-rents. Quasi-rents should disappear as the supply of different factors of production adjusts as time passes, unless market imperfection and frictions exist that can sustain different efficiencies across producers.

The Physiocratic and classical economic theories of economic rent

The concept of rent dates back several centuries to the Physiocrats, founded by François Quesney in the 18th century. The Physiocrats considered rent a surplus payment to landowners above any necessary payment (Lackman, 1976). Rent was later incorporated in classical economics by Adam Smith. In *Wealth of Nations*, Smith defines classical land rent (Smith, 1776):

> "As soon as the land of any country has all become private property, the landlords, like all other men, love to reap where they never sowed, and demand a rent even for its natural

produce. The wood of the forest, the grass of the field, and all the natural fruits of the earth, which, when land was in common, cost the labourer only the trouble of gathering them, come, even to him, to have an additional price fixed upon them. He must then pay for the licence to gather them; and must give up to the landlord a portion of what his labour either collects or produces. This portion, or, what comes to the same thing, the price of this portion, constitutes the rent of land ...."

Smith also describes rent as an excess of price over cost of production. Malthus (1814; 1815) further develops classical rent theory and defines rent as "that portion of the whole produce which remains to the owner of the land, after all the outgoings belonging to its cultivation, of whatever kind have been paid, including the profits of the capital employed". Moreover, Malthus describes that rents would start on the most fertile lands when less fertile land was cultivated, alluding to the concept of differential rent. While other economists such as Sir William Petty and James Anderson also contributed to classical rent theory, David Ricardo was the first to present "clear, coherent statement on the subject" (Lackman, 1976). Ricardo asserts that since land is not unlimited in quantity and of varying qualities, different qualities of land will give rise to different rents. When "land of the second degree of fertility is taken into cultivation, rent immediately commences on that of the first quality and that rent will depend in the difference in quality of these two portions of land" (Ricardo, 1817).

While early definitions of rent were based on land rent, modern economics apply a more generalized term, whereby "Economic rents are payments (imputed or otherwise) to a variable above the marginal cost of supplying that variable" (Robinson, 1938; Worcester, 1946, Alchian, 2008). Other definitions of rents, such as land rent, monopoly rents etc., will be covered by this definition.

Modern rent theories

Since the early works of The Physiocrats and the Classicists[2], researchers have struggled to incorporate the concept of rent into neoclassical economics (Fine, 1983; Bina, 1992). Bina (1992) argues that there is no general theory of rents in political economy. According to Fine (1983), “Neoclassical theory has compromised over this situation by abandoning general equilibrium whenever a theory of rent is required and otherwise adopting a theory of consumer surplus, even occasionally recognizing its schizophrenia”. Moreover, Fine (1983) writes: “The passage to extinction of rent theory in neoclassical economics has mean that it has lived in the underworld of the profession, like a guilty conscience that is at its strongest when crime is committed but which fades with the passage of time only to reemerge sporadically and feebly”.

Modern rent theory is an amalgam of different rent theories, with definitions varying across different schools of economics thought. Moreover, the same type of rent is defined differently by different researchers. Resource rent is a good example. Van Kooten and Bulte (2000) define resource rent as the sum of scarcity rent and differential rent, while other researchers such as Arnason et al., (2018), Jensen et al. (2019) and Schwerhoff et al. (2020) make a clear distinction between resource rents and infra-marginal rents/profits[3].

[2] Marx also developed rent theories; differential rent, monopoly rent and absolute rent (Evans, 1999).
[3] Arnason et al. (2018) use the term inframarginal profits, not inframarginal rent to make a distinction between profits and rents.

Inframarginal rents are created by the inframarginal producers and can be a substantial part of total rents or profits. Inframarginal rents also depend on all the variables in the profit function. Differential costs and rents may also be a result of heterogeneity in skills among producers and may also appear as quasi rents. In the fisheries economics literature, inframarginal rent refers to the positive economic profits that low-cost or high skill producers are able to generate in competitive settings (Clark, 1980; Johnson and Libecap, 1982; Johnson, 1995; Squires and Kirkley, 1999; Heaps, 2003; Johnson and Libecap, 2014). Heterogeneity in skills and knowledge related to resource or production technology allow some producers with lower costs to earn positive rents even though producers at the margin earn zero economic profits. Hence, inframarginal rent arising from differential production costs can be captured by the skilled producers (Johnson and Libecap, 1982). In frictionless markets, this knowledge heterogeneity would not be sustainable over time since the knowledge would be commonplace and/or costless to obtain. Production costs should therefore converge, eliminating any inframarginal rents. Market imperfections, however, allow knowledge heterogeneity, and hence inframarginal rents, to persist over time. A number of studies has shown that such effects exist in the form of technical inefficiency in dual settings or the conditions for them in primal settings. Examples for Norwegian fisheries includes Guttormsen and Roll (2011), Kumbhakar et al., (2013), Asche and Roll (2018) and Asche et al. (2020).

As a consequence of the confusions in modern rent theory, Schwerhoff et al., (2020) propose a taxonomy of rents, and separate different rents into three types; absolute rents (resource rent, regulation rent, market power rent, scarcity rent etc.), inframarginal rents (including differential rents, skill rents, and entrepreneurial rent) and quasi rents (temporary rents). This framework makes a clear separation between resource rent and inframarginal rent, where resource rent is the economic rent that arises when the produced quantity is below the market equilibrium quantity in a perfect competition market due to scarcity in supply (scarcity rent) or scarcity that is caused by regulation (regulation rent), and inframarginal rents are accrued when the market price is above the production costs of inframarginal units given a convex production technology. This rent framework serves as the point of departure for how economic rent is treated in our paper, where we make a clear distinction between resource rent (a form of regulation rent) and inframarginal rent.

3. Method

As discussed above, economic rents is an umbrella term for different types of rents, arising from different variables in the economic agent’s optimization problem, and it is very challenging to disentangle different rents from each other. In this study we apply a framework where we divide total economic rents into two parts, inframarginal rents and other economic rents (mainly a resource rent). The inframarginal rents are generated by different marginal costs or revenues for producers, while the other rents are due to regulation and will if no other rents are present capture the resource rent. However, many studies estimating “resource” rents in fisheries fail to distinguish between regulation rents and inframarginal rents potentially overestimating the “resource” rent. Several studies have found substantial inframarginal rents (Coglan and Pascoe, 1999; Grainger and Costello, 2016).

The principles behind our approach are described below. The point of departure is Gordon’s (1954) traditional bioeconomic model of a fishery (Figure 1). The fleet is competitive, consists of homogenous vessels with a common cost structure, and the fleet’s total economic costs are a linear function of fishing effort (cost of the fish stock is zero).

