Marine Policy xxx (xxxx) xxx

Contents lists available at ScienceDirect

Marine Policy

journal homepage: http://www.elsevier.com/locate/marpol

Economic sustainability of quality-enhancing business models in the Norwegian cod industry

Bernt Arne Bertheussen [a,*], Bent Dreyer [b], Audun Reiertsen [c]

[a] School of Business and Economics, UiT the Arctic University of Norway, Norway
[b] Norwegian Institute of Food, Fisheries and Aquaculture Research Nofima, Norway
[c] The Norwegian Fishermen's Sales Organization, Norway

ARTICLE INFO

Keywords:
Live storage
Cod farming
Wild-caught quality model
Business model portfolio

ABSTRACT

This study describes three fundamental quality-enhancing business models in the Norwegian cod industry, which challenge the traditional and dominant volume-focused wild catch model: a quality-enhancing Live storage model, a quality-enhancing Farm raised model, and a Wild-caught Quality model. Furthermore, the study explores whether the models are sustainable based on their performance over almost two decades along three critical dimensions: capability to counteract seasonal fluctuations, ability to obtain a premium price, and growth potential. Finally, the paper outlines managerial and political implications of the findings.

1. Introduction

In several of the worlds largest fisheries migration patterns induce seasonal harvesting triggered by fixed fluctuations in catch per unit effort. If the character of the migration pattern also includes that the most valuable part of the fish stock in short and predictable part of the year, migrate from high seas to areas close to the shore, the economic incentive for seasonal harvesting is strong. This explains the rationality of seasonality [1]. The migration pattern of important species in worlds fisheries like anchovetas, herring, capelin, cod and salmon are examples that gives strong economic incentives for seasonal harvesting. However, concentration of landings in space and time leads to challenges related to capacity adjustment, quality, logistics and continuity in customer supply. Of course, this is especially true in high end markets based on fresh raw materials.

Different strategies are implemented to overcome challenges related to quality and deliverability issues created by seasonal harvesting. One strategy is to modify harvesting to improve quality and reduce seasonality, i.e. harvest in periods with lower catch per unit effort with fishing method that improve quality. Another strategy is to focus on other production concepts like aquaculture and catch based aquaculture to meet shortcomings in seasonal harvesting of wild fish. According to Barange et al. [2]; almost 50% of the global supply of seafood in 2016 origins from aquaculture, indicating that this concept has proven to add significant volume and value to the worlds supply of seafood.

This paper analyses how three different strategies are implemented and perform in one of the largest traditional seasonal fisheries – harvesting of arctic cod.

Most of the Norwegian coastal cod fishing activities takes place in a hectic winter season determined by the migration pattern of the fish [1]. In season, the cod is near the coast and easily accessible. Therefore, the coastal fleet lands about 90% of its total fresh cod quantity in February to April [3]. There are many advantages with seasonal fishing, such as low harvesting costs, high catch rates, large fish sizes, and access to valuable by-products like liver and roe [4,5]. However, the quality of the fresh cod landed varies, and poor quality propagates throughout the value chain [6]. It affects the post-harvest production schedules, that is, their labor input, fish yield, production flexibility, and thus the costs of production. Finally, poor quality of the raw material affects the value of the end products, and for the fresh fish market, quality variations lead to reduced predictability [7].

In a well-functioning market, it is expected that quality affect the price of the fish sold. The economic literature on this issue is, however, not unambiguous. Asche et al. [8] show that cod price varies with a number of attributes such as size and which month the fish is landed. Pettersen et al. [9] show a well integrated market [10]. show that also in retail, price vary systematically with product attributes, including if the fish is line-caught. However, in a recent study, Henriksen and Nyrud [3] found little correlation between price and quality in the firsthand market for winter- and spring-caught fresh cod in Norway. Large quantities

* Corresponding author. UiT Norges arktiske universitet, Postboks 6050 Langnes, 9037, Tromsø, Norway.
E-mail address: bernt.bertheussen@uit.no (B.A. Bertheussen).

https://doi.org/10.1016/j.marpol.2020.103821
Received 16 October 2019; Received in revised form 13 December 2019; Accepted 17 January 2020

were rewarded over quality, regardless of the gear used. The study concluded that the market is characterized by a failure with respect to reward quality. This finding is in line with sampling based on objective quality measurements, which revealed that price differences are marginal or even nonexistent in the firsthand cod market [11]. A poorly functioning pricing mechanism provides no incentives to fishermen to supply quality as the extra costs incurred by handling and delivering high-quality fish is not compensated in the price of the fish sold.[1] This is a critical weakness of the traditional Wild-caught Volume model of the Norwegian cod fishery. As a consequence, it continues to generate quality-based waste [3,7].

Weaknesses of the traditional model can, however, be exploited by other business models that focus on delivering premium cod quality. Iversen et al. [5] point out that a considerable proportion of fresh quality fish is sold to customers who pay well, a feature that has been shown to be exploited by the Icelandic cod industry (Kuntsson et al., 2016) and even more so by aquaculture producers who have even more control with the production process [12]. The preference for fresh fish indicates that producers should aim at providing stable supplies of high-quality fish throughout the year, even though this is challenging. Moreover, retail markets are consolidating, and supermarkets strive to offer the same product portfolio all year round as this reduce cost [13,14]. Against this backdrop, there is a need for innovative business models that can better satisfy the consumers' need for stable supplies of fresh quality cod if cod is to maintain or improve its market position.[2] Thus, this paper argues that quality-enhancing business models (QEBM) have the potential to promote a more customer-oriented quality logic to add value in natural resource–based industries such as the Norwegian cod industry. The QEBMs have emerged in the wake of the quality problems that have resulted from the dominant volume model of the Norwegian cod industry [7].

The first QEBM discussed is the Live storage model designed to extend the natural, short, and hectic cod season. However, how long the cod can be stored live without being fed is limited by the regulations, limiting this models usefulness. As a result, a process is underway to develop the Live storage model into a catch-based aquaculture model, which can extend the season even further. The second model described is the Farm raised model, which can theoretically deliver fresh quality cod throughout the year. The third and final QEBM discussed is built on the traditional wild cod fishery. In this Wild-caught Quality model, quality-enhancing fishing gear, such as handlines and longlines, is applied more often than the gear used presently.

The overarching purpose of the present study is to investigate whether the QEBMs analyzed are economically sustainable. This is a prerequisite for the models to be able to challenge the traditional volume model in the Norwegian cod industry [7]. More specifically, the strong seasonal pattern of the traditional volume model leads to the market being undersupplied with fresh quality cod in the second half of the year. This is a weakness that can be exploited by new business models. The first research question raised is thus:

RQ 1: Are the QEBMs capable of dampening the seasonality pattern of the traditional cod fishing model?

Moreover, additional costs will incur for actors who supply high-quality fresh cod. Hence, they depend on obtaining a price premium for the fish supplied to cover the extra costs. The next research question therefore is:

RQ 2: Are the QEBMs able to achieve a price premium relative to the traditional model on the fish sold?

The final research question focuses on the future growth potential of the models. Accordingly, their performance is analyzed over almost two decades, a time span considered sufficient for the models to demonstrate that they are capable of gaining and sustaining market shares. Research question three reads as follows:

RQ 3: Do the QEBMs indicate a significant growth potential based on their historical performance?

The rest of the paper is structured as follows. First, a detailed description is provided of the QEBMs that have emerged in the Norwegian cod fishery during the last two decades. Thereafter, the method applied in this research endeavor is outlined, before presenting results. Finally, implications of the empirical findings are discussed.