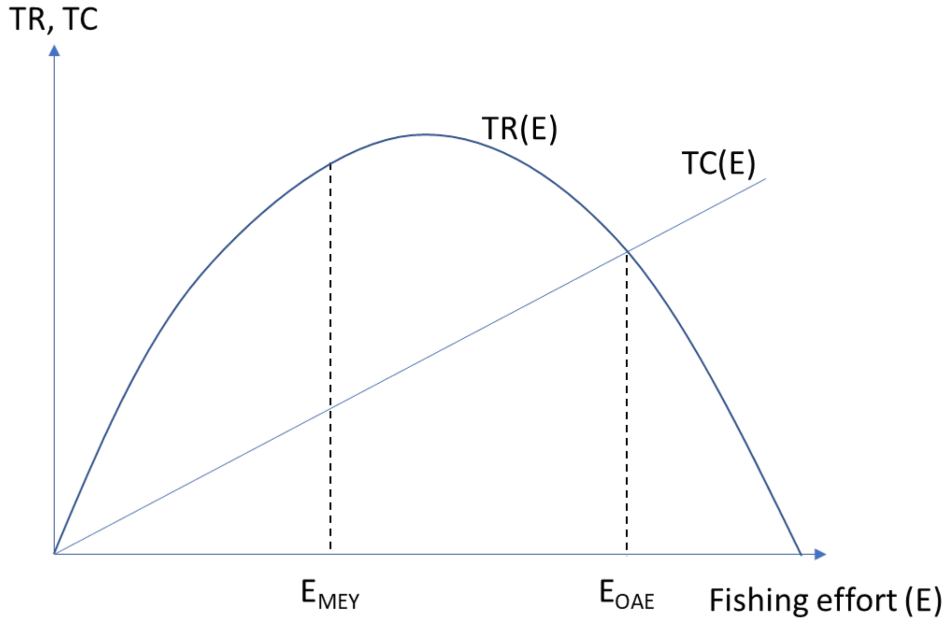

Figure 1. Gordon's (1954) traditional bioeconomic model.

The vessels' total revenues, TR(E), are a parabolic function of effort assuming a parabolic sustainable yield curve and a constant price across time and quantity. Each vessel maximizes its profits. In an open access fishery, the only profit to be earned are normal profits, given by the intersection between the intersection of the total revenue and cost curves. The total fishing effort is given by E_{OAE} (Open access equilibrium effort). At efforts below E_{OAE}, positive economic profits will attract new entrants to the fishery, which will continue until only normal profits remain. Since the cost of the fish stock is set to zero, any potential rents or returns on the fish stock are dissipated.

Hence, the economic objective of a regulated fishery is to monetize the resource rent by reducing the fishing effort to the level E_{OAE} where the fleet's profit is maximized, and the marginal revenue equals marginal cost (Figure 2). This profit maximizing level of fishing effort can be determined by a social planner, or alternatively by a private sole owner of the fishery.

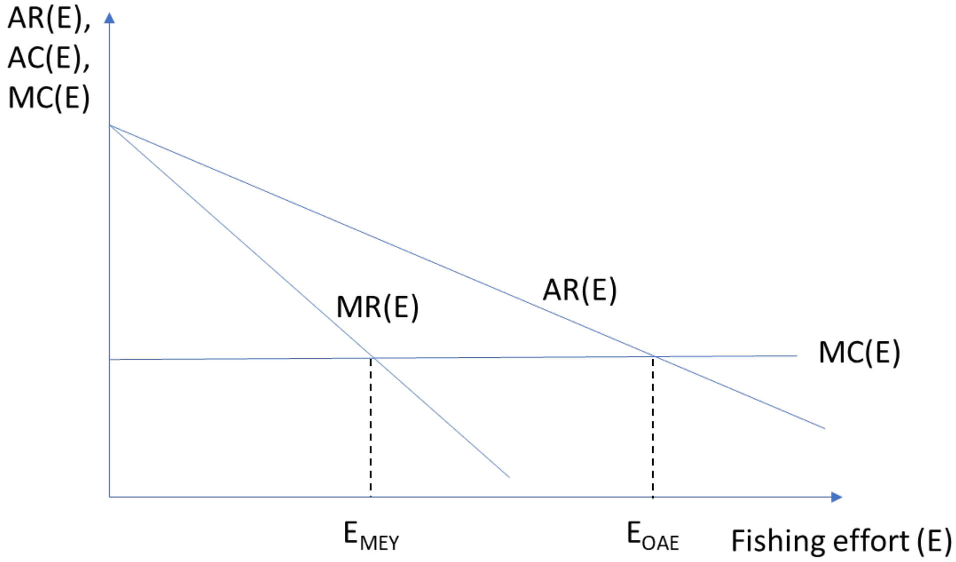

Figure 2. The fleet's marginal revenues and costs, and average cost as a function of fishing effort.

The traditional bioeconomic model assumes a homogenous fleet with a common cost structure. However, Turvey (1970) and Copes (1972) highlight the importance of inframarginal rents, which are not included in the standard bioeconomic model. The maximum gain in a fishery is the sum of consumer surplus, producer surplus (i.e. inframarginal rents), and rents of the other scarce resource which is the fish stock (Turvey, 1970), suggesting the relaxation of the assumption of a homogenous fleet with a common cost structure.

The impact of fisheries management and a heterogenous cost structure in a fleet can be illustrated as follows (following Coglan and Pascoe, 1999). Let *n* denote the number of vessels in an open access fishery. Next, regulation, such as the restructuring used in Norway 1980s–2000s, results in *x* number of boats being removed from the fishery. Consequently, the total fishing effort falls, and the average revenue increases from r_1 (open access revenue) to r_2 (regulated fishery revenue) (Figure 3). Vessel

1 (Figure 3, panel a) has the lowest costs, vessel 2 (Figure 3, panel b) higher than vessel 1, and vessel *n-x* (Figure 3, panel c) is the marginal vessel. The costs and revenues for the total fishery is given in Figure 3 panel d. Vessel 1 earns both a resource rent (dark grey rectangle) determined by the difference between the marginal revenue (p_2) and the open access price (p_1), and an inframarginal rent (rectangle with diagonal lines) determined by the difference between the p_1 and the average cost at effort E_1. The same goes for vessel 2, except that the size of the inframarginal rent per unit of effort decreases since the vessel's average cost is higher. The marginal vessel, *n-x*, will not earn any inframarginal rent, only resource rent. The total profits for the fishery are given by the rectangle abcd (Figure 3 panel d). In this case, total rent can be attributed to both resource rents (the rectangle abb*a*) and inframarginal rent (the area a*b*e).

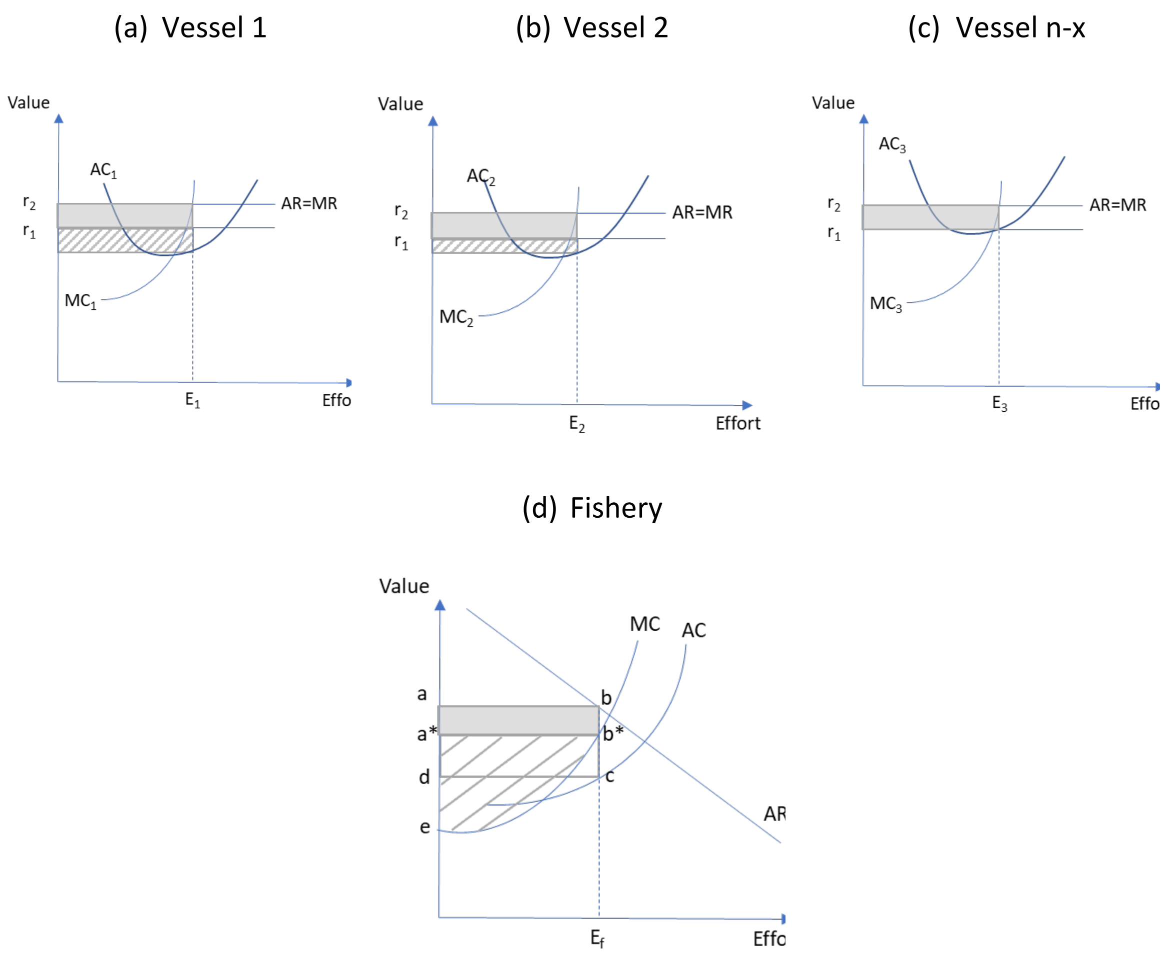

Figure 3. Resource and inframarginal rents in a regulated fishery. Based on Cogland and Pascoe (1999).

Following Coglan and Pascoe (1999), we use Figure 3 as the point of departure for our analysis. We calculate an economic profit margin for each vessel for each year. The economic profit margin is calculated by subtracting operating costs and capital costs from the operating revenues, divided by the latter. The vessels are ranked from highest to lowest economic profit margin and plotted against total output. Since the output in form of fished quantity will differ from type of fishery, we use operating revenues as our measure of output. If the economic profit margin of the marginal vessel (i.e. the vessel with the lowest economic profit margin) is positive, this is taken as evidence of a positive regulation rent. If there is no regulation rent, then the economic profit of the marginal vessel is zero.

The size of the regulation rent is given by the magnitude of the economic profit margin of the marginal vessel multiplied with the total operating revenues. The remaining part of the (positive) economic profit will be inframarginal. Negative economic profits are termed economic losses. Some studies refer to these as negative resource rents, however this is not in line with the definition of excess profits.

3.1. Norwegian fisheries

FAO tends to rank Norway as the world's 10th to 14th largest fishing nation depending on year. In Figure 4 Norwegian landings is shown by main species group, while Figure 5 show real landing value. The pelagic group is the most important by quantity. The most important species are capelin, herring and mackerel, while there is also a handful of other species in this group. The second most important group is whitefish. Cod and saithe are the two most important species by quantity and together with haddock makes up more than 90% of the whitefish landings in most years. The other group consist of a wide variety of species from low-value species primarily reduced to fishmeal such as sand eels to high value species like lobster. Mackerel was the first species where one tried to protect the stock with a quota as this was imposed in 1972 (Standal and Asche, 2018). Management became more ambitious after 1977 when a 200 miles Exclusive Economic Zone was declared, although stocks are shared with other nations and some straddles international waters. Hence, most quotas are set based on advice from ICES but after negotiations with several other countries (Bjørndal, 2009). From the 1990s, landings have been relatively stable at between 2 and 2.5 million mt, and in the lower bound in recent years primarily due to weak herring stocks.

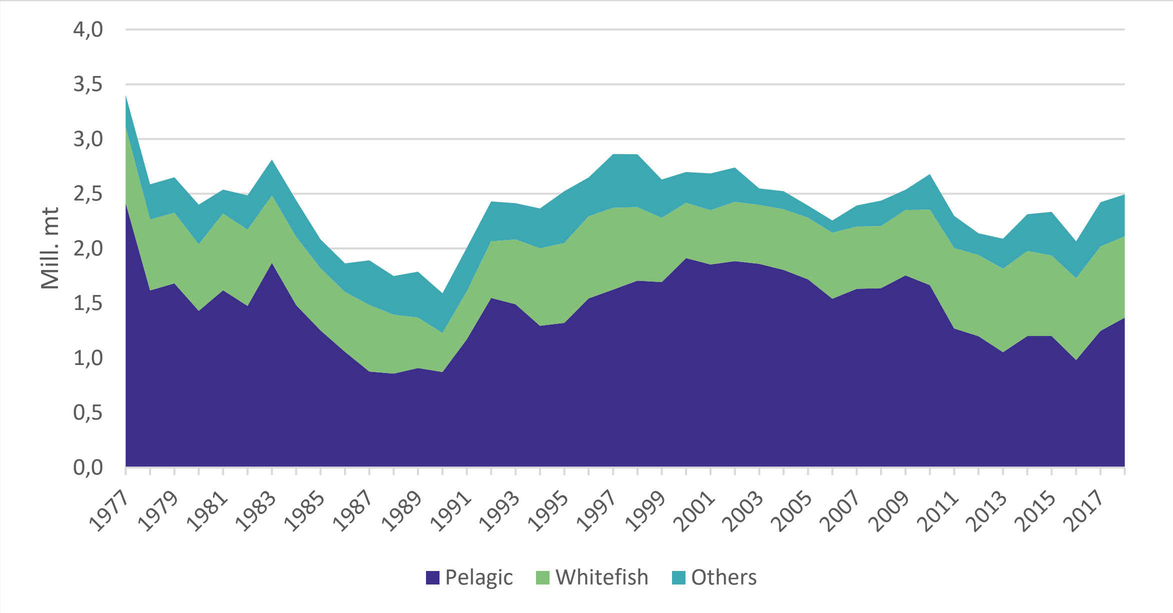

Figure 4. Norwegian landings, 1977–2018

Source: SSB, Directorate of Fisheries

When looking at values, the picture differs significantly. Whitefish is clearly most important with more that 50% of the landed value due to its higher price. Cod is by far the most important species, as its price is significantly higher than the price of saithe, and also makes this the most politically sensitive fishery due to its importance for supporting livelihoods in coastal communities (Cojocaru et al., 2019). This consideration is key for the most important distinction in Norwegian fishing regulations, the one between ocean going and coastal vessels. This is present in the whitefish as well as the pelagic fisheries, and the Norwegian quota is divided between the vessel groups by given formulas (Guttormsen and Roll, 2011; Asche et al., 2020). To a large extent the distinction between ocean going and coastal vessels and the two main fisheries are also distinctions by gear type. Ocean going pelagic vessels are purse seiners while coastal pelagic vessels use smaller seins and nets. Ocean going whitefish vessels are trawlers or long-liners, while costal vessels use a variety of gears such as Danish sein, troll nets and hook and line. As the gear and vessels mobility influence price systematically (Sogn-Grundvåg et al., 2020; Pettersen and Asche, 2020), this also influence inframarginal rents