2. Quality-enhancing business models

The primary purpose of a business is to drive growth and performance while generating value for customers. A firm can achieve this goal through operating one or more business models. The business model concept describes the underlying logic by which a firm creates and captures values [15,16]. Teece defines a business model as "the manner by which the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit" (2010, p. 172). Firms are today increasingly introducing dual or multiple business models as a basis for growth and diversification [17–20]. Thus, the aim of the firm is to establish a unique bundle of business models that can deliver sustainable competitive advantages [20,21]. In this section, the basic attributes of different QEBMs that are implemented in the Norwegian cod industry are discussed.

2.1. The live storage model

In this model, wild fish are caught live to be slaughtered later [22]. Thus, a partial control of the production cycle is ensured. Cod for live storage is mainly cought with Danish seine [23]; Standal and Sønvisen, 2015). Fishing boats, which already have cod quotas, are engaged in catching cod for live storage. Consequently, there is a trade-off for the firm if the vessel is to operate as a "pure" wild catcher of fish or also add on live storage [13]. The fishermen deliver the live catch to land plants that store the cod in cages until slaughter [22]. Thus, fishermen invest in equipment for catching, transporting, and live storage. Moreover, the fish is owned by the fishermen until the sales note is written, and in most cases, this is when the fish is slaughtered [24].

To incentivize higher activity, since 2008, the authorities have subsidized live storage through a temporary quota bonus of 4000 tons, which was reduced by 1000 in 2019. Live storage leads to increased harvesting and handling costs and additional costs and risk for the storage of live fish. These costs are partly compensated by a quota bonus meant to encourage live storage. The quota bonus gives fishermen who catch live cod a lower quota deduction. A 50% bonus means that only half the catch is deducted from the vessel's quota [24]. The quota bonus makes this model more competitive relatively to the traditional Wild-caught Volume model. Live storage of cod has experienced periods of high activity when the quotas have been low and prices correspondingly high, and vice versa when the quotas have been high [13].

Cod for live storage is caught in coastal waters and slaughtered outside the wild catch season. The cod is caught during its spawning migration or it may be younger cod that is feeding on capelin. The cod feeding on capelin has a particular growth potential (ibid.). The fish size when harvested and the growth potential provide good opportunities for supplying high-quality fresh cod in the best-paid size ranges. Out of season, demand and prices are higher as a result of small accessible quantities of wild-caught cod. In the case of live storage, the time of slaughter can be postponed and better adapted to the demand in the market [25]. In addition, the live-stored cod gives a price premium

[1] There are, of course, a number possible explanations for this. For instance, Homans and Wilen [64] show how a race to fish leads to the higher price fresh market not being served for Pacific halibut, and Asche and Smith [12] provide a more general discussion with respect to the relationship between regulatory system, markets and quality.

[2] This is a challenge in many markets for all fish. For instance, Shamshak et al. [65] discuss how cod and most other wild species is declining in importance in the U.S. market, and is replaced by farmed fish.

compared to wild-caught cod [26]. Historically, the price premium has been between 30% and 40% [13]. However, the price premium is affected by the cod price in traditional value chains.

The cod is stressed when caught, and the blood volume in the muscles increases. This reduces its quality when slaughtered. However, the recovery when stored alive causes the fish to get rid of stress-related blood in the muscles, which significantly improves the quality of the fish meat [25]. Catch damage can occur in the form of wounds and scars in the skin that become visible to the consumer [24]. However, the cod can recover from catch damage when it is stored in the interim. This further improves the quality of the fish [26]. Accordingly, the Live storage model has the potential to increase the quality of wild-caught cod [13]. Hermansen et al. [24] evaluated the raw material quality of live-stored fish. They found that the quality was significantly better than that of wild-caught fish. Given that live-stored cod is not stored too long without being fed or that it is fed properly during storage, the fish meat is of the highest quality [27].

Live storage increases the cost of catching wild cod. If this activity is to be profitable for the fishermen, the additional income must exceed the extra costs. Fishermen who choose to catch live cod do so for several reasons. Hermansen et al. [24] found that increased fish prices do not alone explain the increase in live store catches, as the quota bonus was crucial for profitability. Thus, the quota bonus cannot be removed until live storage becomes profitable in itself [26].

Other factors also affect the costs of the Live storage model. Hermansen et al. [24] indicate that possible alternative costs, weather conditions, and crew size are important. Furthermore, catch efficiency, knowledge, traditions, and the crew's preferences influence the choice of a Live storage model. Catching cod for live storage also means that relatively large quantities of cod must be sorted on board. Moreover, the load capacity is reduced. Live storage can also impose increased risk and liquidity challenges for the firm since the payment of the fish is postponed.

2.2. The farm raised model

Cod farming differs from wild fish harvesting in that quotas are not required (The Norwegian Aquaculture Act, §§ 4–6). Like other fish farming, the cod farmer controls the entire life cycle from eggs to ready-to-eat fish [28]. Thus, the farmer can adjust the time of slaughter and sale [29]. The fact that the cod farmer controls the production process is an important value driver in this model.

The quality of whole fish and fillet from farmed cod has been assessed through market tests based on sensory quality attributes. The results show that farmed cod is a quality product. Among other things, appearance, freshness, skin color, consistency, smell, and total impression are considered. For all surveys, there was very good feedback on quality [30]. Thus, the quality gives farmed cod a strength compared to the quality challenges found in a significant portion of wild-caught cod.

Price statistics for farmed and wild-caught cod indicate that the price formation of wild-caught cod strongly influences the price of farmed cod. Henriksen et al. [4] found that the largest quantity of farmed cod in the 2003–2017 period was sold in October–February as the market price peaked in these months.

However, the cod farmers experienced major problems in gaining control of the production cycle. Cod fry need live feed in the earliest phases of life [31]. The production of fry has proven difficult, and this has driven up the prices and production cost in the model. Inferior-quality juveniles affect further growth, how resistant the fish is to diseases, and mortality in the production stage. Thus, high fry prices and low fry quality result in increased production costs for farmers.

After outlay and during production, there are concerns with increased mortality, poor growth, escapes, diseases, and early sexual maturity. Overall, these issues have also contributed to high production costs. Gender maturation has led to increased mortality among female cod. In addition, a large proportion of farmed cod is already mature at two years [4]. Early maturation results in lower growth and a higher feed factor [32], and smaller fish also command a lower price [8]. Furthermore, diseases have contributed to major losses in the food fish stage [4]. Sogn-Grundvåg et al. [32] note that the disease francisellosis, which is a bacterium present in Atlantic cod, leads to high mortality. This disease alone has forced some cod farmers to liquidate their operations.

Moreover, adaptation problems and stress have affected the feed intake of the fish and caused great growth variations. The publicly listed company Codfarmers was the biggest player in the Norwegian cod farming industry. This firm experienced problems of growing the cod into the best-paid size ranges. For the fish to achieve a good price, the slaughter weight must be more than 2 kg [4]. Escapes can also be a problem as both biomass and reputation are lost. Escapes can be due to poor equipment, untrained employees, and the cod's behavior (ibid.).