IFQs was introduced without transferability for the ocean-going purse seiners in 1986 and for the trawlers in the mid-1990s. In the mid-1990s, a limited degree of transferability was also allowed, as up to three vessels could buy a vessel with quota, scrap the vessel, and split the quota between the buying vessels. The purchased quota was to revert to the government after 13 years. After several revisions, the quota can be used for 25 years, and will than go back to the pool for the specific vessel group and thereby increase the IFQ for all vessels in the group marginally. Nøstbakken (2012) show how different factors influence who buys and who sells quota, and thereby how this is a source for inframarginal rents.

In 2003 the coastal fleet for whitefish was divided into groups by length. In 2004, IFQs was introduced for coastal vessels over 15m, and in 2007 for coastal vessels over 11 with a professional license. An open group is maintained where most vessels are smaller than 11m which is still regulated by maximum catch and the group quota.

There are limitations of how much quota any vessel can own. However, this limitation has been relaxed several times in all vessel groups, leading to new rounds of quota purchases and reductions in the number of vessels.

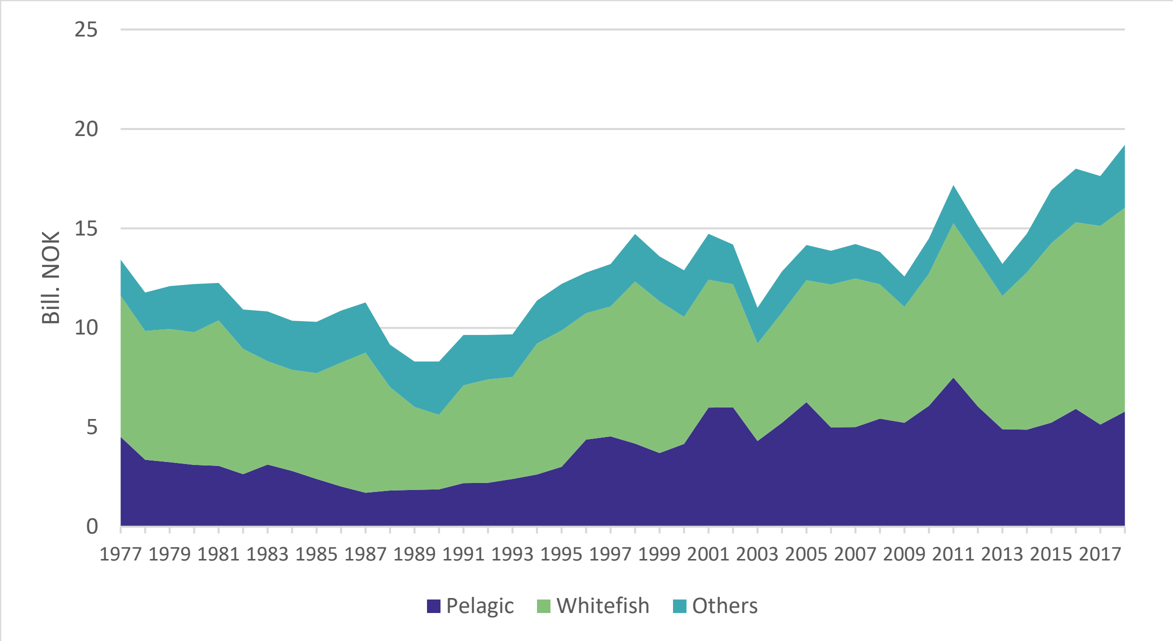

Figure 5. Norwegian real landings values (2015=100), 1977–2018

Source: SSB, Directorate of Fisheries

4. Data

The dataset consists of vessel data for a sample of the Norwegian capture fisheries industry from 1985 to 2014. Figure 6 shows the development in the number of Norwegian fishing vessels between 1982 and 2019. In the 1920s, the Norwegian fishing fleet consisted of around 20,000 fishing vessels, increasing to around 40,000 in the 1960s, before following a downward trend. In the 1960s, the collapse of the North Sea Herring stocks led to new fisheries regulation governing participation in the fisheries in 1972. The initial regulations were involved participation, quotas, and the closing of fisheries. However, technological advances, modernizations and replacement of vessels lead to catch efficiencies, lead to overcapacity in the fisheries sector, adversely impacting profitability (NOU 2016:26). In the four decades between 1970s and 2009, various capacity reduction schemes resulted in a reduction in fishing capacity and increased profitability (Figure 7).

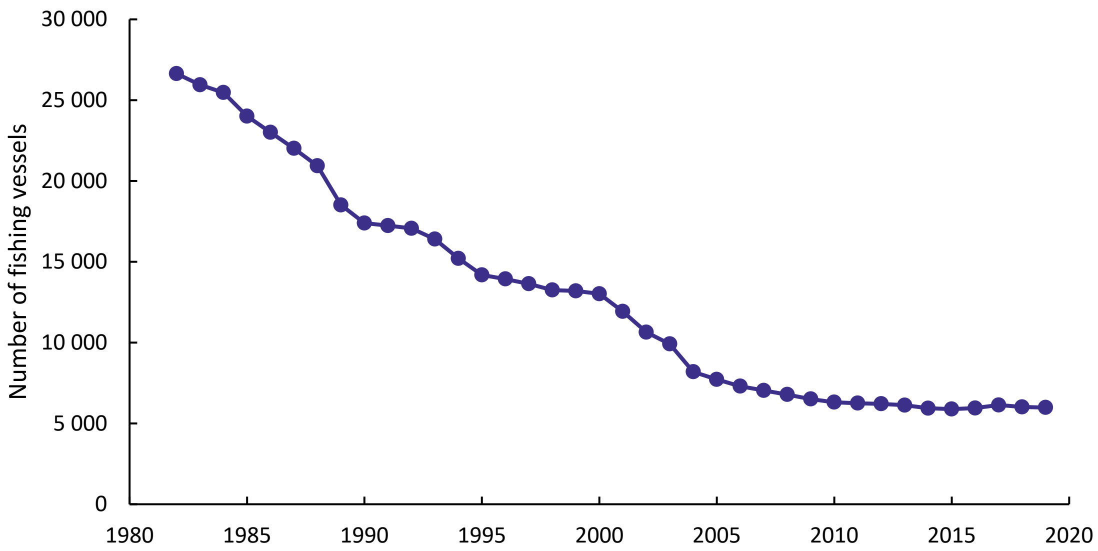

Figure 6. Number of fishing vessels. Source: Norwegian Directorate of Fisheries.

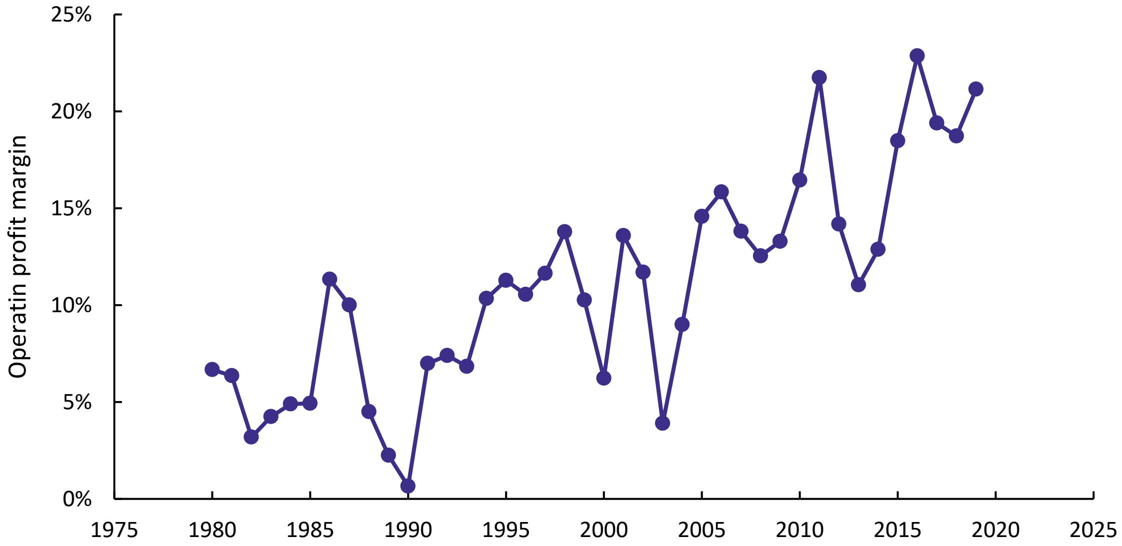

Figure 7. Profitability in the fishing sector. Source: Norwegian Directorate of Fisheries.

Our data sample does not include all the vessels in the total population. First, a proportion of the vessels are excluded since they do not meet certain minimum requirements. These minimum requirements have changed over time, but are typically related to minimum catch size, revenues or hold size. The number of vessels meeting these minimum requirements have, in the last decade, been around 90% of the total population (Figure 8).

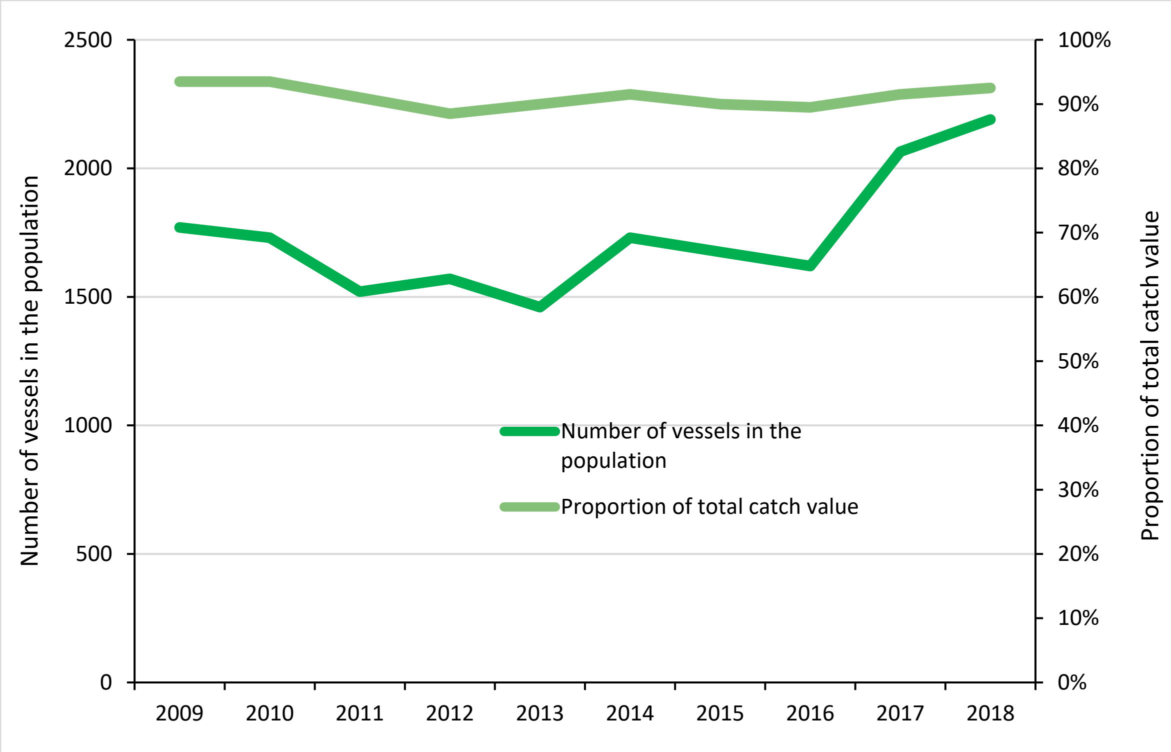

Figure 8. The fishing vessel population's proportion of total value of fisheries. Source: Norwegian Directorate of Fisheries.

Out of this reduced sample of vessels, the Fisheries Directorate has collected detailed survey data from a representative sample of around 5–10% (Table 1).

Table 1. Sample vs population.

	2018	Comment
Number of registered fishing vessels	6,018	Registered in the Directorate of Fisheries.
Number of active vessels	5,295	Registered with catch
Number of vessels in "population"	2,184	Number of vessels that meet a minimum requirement*
Number of vessels in sample	331	Selected sample from the "population" of vessels

Note. *The minimum requirement has changed over time (revenues, catch size and hold size). In 2018 it was a minimum revenue for each vessel size: 0–9.9 meters = 550,000 NOK, 10–10.9 meters = 914,000 NOK, 11–14.9 meters = 1,377,000 NOK and >15 meters = 2,751,000 NOK. Source: Norwegian Directorate of Fisheries.

Table 2 describes the data set. The data set comprises 5–10% of the population, covering the years 1985–2014. For most of the observations between 1985 and 2003, data on capital is not available, so the majority of the data are from the years 2003 and 2014. The largest number of observations are from the coastal vessel segment with 3,702 vessel-year observations. By comparison, we have 569 vessel-year observations for the long-liner segment. The annual average profit margin varies across segments. The largest purse seiners have on average generated an operating margin of 10%, while the other segments have had much lower average profit margins, around 1–2%, which in general is very low. Some segments, such as coastal vessels and long-liners have on average had negative profit margins. Greaker et al. (2017) find negative resource rents in Norwegian fisheries for most years except 2011. The variation in profit margins is large, as shown by standard deviations of 10–20%.