In 2006, cod farmers had NOK 13.63 in losses per kilogram of fish produced [32]. Calculations from 2009 show a production cost per kilogram round weight of NOK 40.5°, including well boat and slaughter costs [33]. Dundas [34] interviewed the eight largest companies in 2009. Based on this information, the average production cost per kilogram round fish was found to be NOK 28.92 before costs for well boat freight and slaughter. Henriksen et al. [4] examined the production costs of farmers who put out cod fry in 2015. Their estimated production costs were at the same level as salmon farming, which is about NOK 37.5/kg in 2018.

When comparing cod farming with salmon farming, the latter also experienced high production costs in the early stages. However, as very little wild salmon was landed, salmon prices were very high. This resulted in profitable operations also in the early stages, despite high production costs. Furthermore, costs were reduced significantly as learning improved and quantity increased [35]. Cod farmers meet other market challenges as there is already a high supply of wild-caught cod. In the period from 2017 to 2019 farmed cod achieved a price that was only 60% of the price achieved for farmed salmon. At the same time the highest valued fresh wild caught cod ("Skrei") achieved a price that was only 70% of farmed salmon (Statistics Norway).

The long production cycle makes cod farming capital intensive. An outlay of 1.5 million fry in 2009 corresponded to costs of about NOK 80–90 million [34]. The model involves large investments and risky binding of capital in equipment, fry, locations, and licenses. Capital tied up means that cod farmers are not flexible as they cannot switch easily to other forms of production [36]. Entry barriers to other concepts in the form of quotas, boats, and equipment further impair their flexibility.

2.3. The wild-caught quality model

Fish caught on lines have better and less varying quality than fish caught on other types of gear [3,6,37]. Gears like trawl, gill net, and Danish seine deliver fish with the most serious quality errors [3,5]. To achieve good quality of wild catches, it is crucial that the fish are not exhausted or stressed during the catch operation. Furthermore, the fish must be bled quickly, cooled well, and handled with care [38]. Accordingly, fish of good quality entail increased operating costs and reduced capacity utilization on boat and/or gear [5]. Hermansen and Dreyer [1] found that fishermen could downgrade quality to avoid such costs.

To incentivize higher activity, the authorities have subsidized catch of fresh cod through a fresh fish scheme. The scheme means that vessels that land all catch freshly after the seasonal fishing receive a quota bonus on cod. The quota bonus is given regardless of whether the vessel has cod quotas left or not. A total of 16,840 tonnes of cod were allocated to the fresh fish scheme in 2019.

In recent years, the Norwegian Seafood Council has established the quality brand "Skrei." This is whole fresh skrei (cod), which is packed within 12 h after the catch, and extra effort has been made to secure the quality through all stages till the fish reach the customer. The purpose is

always to ensure a good and stable quality of cod/skrei. Thus, this campaign can be regarded as an extension of the Wild-caught Quality model.

The Wild-caught Quality model is more in line with the Icelandic business model which focuses on high quality raw material and higher valued product forms such as fresh fillets [39,40]. Table 1 summarize key attributes of the QEBMs described.

3. Method and data

To investigate the research question whether the business models discussed are competing or complementary, this study provides a detailed empirical analysis of the production of fresh cod in Norway during 2002–2017. During this period, significant investments have been made in all three models. At the same time, the prerequisites to exploit their advantages and avoid their weaknesses were altered to such an extent that it becomes possible to study how sustainably the models have performed during significant environmental and institutional changes [41].

3.1. Business model as level of analysis

This study focuses on the competitive advantage and performance differences between business models. A business model thus represents a strategic group of firms that apply the same value-creating concept. This implies that the analytical perspective is raised from a firm to a business model level. Several empirical studies have used a firm perspective at other levels of analysis than firms. This applies, for example, to Hervás-Oliver and Albors-Garrigós [42] who used the firm perspective to study business clusters, and Lawson [43] who used the firm perspective to conduct regional-level analysis while arguing that competence as a firm resource is just as relevant for a region as for companies. Maskell and Malmberg [44] also analyzed firm resources at the regional level. In addition to these empirical studies, classical Ricardian analyses utilize the firm resource perspective with nations as the level of analysis [45].

Table 1
Key attributes of the QEBMs of the Norwegian fresh cod industry.

	Wild-caught Quality model	Live storage model	Farm raised model
Quality and deliver-ability	In-season supply of fresh quality cod. Fishermen applying handlines and longlines supply plants daily when weather permits.	Season extension supply of fresh quality cod. Danish Seine fishing. Daily deliveries to land plants depending on weather.	All-year supply of fresh quality cod. Deliveries independent of weather conditions.
Control of production process	Production process controlled by nature and public regulations (TAC/ITQ).	Production process controlled partly by nature/regulations and the firm.	Quota not required. Control of the entire life cycle from egg to ready-to-eat fish.
Flexibility	Small equipment investments needed to move the fishing vessel to the Live storage model.	Small investments needed to reverse to the Wild-caught Quality model or the traditional volume model.	Investments in facilities and equipment are regarded as sunk cost.
Scalability	Restricted harvesting of a fully exploited species, but only a small portion of landings are of high quality.	Limited scalability due to restrictions on bonus quotas.	No quota restrictions. Scalable model (refer to the Norwegian farmed salmon model).
Subsidies	Directly through a fresh fish scheme.	Directly through a quota bonus.	Indirectly through public research initiatives.

3.2. Choice of empirical context and time horizon

The choice of theoretical perspective requires the study to choose a common industry to investigate the effects of the attributes of the different business models. Furthermore, it is recommended to use time series and an evolutionary approach [46]. The business models' performance during this period must also be measured. This measure must be able to represent how a business model creates value for customers and profit for the businesses operating in the same strategic group [20]. Moreover, explanatory variables that represent attributes of the business models must be constructed (ibid.). Also, the time period studied must be sufficiently long to compare the effects of variations of the attributes at different points in time [46]). This requires the study to select a period and find a context where the three business models studied have operated in parallel over time [36,47]. Finally, it must be possible to measure how the models perform in relation to each other during this period. This study uses secondary data for the time series. In addition to be less resource-intensive, these data are more transparent. The drawback is that secondary data do not always give as relevant answers to the research question as primary data [48].

3.3. Performance measurement

Performance is a multidimensional concept, and can, for example, be measured by growth, market share, or firm profitability. Performance can also be measured using nonfinancial goals, such as flexibility and quality [36]. Barange et al. [2] point out that the world's production of wild fish has stagnated in recent years. Globally, the growth in seafood quantity has come from business models such as Farm raised and catch-based aquaculture [49]. This study uses production quantity as a measure of how the business models have grown and thus performed in relation to each other.

4. Empirical analysis

This section presents empirical analyses that can shed light on the research questions raised in the introduction of this paper.

RQ 1: Are the QEBMs capable of dampening the seasonality pattern of the traditional cod fishing model?

Fig. 1 displays the seasonal pattern of the three models.

The Wild-caught Quality model is strongly influenced by the Norwegian "Skrei" season that takes place in January–April. The Live storage model largely replicates the traditional season, but with a certain lag toward May, June, July, and August. However, the Farm raised model fully exploits the other models' weaknesses in supplying the market with fresh quality cod in the second half of the year, utilizing the higher degree of control with the production process.

RQ 2: Are the QEBMs able to achieve a price premium relative to the traditional model on the fish sold?

Fig. 2 shows the price premiums of the Farm raised model and the Live storage model relative to the Wild-caught Volume model, which is not capable of creating premium prices (Henriksen and Nyrud, 2019).