Table 2. Descriptive statistics of data

Vessel group	Number of observations	Average profit margin	Standard deviation	25 percentile	50 percentile	75 percentile
Coastal vessels	3,702	–0.007	0.177	–0.076	0.020	0.096
Coastal seiners	1,114	0.008	0.192	–0.067	0.033	0.118
Large purse seiners	1,303	0.100	0.144	0.018	0.111	0.199
Cod Trawlers	906	0.011	0.168	–0.079	0.033	0.123
Long-liners	569	–0.017	0.118	–0.063	0.005	0.060

Calculation of rent

We follow Greaker et al. (2017) and calculate realized economic profit/rent as follows (Table 3):

Table 3. Calculation of realized resource rent based on national accounts.

+	Basic value of production (revenues)
-	Intermediate uses
+	Taxes on products
-	Subsidies on products
=	Gross product
-	Non-industry specific taxes
+	Non-industry specific subsidies
-	Compensation of employees
-	Return on fixed capital
-	Capital consumption
=	Resource rent

The data from the Directorate of Fisheries is based on accounting information, and economic profit and rent can be estimated from this data in a slightly different way. The point of departure is the earnings before interest and taxes (EBIT). This number is calculated by subtracting operating costs (including labor costs and other compensations to employees) and depreciation from the revenues.

However, the EBIT includes depreciation of fishing licenses. The latter are considered payment for resource rent and must be added back (Table 4). Moreover, for the same reason, the value of the fishing licenses must be excluded from the calculation of capital. Finally, capital costs are deducted to arrive at the estimate for rent. The capital costs are calculated by multiplying a cost of capital (both debt and equity costs of capital) by the capital. We use the book value of capital (total assets) less book value of fishing licenses as our measure of capital. A relevant measure of the cost of capital (nominal) in the seafood industry is between 8 and 10 percent (Campo and Zuniga-Jara, 2017) and have betas similar to the general market indices (Misund, 2018; Misund and Nygård, 2018). Some studies in the fisheries use lower costs of capital. Greaker et al., (2017) use a cost of capital of 4 percent (~6 percent nominal) as a cost of total capital, while Flaaten et al. (2017, p.312) use "Calculated interest on equity is based on the book value of equity and the previous average interest rate paid for long-term and current liabilities". The latter approach, multiplying the book equity value equity with a debt cost of capital, is at odds with finance theory and textbooks that suggest that equity cost of capital is estimated using the asset pricing models such as the capital asset pricing model (CAPM, see e.g. Brealey and Myers, 2019). Ideally, the equity costs of capital should be calculated for each year, based on the equity betas of the vessels, the risk premium and the risk-free rate. For a diversified investor, the equity beta should reflect the systematic risk in the future cash flows from the vessels. In practice this is very difficult to calculate. Moreover, the measure of capital is adjusted for the book value of fishing licenses, but there is no information on how these licenses were financed, i.e. equity, debt or a combination, making adjustments to the cost of capital a very challenging task. Finally, the calculation of capital costs should be based on market values, not book values since the latter are based on historical cost accounting, which is conservative in nature. Book values will tend to underestimate the true value of capital. We therefore apply a range of costs of capital (for total capital, equity plus debt). Our calculations of rent apply both 6 percent and 10 precent to illustrate the impact of choice of cost of capital on the result.

Table 4. Calculation of realized resource rent based on vessel data

+	Earnings before interest and taxes (EBIT)
+	Depreciation of fishing licenses
-	Return on fixed capital (6 and 10 percent)
=	Economic rent

5. Analysis of rents

A profit margin is calculated for each vessel for each year and sorted from largest to lowest margin and plotted against cumulative revenues. If the lowest profit margin is positive, then the resource rent is calculated as the margin times the total revenues. If the lowest profit margin is negative, then the resource rent is deemed to be non-existent. The inframarginal rent is calculated as the sum of economic rents for those vessels with a positive profit margin, less any resource rents. The remaining profits come from the vessels with negative profit margins. This procedure is carried out for every vessel, for each year, in five vessel groups. The results are shown in Figures 9 – 13 below.

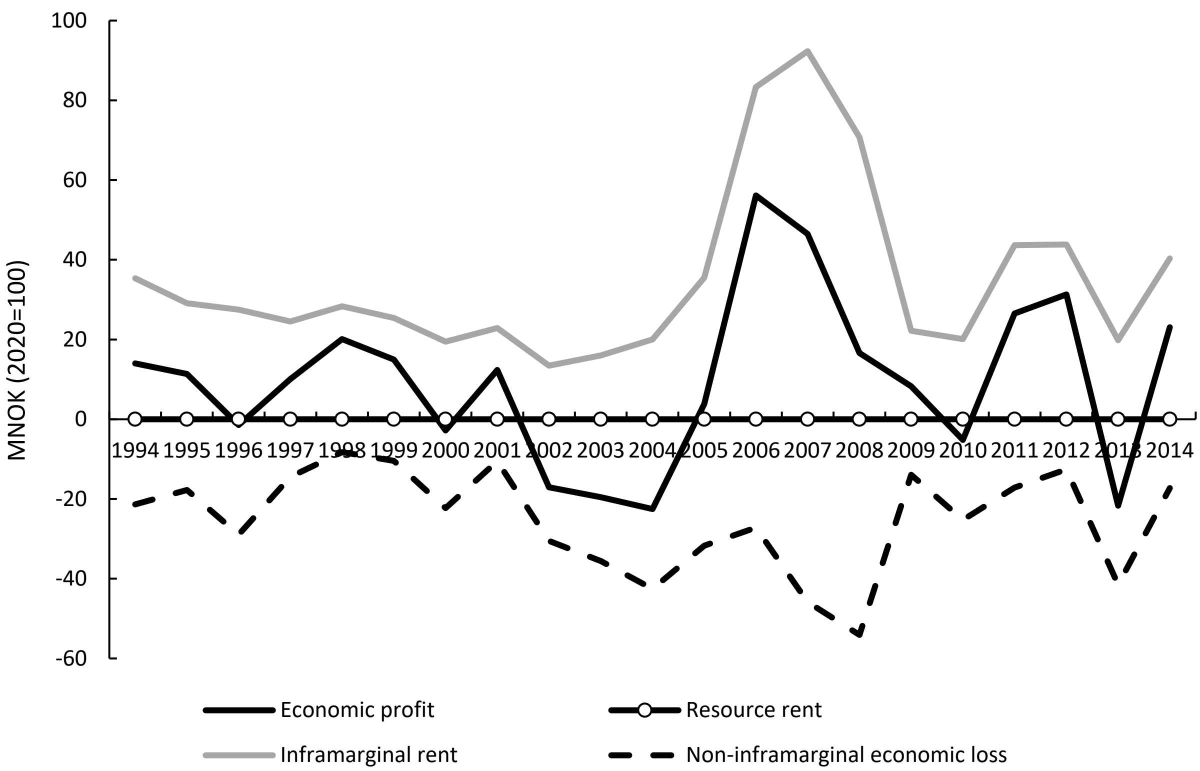

Figure 9. Rents in the Coastal vessels segment (vessel length < 90 feet). The number of vessels in the sample varies between 69 and 359, with an annual average of 176 vessels.