Price premiums are calculated based on export and first hand prices for wild caught cod, live caught cod and farm raised cod. Fig. 2 shows that both the Live storage and the Farm raised models generate significant price premiums. Farm raised cod is paid by NOK 0–9 better per kilogram than cod supplied by handline and longline. The same goes for Live storage cod, which gives an annual price premium of NOK 2 to over NOK 8 per kilogram. The main reason for the price premiums is that Live storaged cod and Farmed raised cod are primarily sold in the second half of the year when prices are highest. The price premiums for both Live storaged and Farm raised cod dropped dramatically during the financial crisis of 2009. Please note that at the beginning and end of the time series, the volume of Farm raised cod was modest.

RQ 3: Do the QEBMs indicate a significant growth potential based on their historical performance?

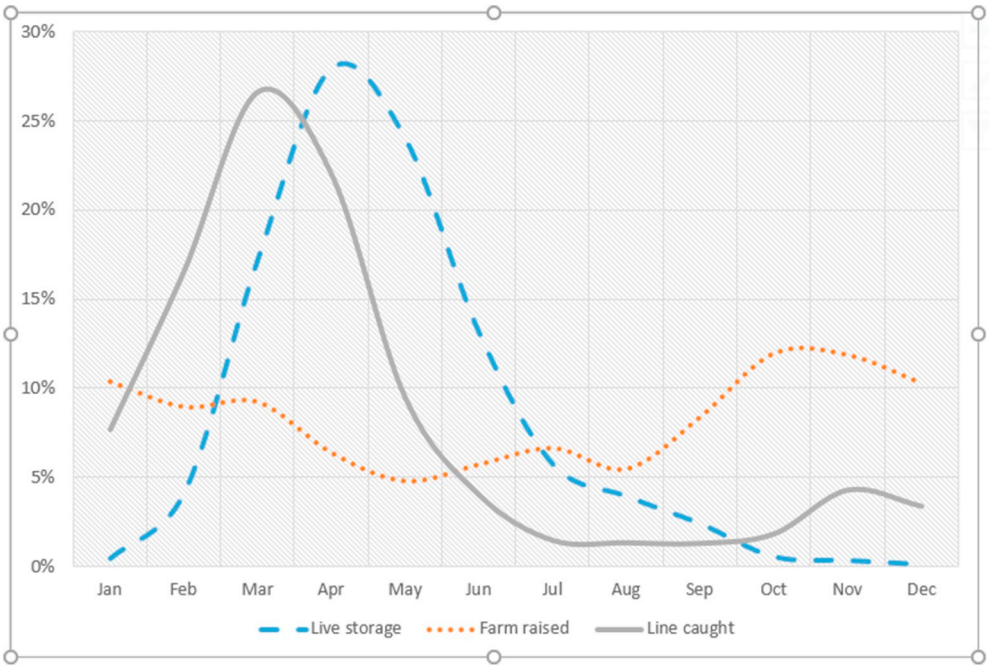

Fig. 1. Seasonality of QEBMs (2002–2017). Source: The Norwegian directorate of fisheries.

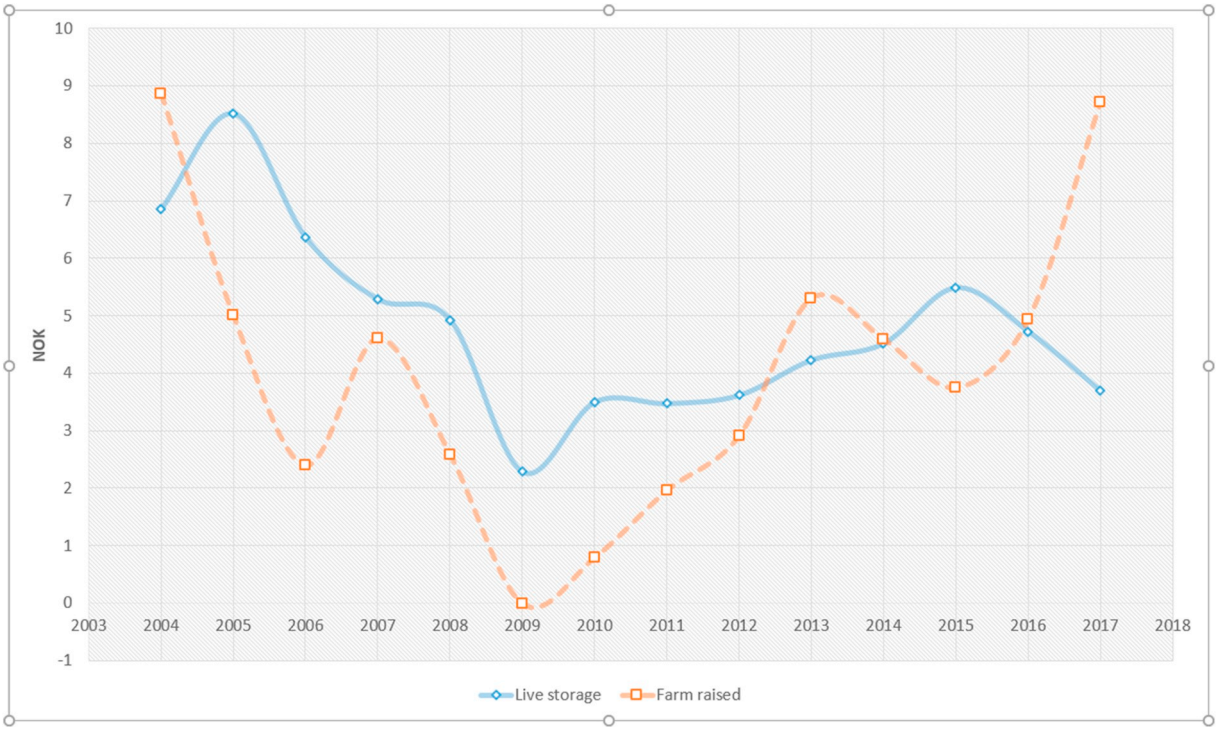

Fig. 2. Price premiums of Live storage and Farm raised cod (2004–2017). Source: The Norwegian Fishermen's Sales Organization.

Fig. 3 illustrates the production volumes of the QEBMs discussed in the period 2002–2017. The historical trends that are plotted can provide a good indication of the future growth potential of the three models.

4.1. *The wild-caught quality model*

In Fig. 3, the volume of wild cod caught by handline and longline is measured against the right axis, which has a magnitude of nearly five times the left axis. Accordingly, the Wild-caught Volume model is the most significant when it comes to historical production volumes. During 2002–2008, the model showed a declining trend despite the Norwegian cod quotas being stable during the same period (about 200,000 tons on average). However, the volume of the line-caught wild cod model doubled from 30,000 to 60,000 tons during the next six years. In this period, the Norwegian cod quota also doubled. Since 2015, the volume of the model has fallen sharply. This is also in line with falling cod quotas. In summary, the line-caught wild cod model roughly follows the volume fluctuations of the Norwegian cod quota, but the model has