Our result suggests that all of the rent is inframarginal (Figure 9). In all years, the least profitable vessel generates an economic loss. The size of the inframarginal rent varies over time, and is highest during the time period 2006–2008, and in 2011–2012. Furthermore, during 2006–2008, the economic losses are also the largest.

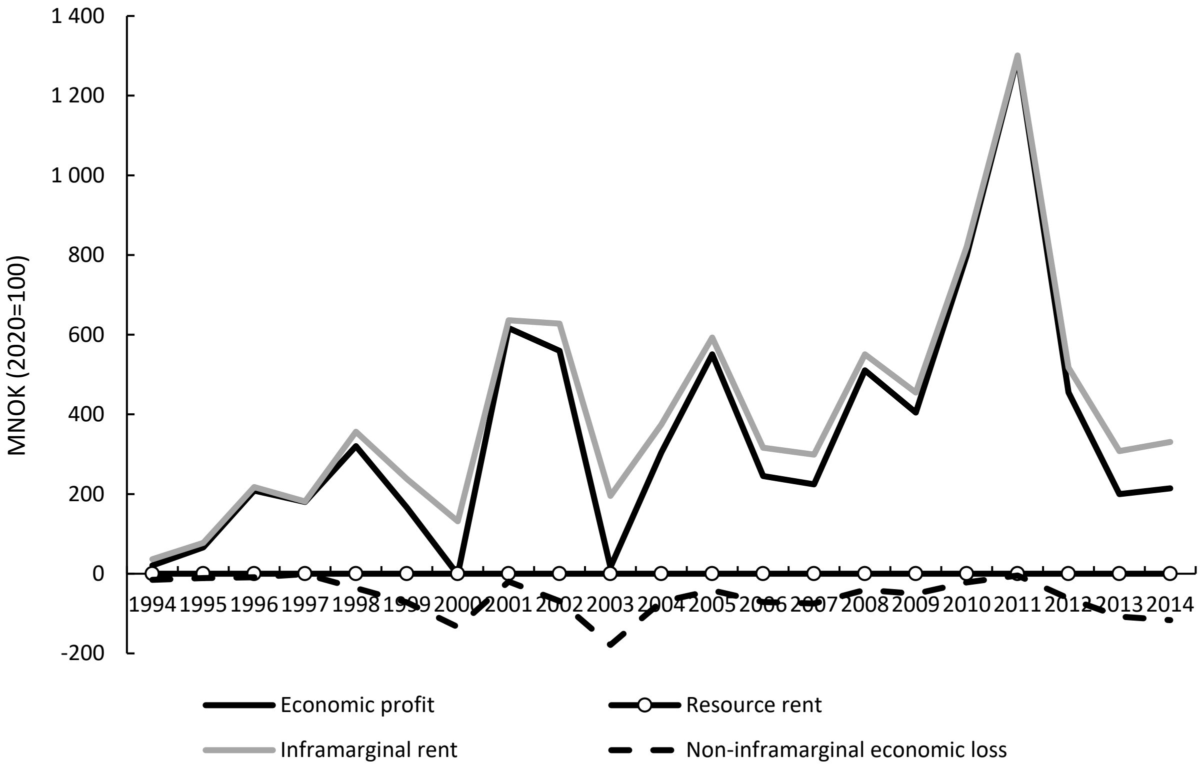

Figure 10. Large purse seiners (>90 feet).

The large purse seiners are found to be the most profitable segment. But also in this segment, we fail to identify a resource rent (Figure 10). All rents are inframarginal. The profits and inframarginal rents peak in 2010–2011.

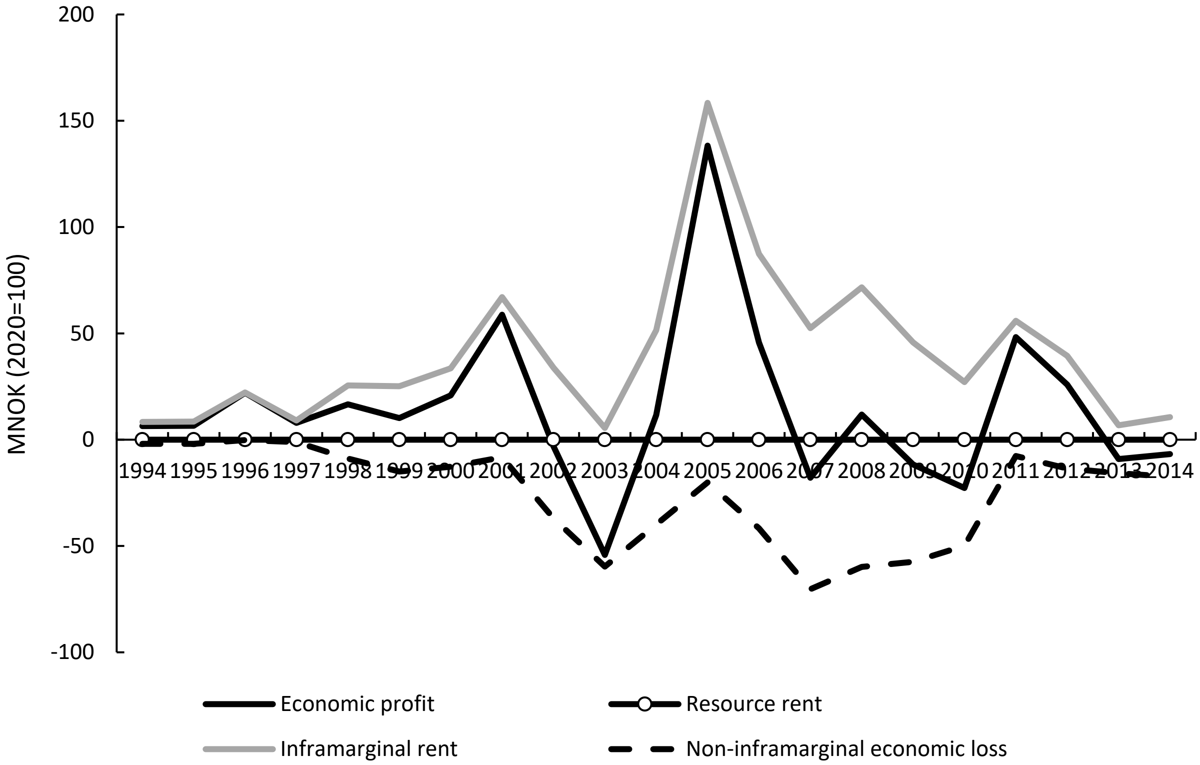

Figure 11. Coastal seiners (<90 feet)

Similarly, all rent is inframarginal also in the small coastal seiner segment (Figure 11). Profits and inframarginal rents are highest in 2005–2006.