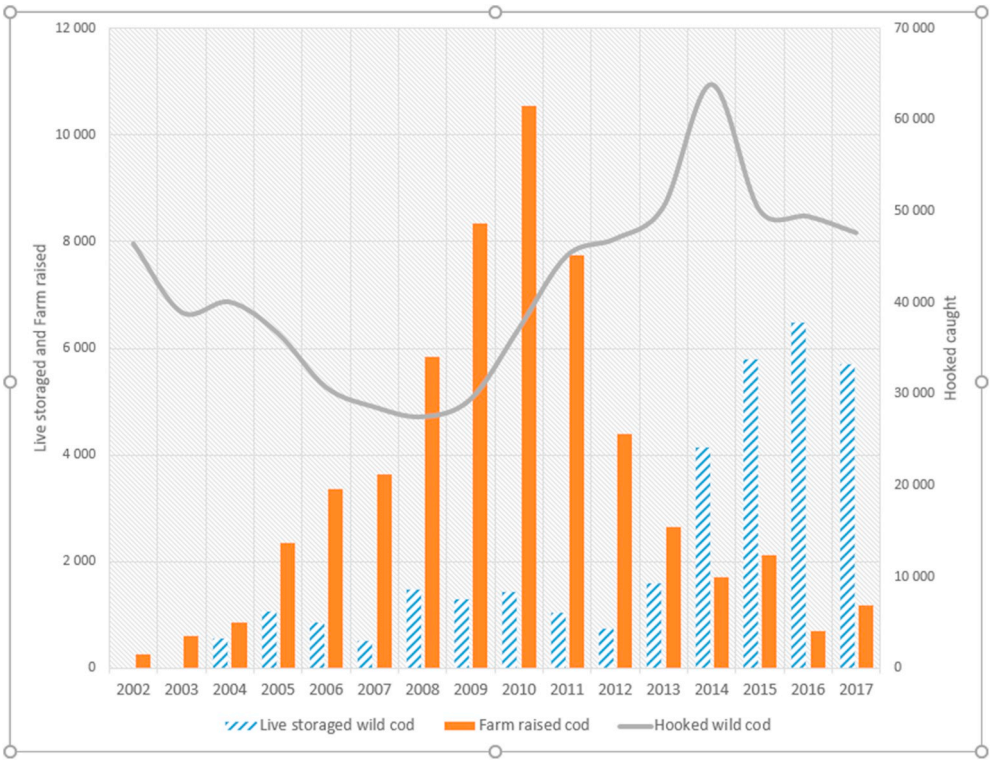

Fig. 3. Production volumes of QEBMs in 2002–2017. Source: The Norwegian Directorate of Fisheries.

trouble defending its share of the TAC when competing with less quality-oriented gear, such as gill nets, Danish seine, and trawl nets [7].

4.2. The farm raised model

The Farm raised model shows a typical boom-and-bust development pattern. In the period 2002–2010, production with this model grew strongly. However, in 2011, the growth was replaced by an equally steep fall as it became difficult for the companies to finance deficits and further expansion following the financial crisis in 2008–2009. In addition, the Norwegian cod quota increased sharply in the years that followed; thus, the model faced stronger competition from the wild fish sector.

4.3. The live storage model

The Live storage model shows promising growth since 2014 after the quota bonus was raised from 20% of the catch to 50% in 2013. Accordingly, to promote growth, this model may depend on a high quota bonus. The legitimacy of the quota bonus intervention is, however, debated strongly by stakeholders. In addition, a major challenge for this model has proven to be the ability to suspend slaughtering sufficiently to achieve the seasonal price premium during the late autumn.

5. Discussion

The need for sustainable seafood production is expected to intensify in the years to come [2]. Historically, the Norwegian cod fishery has been dominated by a Wild-caught Volume model, which is characterized by fishing as large volumes as possible with the highest possible CPUE [7].

The migration pattern of the cod, new technology that stimulates economies of scale [50], and a failure of the firsthand market to compensate fishermen pricewise for the extra effort needed to deliver high-quality fish [3] have reinforced the dominance of the volume model.

This strategy has resulted in quality-based waste manifested by the reduced quality of the catch landed, a product mix dominated by low-end products, and limited socioeconomic value creation [7]. However, in the wake of the weaknesses of the traditional model, new business models have emerged, aspiring to supply the market with high-quality cod throughout the year. Examples of such models are the Live storage model, the Farmed raised model, and the Wild-caught Quality model. The overarching purpose of this study was to discuss whether the QEBMs analyzed are economically sustainable as this is regarded as a prerequisite to challenge the traditional volume model (ibid.). More specifically, economic sustainability was empirically investigated along three dimensions: (1) the capability of the models to counteract seasonal fluctuations; (2) the ability of the models to obtain a price premium in the firsthand market; and (3) the growth potential of the models.

5.1. Seasonality and price premium

Different business models can compete and conflict with one another, thus resulting in cannibalization rather than creating synergies [51]. The essence of a business model is to define how a business adds value for customers, gets customers to pay for the values, and convert these payments into profits of the firm [20]. However, if a share of the added value of a new business model is captured from another model, this becomes an opportunity cost of the new model. If this cost is considerable, the net added value can be marginal, and, in the worst case, negative [52]. Thus, on an empirical basis, a significant aim of this study was to investigate whether the QEBMs in the Norwegian cod fisheries compete or complement each other.

The Wild-caught Quality model increases the quality of the landings by using gentle gear as handline and longline, and thus addresses a major weakness of the traditional volume model. However, fishing is still seasonal, and the model is unable to meet the demand for fresh cod in summer and autumn (see Fig. 1). The Live storage model fit well with a major weakness of the Wild-caught Quality model, as the season is

extended. Moreover, the Live storage model provides high and stable quality, provided the storage length and feeding are performed properly. As a result, the model obtains a price premium by delivering just after the season is over (see Fig. 2). However, feeding and feed costs are issues [24]. When the demand is high and prices are at their best, it is difficult to maintain high quality over time and thus deliverability with short-term storage. The Farm raised model delivers high-quality fresh cod regardless of quotas, and the harvesting can be adapted to the wild catch season. However, high production costs are the main weakness of cod farming as early maturation, slow growth, and vulnerability to diseases cause high mortality [4]. Furthermore, a large proportion of small cod has to be sold, which pushes the prices down. Finally, the model is at high risk financially as a large amount of capital, which can be regarded as sunk cost, is tied up in costly specialized production facilities.

Based on the above discussion, it seems reasonable to conclude that the QEBMs analyzed are not competing, but complementary. All models are designed to exploit at least one of the major weaknesses of the traditional Wild-caught Volume model, which is very modest landings of quality fish and a pronounced seasonal pattern. However, the volume of quality cod that each QEBM supplies is so modest (see Fig. 3) that there is no actual rivalry between them. In addition to the quality problem, two of the models (Live storage and Farm raised) also address the seasonality issue. It turns out that the models extend the season for different periods of the year so that they do not pose a competitive threat to each other in this way either. This strengthens their sustainability.

5.2. Growth potential

Using production quantity as a measure of business model performance and future growth potential, Fig. 3 shows that the Wild-caught Quality model is the dominant QEBM in the Norwegian cod industry as its production volume is more than five times that of the other models. The model has historically followed the fluctuations in the Norwegian cod quotas, and the pattern is expected to continue in the future. However, the fact that the model struggles to maintain its share of the cod quota compared to other types of gear, such as gill nets, Danish seine, and trawl nets [7] is worrying when it comes to the growth potential of the model. Furthermore, the future potential of the model is restricted severely by a failure of the firsthand market in differentiating the prices of cod of good and poor quality [3].

The Farm raised model experienced strong growth from 2004 to 2010 (see Fig. 3), before it almost collapsed as a result of technical production problems, increased quotas of wild cod, and the financial crisis in 2007–2009 [53]. As of today, this model does not seem to have a great future growth potential, despite continued public research efforts. The Live storage model has, after a very modest start, shown strong growth since 2013 (see Fig. 3). However, it is uncertain how long the quota bonus will continue and to what extent. The future growth potential of the Live storage model is therefore uncertain. To sum up, the QEBMs discussed do not individually or together wind up as significant competitors to the volume model that dominates the Norwegian cod industry. This is in stark contrast to the Icelandic cod industry, which pursues a differentiation strategy by exporting high-priced whitefish fillets based on high-quality raw materials caught by handline and longline [39].

6. Concluding remarks

This study has concluded that the QEBMs discussed are complementary and therefore make a good fit strategically. As a result, a firm can combine the models in a business model portfolio, hence forming a system of reinforcing synergetic activities. The portfolio can enhance individual activities and create unique and hard-to-imitate resources and capabilities, which in sum can lead to enhanced performance [51]. An additional business model may provide access to valuable assets that can strengthen the existing model. Both the Wild-caught Quality model and the Live storage model can share physical assets and technology with the traditional volume model. By sharing, a firm can harvest economics of scope and eliminate redundancies [54]. Moreover, a firm can create cross-business model synergies through sharing valuable knowledge and financial resources. Finally, multiple business models can help firms reduce risk by tapping into different revenue streams [55].

The main purpose of business model diversification is to enable a firm to maximize the yield from existing resources while developing capabilities that enhance their value across multiple activities [51]. Accordingly, it is important to assess whether a new business model helps maximize the use of the current resource base while simultaneously meeting a new and important customer need [21]. If successful, a firm can differentiate itself (e.g., by delivering high-quality cod) and generate cost efficiencies while also providing opportunities for risk reduction. Therefore, when implementing a new QEBM, a firm needs to ensure that the model is linked to the company's existing distinctive capabilities [20,21].

In Norway, only active Norwegian fishermen are allowed to dispose of a quota and operate a fishing vessel (Participation Act of 1999). Accordingly, the post-harvest plants, which are in need of stable quality deliveries to operate profitably [56], are prohibited from engaging in fishing activities and integrate upstream vertically [57], limiting the opportunity to coordinate various levels in the value chain [58]. Thus, plants are not allowed to engage directly either in the Wild-caught Quality model or in the Live storage model. Moreover, the plants are operating in a highly competitive environment with significant economic challenges, as the number of plants has been significantly reduced in recent decades [59]. However, Nilssen et al. [56] found that Norwegian land plants that based their operation on high-quality input performed better than those who did not. The best companies chose a raw material strategy based on a large proportion of fresh raw materials delivered from handlines and longlines, as these firms were able to exploit the opportunity formed by the geographical proximity to rich fishing grounds. In line with these findings, it is important for the post-harvest plants to create strategic alliances with QEBMs, which can deliver fresh raw material of high quality as stably as possible throughout the year; that is, the Wild-caught Quality model and the Live storage model. However, in principle, it is even more important for the plants to establish a Farm raised model as such a model avoids the strict legislation that obstructs vertical integration in the industry [57]. However, engaging in a Farm raised model is an uncertain venture as it has proven very costly to be a first mover [53]. Thus, it may pay better off to move later [60] as there are still major problems in establishing a biological and economic sustainable business model in cod farming [4].

The vessel owners who operate with gill nets already possess the majority of resources and capabilities necessary to engage in the Wild-caught Quality model. They are operationally flexible [36] and can run multiple business models [18,20]. What is needed is to replace nets with handlines or longlines. Fishing with lines is, however, more labor intensive than fishing with nets. For a shift of model to be profitable, the fishermen must be paid extra for the superior quality of fish landed. As of today, the failure of the pricing mechanism in the firsthand market discourages a shift of gear. It is a political responsibility to correct the failure of the firsthand market.

Moreover, only fishermen are allowed to engage in the Live storage model as the model requires a quota. Also, this model requires modest extra investments and the fishermen can shift between wild catch and live storage flexibly. However, the model incurs increased costs to catch and store the fish. They are nevertheless not compensated for the increased quality supplied by the market [3], but by public subsidies through a so-called quota bonus scheme [4].

Sogn-Grundvåg et al. [61] studied the firsthand market for frozen Norwegian cod sold at auctions. They found that line-caught cod (longline) achieved a price premium of 9.5% and 16.1%, measured against cod caught with a trawl and Danish seine, respectively. Auction

prices thus revealed a clear correlation between fish quality and price. This study therefore proposes, in line with Henriksen and Nyrud [3]; that auctions should be implemented also for fresh cod to curb the failure observed under the current market regime. Society suffers an economic loss if quality-based waste continues in the Norwegian cod industry [7]. It is thus important that the institutional framework encourages the emergence of QEBMs to gain maximum socioeconomic value creation.

The authorities have means to create framework conditions for making QEBMs more attractive. They can allocate more live storage sites. They can distribute more quotas for both capture based aquaculture and fishing methods that prioritize quality and harvesting out of season. They can lift quotas out of intensive seasonal periods to other parts of the year. They can organize the first-hand market so that intensive and low-quality catches are severely penalized in the first-hand market. They can distribute quotas to the post harvest part of the value system. However, there are several challenges with implementing such institutional framework adjustments. The allocation of quotas must change, catch costs will increase, energy consumption in the catch and storing operation will increase, and end products must necessarily be more expensive. The political cost of such institutional changes indicate that they will hardly be implemented. This means that the most important incentive for QEBMs to be chosen is that customers are willing to bear the extra costs of quality products that can be delivered continuously – even in periods outside the traditional seasonal fisheries.

6.1. Global seafood implications

This paper addresses quality enhancement in the Norwegian cod industry by applying alternative business models. The findings, however, have some implications for global seafood production. According to the Barange et al. [2]; the growth in seafood production will occur in the Farm raised model. Our findings indicate some guidelines to choose the species for this model. High-value species with shortcomings in the wild-caught model related to poor stock management, low CPUE, quality problems, or seasonality in harvesting are promising candidates. Failures in the wild-caught model create a strategic opportunity for both the Farmed raised model and the Live storage model. The sustainability of the three models seem to depend on how well they perform in relationship to each other. The complementarity of the models, if applied to the best candidates, indicate a pathway to add both volume and value to seafood globally.

6.2. Further development of the live storage model

Further development is ongoing to extend the Live storage model into a catch-based aquaculture QEBM, as the long-term storage of cod is necessary to smooth out the cod season [24]. However, cod cannot be stored for longer than twelve weeks before being transferred to aquaculture facilities [26]. Thus, the firms need an aquaculture permit, which places considerably stricter requirements on the sites. Many sites are located close to the post-harvest processing plants and have difficulty in fulfilling the requirements [62]. In addition to the regulations on long-term storage, feeding is mandatory to maintain the quality and to meet fish-welfare concerns. When the fish is fed, it also grows into higher price ranges. However, the feeding of cod is an issue that has implications for both short- and long-term storage [24]. It has proved challenging to feed wild-caught cod because a proportion of the fish refuses to eat. In particular, it has been challenging to adapt wild-caught cod to formulated feed. Formulated feed has several advantages over other feed types [63]. If the problem of developing a dry feed that works for wild-caught cod is solved, this would probably improve the feeding and growth of the fish and make catch-based aquaculture a promising path to higher quality, reduced seasonality, and increased profitability for the players [24].

Declaration of competing interest

None.

Acknowledgments

We appreciate and thank Charles Aas in the Norwegian Fishermen's Sales Organization, and Øystein Hermansen in the Norwegian Institute of Food, Fisheries and Aquaculture Research (Nofima) for their assistance with collecting data to this study.