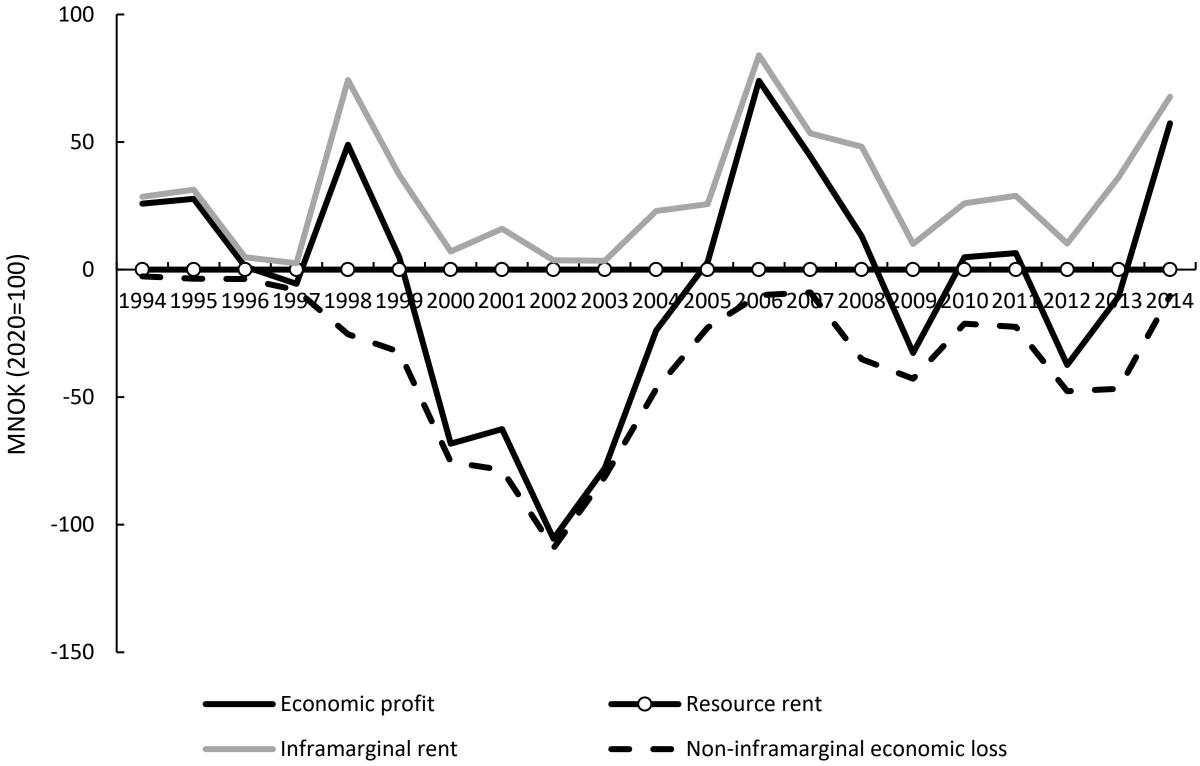

Figure 12. Deep sea long liners (all lengths)

In the deep-sea long liners segment, all rent is inframarginal (Figure 12). This is one of the least profitable segments, generating substantial losses between 1999 and 2004. Profits and inframarginal rents peak around 2006 and 2014.

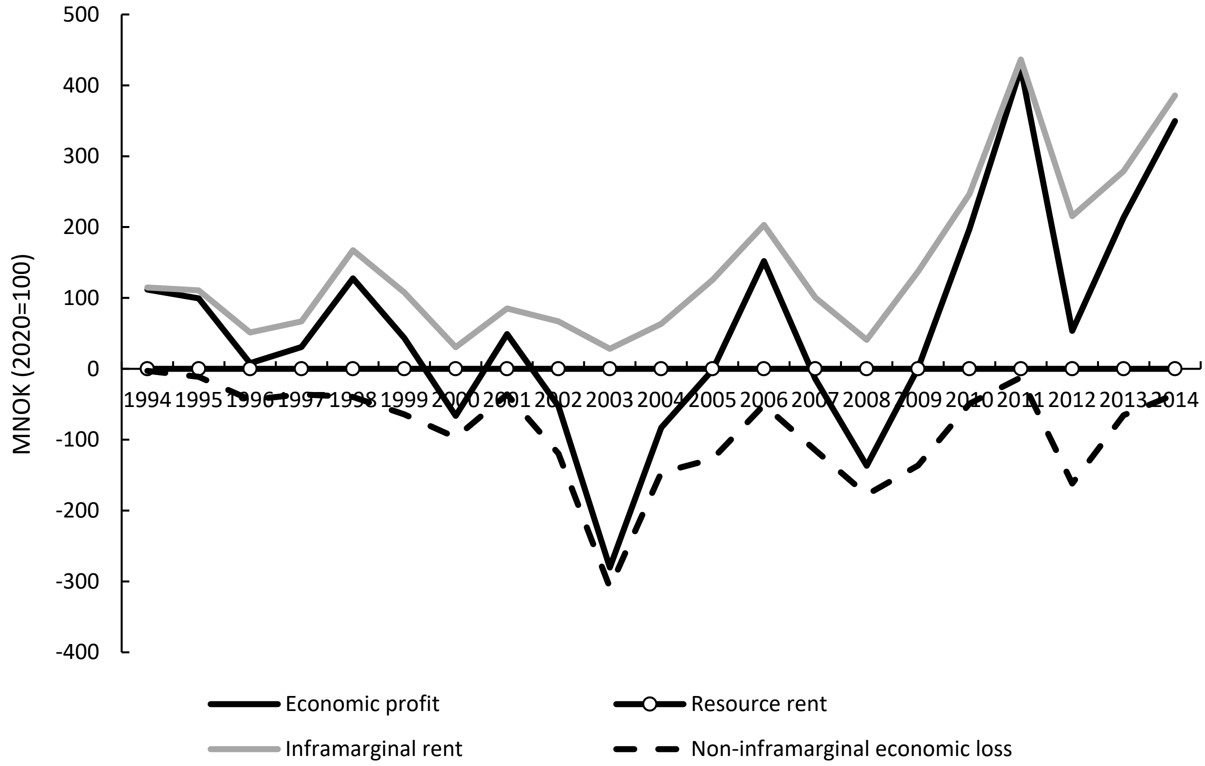

Figure 13. Cod trawl

In the cod trawl segment, all rents are inframarginal (Figure 13). In this segment, profits and inframarginal rents vary over time, but seem to vary over a long-term increasing trend.

6. Conclusion

This study examines resource, inframarginal and quasi rents in Norwegian fisheries. Previous research suggests the existence of inframarginal rents in fisheries, but very few studies estimate them. Applying aggregate data to estimate economic rents will invariably ignore inframarginal rents. Using vessel data between 1985–2014, we examine the size of resource and inframarginal rent in Norwegian fisheries. We fail to quantify any regulation rent, suggesting that all rents are either inframarginal or quasi rents. Further research should be carried out to examine the drivers of inframarginal rents in Norwegian fisheries. Are they due to skill, or inefficiencies, or are they quasi rents?

Our findings have policy implications. Historically, overcapacity in the Norwegian fisheries sector resulted in low fishing vessel profitability. Subsequent fleet restructuring has been successful in increasing average profitability and rents. However, there are large variations in profitability, suggesting the existence of inframarginal rents. Our results can provide valuable insights into the design of rent capture policies. When designing optimal rent capture policies, it is crucial to identify the source of the rent. Some rents, such as scarcity and resource rents, are candidates for rent taxation. Others, such as regulation rents resulting from environmental regulation should be reduced, e.g. with Pigouvian taxes, to improve efficiencies. Others, such as investment rents, should be stimulated since they incentivize investments that have benefits for society.

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