References

[1] Ø. Hermansen, B. Dreyer, Challenging spatial and seasonal distribution of fish landings—the experiences from rural community quotas in Norway, Mar. Pol. 34 (3) (2010) 567–574.
[2] M. Barange, J. Alder, U. Barg, S. Funge-Smith, P. Mannini, M. Taconet, J. Plummer, The State of World Fisheries and Aquaculture (SOFIA) - Meeting the Sustainable Development Goals, Food and Agriculture Organization of the United Nations (FAO), Rome, 2018.
[3] E. Henriksen, T. Nyrud, Markedssvikt i førstehåndsomsetningen i vinter-og vårtorskefisket i Nord-Norge [Market failure in first-hand sales in winter and spring cod fishing in northern Norway], Økonomisk fiskeriforskning: Ledelse, marked, økonomi 29 (1) (2019) 33–49.
[4] E. Henriksen, M. Heide, Ø.J. Hansen, A. Mortensen, Rapport - Kunnskaps- Og Erfaringsgrunnlag for Torskeoppdrett, Tromsø, Nofima, 2018 (23). [Report - Knowledge and experience base for cod farming].
[5] A. Iversen, Ø. Hermansen, E. Henriksen, J.R. Isaksen, P. Holm, B.-I. Bendiksen, T. Nyrud, K.M. Karlsen, P.B. Sørdahl, B. Dreyer, Fisken Og Folket [The Fish and the People], Orkana Forlag, Stamsund, 2016.
[6] M. Heide, E. Henriksen, Rapport - Variabel Kvalitet I Verdikjeden : Hvordan Påvirker Kvalitet Lønnsomhet, Tromsø, Nofima, 2013 (3). [Report - Variable quality in the value chain: how does quality affect profitability?].
[7] B.A. Bertheussen, B.M. Dreyer, Are the Norwegian cod fisheries caught in a value-destructive volume logic? Mar. Pol. 103 (2019) 113–120.
[8] F. Asche, Y. Chen, M.D. Smith, Economic incentives to target species and fish size: prices and fine-scale product attributes in Norwegian fisheries, ICES (Int. Counc. Explor. Sea) J. Mar. Sci. 72 (3) (2015) 741–752.
[9] I.K. Pettersen, E. Brækkan, Ø. Myrland, Are Norwegian fishermen selling in the same market? J. Commod. Mark. 12 (2018) 9–18.
[10] G. Sogn-Grundvåg, T.A. Larsen, J.A. Young, The value of line-caught and other attributes: an exploration of price premiums for chilled fish in UK supermarkets, Mar. Pol. 38 (2013) 41–44.
[11] S. Joensen, T. Tobiassen, B.I. Bendiksen, Fangstskaderegistreringer I Torskefangster 2014–2016 [Capture Damage Records in Cod Catches], Lecture for Ministry of Trade, Industry and Fisheries, Oslo, 2016.
[12] F. Asche, M.D. Smith, Induced innovation in fisheries and aquaculture, Food Pol. 76 (2018) 1–7.
[13] B. Dreyer, B.H. Nøstvold, K.Ø. Midling, Ø. Hermansen, Capture-based Aquaculture of Cod, vol. 508, FAO Fisheries Technical Paper, 2008, pp. 183–199.
[14] G. Sogn-Grundvåg, F. Asche, D. Zhang, J.A. Young, Eco-labels and product longevity: the case of whitefish in UK grocery retailing, Food Pol. 88 (2019) 101750.
[15] L.L. Martins, V.P. Rindova, B.E. Greenbaum, Unlocking the hidden value of concepts: a cognitive approach to business model innovation, Strat. Entrepr. J. 9 (1) (2015) 99–117.
[16] C. Zott, R. Amit, Business model design: an activity system perspective, Long. Range Plan. 43 (2–3) (2010) 216–226.
[17] R. Amit, C. Zott, Creating value through business model innovation, MIT *Sloan Manag. Rev.* 53 (3) (2012) 41–49.
[18] C. Markides, C.D. Charitou, Competing with dual business models: a contingency approach, Acad. Manag. Perspect. 18 (3) (2004) 22–36.
[19] C. Markides, D. Oyon, What to do against disruptive business models (when and how to play two games at once), MIT Sloan Manag. Rev. 51 (4) (2010) 25.
[20] D.J. Teece, Business models, business strategy and innovation, Long. Range Plan. 43 (2–3) (2010) 172–194.
[21] C. Markides, Business model innovation: what can the ambidexterity literature teach us? Acad. Manag. Perspect. 27 (4) (2013) 313–323.
[22] B. Isaksen, K.Ø. Midling, Fangstbasert akvakultur på torsk - en håndbok [Catch-based aquaculture - a handbook], Tromsø, Nofima, 2012.
[23] Ø. Hermansen, En økonomisk analyse av verdikjeden for fangstbasert akvakultur – med fokus på fangstleddet [An economic analysis of the value chain for catch-based aquaculture - with a focus on harvesting], Økonomisk fiskeriforskning 28 (1) (2018) 1–19.
[24] Ø. Hermansen, J.R. Isaksen, B. Dreyer, Rapport - Evaluering Av Ferskfiskordningen Og Kvotebonus for Levendelagring (27) [Report - Evaluation of the Fresh Fishery Scheme and Quota Bonus for Live Storage, Tromsø, Nofima, 2017.
[25] K.Ø. Midling, K. Aas, T. Tobiassen, L. Akse, B. Isaksen, S. Løkkeborg, O. B. Humborstad, Rapport - fangstbasert havbruk - mellomlagringsløsninger for den mindre kystflåten (22) [Report - catch-based aquaculture - interim storage solutions for the smaller coastal fleet], Tromsø, Fiskeriforskning og Havforskningsinstituttet (2005).

[26] Ø. Hermansen, G. Sogn-Grundvåg, B. Dreyer, Hvordan går det med fangstbasert akvakultur av torsk? [How about catch-based aquaculture of cod? Norsk sjømat (1) (2018) 35–38.
[27] T.N. Ageeva, R.L. Olsen, S. Joensen, M. Esaiassen, Quality aspects of fillet, loin and tail products made from live-stored feed-deprived Atlantic cod (Gadus morhua L.) at different times post mortem, J. LWT Food Sci. Technol. 97 (2018) 656–661.
[28] J.C. Holm, T. Svåsand, V. Wennevik, Håndbok i torskeoppdrett: stamfiskhold og yngelproduksjon [Handbook in cod farming: broodstock and juvenile production], Berg: Havforskningsinstituttet. Senter for havbruk (1991).
[29] H. Tvenning, F. Bachmann, *Fiskeoppdrett* [Fish Farming, 4. ed., Aschehoug, Oslo, 1991.
[30] J. Østli, markid, M. Heide, Rapport - markedstest av oppdrettet torsk i det spanske restaurantsegmentet (4) [Report - market test of farmed cod in the Spanish restaurant segment], Tromsø, Fiskeriforskning (2004).
[31] Ø.J. Hansen, V. Puvanendran, J.P. Jøstensen, I.B. Falk-Petersen, Early introduction of an inert diet and unenriched Artemia enhances growth and quality of Atlantic cod (Gadus morhua) larvae, Aquacult. Nutr. 24 (1) (2018) 102–111.
[32] G. Sogn-Grundvåg, K. Grønhaug, F.-A. Egeness, T. Trollvik, Kritiske suksessfaktorer for torskeoppdrett: finnes de? [Are there critical success factors in cod farming?], Økonomisk fiskeriforskning: Ledelse, marked, økonomi 20 (1) (2010) 9–16.
[33] H. Skuseth, Strategiske utfordringer for torskeoppdrett [Strategic challenges of cod farming], Norsk Fiskerinæring (4) (2010). Retrieved july 2, 2019 on: http://www.aege.no/userfiles/Site_1/file/05052010%20Artikkel%20torskeoppdrett%20nf.pdf.
[34] A.S. Dundas, Hvordan Verdsette Torskeoppdrettsselskapet Codfarmers ASA? [How to Value the Cod Farming Company Codfarmers ASA, Master Thesis, Norges Handelshøyskole, Bergen, 2009.
[35] F. Asche, T. Bjørndal, The Economics of Salmon Aquaculture, Wiley-Blackwell, Chichester, 2011.
[36] B. Dreyer, K. Grønhaug, Uncertainty, flexibility, and sustained competitive advantage, J. Bus. Res. 57 (5) (2004) 484–494.
[37] E. Henriksen, M. Svorken, Rapport - Fangstregulering Og Råstoffkvalitet I Kystflåten : Ferskt Råstoff Til Fiskeindustrien I Nord-Norge (25) [Report - Catch Regulation and Raw Material Quality in the Coastal Fleet: Fresh Raw Material for the Fishing Industry in Northern Norway], Tromsø, Nofima, 2011.
[38] A.J. Borderías, I. Sánchez-Alonso, First processing steps and the quality of wild and farmed fish, J. Food Sci. 76 (1) (2011) R1–R5.
[39] D.B. Björgvinsson, B.A. Bertheussen, B. Dreyer, Differences in harvesting and marketing strategies between Iceland and Norway, Økonomisk fiskeriforskning 25 (1) (2015) 21–36.
[40] Ö. Knútsson, D.M. Kristófersson, H. Gestsson, The effects of fisheries management on the Icelandic demersal fish value chain, Mar. Pol. 63 (2016) 172–179.
[41] J.B. Barney, Firm resources and sustained competitive advantage, J. Manag. 17 (1) (1991) 99–120.
[42] J.L. Hervás-Oliver, J. Albors-Garrigós, Do clusters capabilities matter? An empirical application of the resource-based view in clusters, J. Entrepr. Region. Develop. 19 (2) (2007) 113–136.
[43] C. Lawson, Towards a competence theory of the region, Camb. J. Econ. 23 (2) (1999) 151–166.
[44] P. Maskell, A. Malmberg, Localised learning and industrial competitiveness, Camb. J. Econ. 23 (2) (1999) 167–185.
[45] S.D. Hunt, R.M. Morgan, The comparartive advantage theory of competition, J. Market. 59 (1995) 1–15.
[46] W.P. Barnett, H.R. Greve, D.Y. Park, An evolutionary model of organizational performance, Strat. Manag. J. 15 (S1) (1994) 11–28.
[47] D. Miller, J. Shamsie, The resource-based view of the firm in two environments: the hollywood film studios from 1936 to 1965, Acad. Manag. J. 39 (3) (1996) 519–543.
[48] M.N.K. Saunders, P. Lewis, A. Thornhill, Research Methods for Business Students, sixth ed., Pearson, Harlow, 2012.
[49] J.L. Anderson, F. Asche, T. Garlock, Globalization and commoditization: the transformation of the seafood market, J. Commod. Mark. 12 (2018) 2–8.
[50] D. Standal, B. Hersoug, Shaping technology, building society; the industrialization of the Norwegian cod fisheries, Mar. Pol. 51 (2015) 66–74.
[51] P. Aversa, S. Haefliger, D.G. Reza, Building a winning business model portfolio, MIT Sloan Manag. Rev. 58 (4) (2017) 49–54.
[52] E.M. Pertusa Ortega, J.F. Molina-Azorín, E. Claver-Cortés, Competitive strategies and firm performance: a comparative analysis of pure, hybrid and 'stuck-in-the-middle' strategies in Spanish firms, Br. J. Manag. 20 (4) (2009) 508–523.
[53] K.H. Enoksen, *Å Temme Torsken – Fremveksten Av Norsk Torskeoppdrettsnæring. En Beretning Om Kollektivt Entreprenørskap*. [To Tame the Cod - the Emergence of the Norwegian Cod Farming Industry. An Account of Collective Entrepreneurship]. Dissertation for the Degree of Philosophiae Doctor, Faculty of Life Sciences, Fisheries and Economics, Norwegian Fisheries College, University of Tromsø, 2018.
[54] R. Casadesus-Masanell, J. Tarzijan, When one business model is not enough, Harv. Bus. Rev. 90 (1/2) (2012) 132–137.
[55] V. Sabatier, V. Mangematin, T. Rousselle, From recipe to dinner: business model portfolios in the European biopharmaceutical industry, Long. Range Plan. 43 (2–3) (2010) 431–447.
[56] J. Nilssen, B.A. Bertheussen, B. Dreyer, J.F. Molina-Azorín, E. Claver-Cortés, Sustained competitive advantage based on high quality input, Mar. Pol. 52 (2015) 145–154.
[57] J.R. Isaksen, Upstream Vertical Integration and Financial Performance. The Case of the Norwegian Fish Processing Industry. A Dissertation for the Degree of Philosophiae Doctor, University of Tromsø, Norwegian College of Fishery Science, Department of Economics and Management, 2007.
[58] O. Kvaløy, R. Tveteras, Cost structure and vertical integration between farming and processing, J. Agric. Econ. 59 (2) (2008) 296–311.
[59] A. Cojocaru, F. Asche, R.B. Pincinato, H.-M. Straume, Where are the fish landed? An analysis of landing plants in Norway, Land Econ. 95 (2) (2019) 246–257.
[60] V. Shankar, G.S. Carpenter, L. Krishnamurthi, Late mover advantage: how innovative late entrants outsell pioneers, J. Market. Res. 35 (1) (1998) 54–70.
[61] G. Sogn-Grundvåg, D. Zhang, B. Dreyer, Auksjon Eller Kontrakt? Råfisklagets Omsetning Av Fryst Hvitfisk [Auction or Contract? the Norwegian Fishermen's Sales Organization Auction of Frozen White Fish], Nofima rapportserie, Tromsø, 2019, ISBN 978-82-8296-599-6.
[62] S.A. Sønvisen, D. Standal, Catch-based aquaculture in Norway-Institutional challenges in the development of a new marine industry, Mar. Pol. 104 (2019) 118–124.
[63] B.-S. Sæther, C. Noble, O.B. Humborstad, S. Martinsen, E. Veliyulin, E. Misimi, K. Ø. Midling, Fangstbasert Akvakultur. Mellomlagring, Oppföring Og Foredling Av Villfanget Fisk [Catch-Based Aquaculture. Intermediate Storage, Feeding and Processing of Wild-Caught Fish], Tromsø, Nofima AS, 2012.
[64] F.R. Homans, J.E. Wilen, Markets and rent dissipation in regulated open access fisheries, J. Environ. Econ. Manag. 49 (2005) 381–404.
[65] G.L. Shamshak, J.L. Anderson, F. Asche, T.M. Garlock, D. Love, U.S. Seafood consumption, J. World Aquacult. Soc. 50 (2019) 715–727.