

Prices in the Land of Cod

Analyzing the First-hand Market for Cod in Norway

by

Ingrid Kristine Pettersen

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University of Stavanger

N-4036 Stavanger

Norway

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Summary

According to economic theory, a competitive market leads to the most efficient allocation of resources amongst producers, and for goods and services among consumers.

In this dissertation, various aspects of the first-hand market for cod is investigated. Through the study of the price determination processes, both geographically and in product space, we have been able to reveal that this market functions well.

The first paper investigates the level of market integration between different regions that include the two biggest sales organizations in Norway, and between fresh and frozen cod. The results indicate that the market for ex-vessel cod in Norway is integrated. There is evidence that the price determination in the area of the largest sales organization is leading the smallest. Fresh and frozen cod also belongs to the same market, and the frozen cod market is leading the fresh market, ensuring that the Norwegian market for fresh cod is also a part of a global market.

The second paper estimates the value of the different attributes of cod across different regions, such as the processing form, the quality, size and gear-type. There are significant differences in the valuation of different attributes and the results shows heterogeneity in the pricing of the attributes between regions. This implies that even though there is basically one representative price for cod that is valid for all regions, there are still regional price variations.

The third paper finds that the seven major product forms of cod at the export level can be aggregated into one representative index, hence, cod is a commodity. In addition, there is a long-run relationship between the first-hand price of cod and the cod price index. This shows that there is one representative price for cod at the export level which follows the same price pattern over time as the first-hand price of cod.

The fourth paper finds a link between the legally mandated minimum price of cod and several of the exported cod products, so indicating that the minimum price is market-based. Furthermore, we estimated the effect of the cod price index from paper 3, and other variables, on the margin between the minimum price and the first-hand price. The aggregate price transmission effect is less than or equal to one, implying that the price signals from the market is transmitted to the first-hand market in a 1:1 relationship.

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PART I

1. Introduction

“Markets are where prices are established” (Stigler & Sherwin, 1985, p. 555).

The role of the market is to facilitate trade, and it is the transactions between a set of buyers and sellers that determine the price of a good. The purpose of defining a market is to identify the buyers and sellers that establish the prices of a good within an area, both geographically and in product space, so as to ascertain how far movements of supply and demand in one market place are influenced by those in other markets (Marshall, 1920; Stigler & Sherwin, 1985). In a perfectly competitive market structure, prices will adjust instantly and correctly to new information.

This dissertation focuses on the first-hand¹ market, and thus the establishment of prices for cod in Norway. The market is characterized by many, mostly small buyers and sellers, fishermen as well as buyers. All the trade of cod at first-hand level is organized through sales organizations which, by law, are entitled to set rules for how transactions are to be conducted, as well as for setting minimum prices. The minimum price should be market-based, meaning that it should depend on information about supply and demand and other relevant factors, such as inventory and expectations, in regard to future market development with respect to income, preferences and so on.

Norway has one of the world’s longest coastlines, and there is an active fishery along the entire coast, especially in the north. Regional differences are related,

¹ First-hand market and the ex-vessel market are used interchangeably throughout the text and refer to sales between the boat and the buyer.

for instance, to catch methods and the size composition of the accessible cod. The fishing fleet is divided into a coastal and an ocean-going fleet, which influences quotas, and is quite heterogeneous. The coastal fleet consists of smaller vessels with limited ability to cover large distances and mainly delivering fresh cod, so limiting arbitrage possibilities.

Owing to the limited mobility and the biology of the cod, the majority of the cod is caught during a few winter months. On the other hand, the ocean-going fleet consists of larger vessels, which are more mobile. The majority of the vessels in this fleet have onboard freezing capacity, which dilutes the seasonality. In addition, the storability of the frozen cod is an advantage in the market situation where they are not obliged to sell the fish immediately, unlike the sellers of fresh cod. The gear types used in the Norwegian cod fishery have the potential to affect both the environment and the quality of the cod. In addition, there are different costs associated with their use.

Since the beginning of the 10th century, the export of cod has connected the Norwegians to an international market, where fish has been traded for other commodities. The export of fish amounted to 25% of total Norwegian exports in the beginning of the 20th century (Hallenstvedt, 1982). The first product exported was dried cod, while the first markets were in Southern Europe. The cod fishery was the most important fishery in Norway for hundreds of years, and one of the most important sectors of the economy (Hannesson, Salvanes, & Squires, 2010). Today the majority of cod is exported, and in several different product forms such as dried, salted, salted and dried, whole and filets (fresh and frozen). Southern Europe, and especially Portugal, is still an

important market for Norwegian cod, however, the market has extended to all continents.

The Norwegian cod market is quite regulated, due to the objectives of the Norwegian fisheries policy, which in addition to ensuring sustainability and profitability, also aims at ensuring employment and settlement along the coast. Some observers have claimed that these two goals may be contradicting, where for instance measures to reduce costs, like increased capital intensity in fishing and processing, might lead to reduced need for labor (Nærings- og fiskeridepartementet, 2014). However, the political measures are constructed to meet these aims in different ways, e.g. a higher share of the quota is allocated to the coastal fleet to insure employment in the districts. Trawlers are bound by a supply obligation to specific locations to ensure employment and to help fish processing companies to stay in business throughout the year.

Despite all these special features of the cod market, as it turns out, it is not that complicated. We have shown that the price determination process associated with a highly competitive market structure is largely in force for the cod market. Earlier research has shown that there is a global market for cod (Asche, Flaaten, Isaksen, & Vassdal, 2002; Asche, Gordon, & Hannesson, 2004; Asche, Menezes, & Dias, 2007; Asche, Gordon, & Hannesson, 2002; Gordon & Hannesson, 1996; Nielsen, Smit, & Guillen, 2009). We show that, despite many different product forms, they can be regarded as a commodity (paper 3). In addition, it can be shown that price signals from the market are transmitted to the minimum price, indicating that the minimum price is indeed market-based (paper 4). Furthermore, despite large distances between the regions,

limited mobility of the fleet and regions being operated by different sales organizations, we find that there is one price for cod, as the Law of One Price holds² (paper 1). We have also found that the market for the perishable fresh cod and the storable frozen cod is integrated.

However, the frozen cod receives a higher price than the fresh cod, probably because of its storability and an efficient auction system used for frozen cod. We also find that attributes of the cod have different valuations. In particular, it is interesting to see that trawlers, which are regarded as more environmentally degrading than passive gears (like line), receive the highest premiums. The valuation of these attributes varies between regions. Hence, even though prices between regions move together over time, there are still regional price variations (Paper 2). The variation in attribute values between regions also indicates that the minimum price cannot be binding, in line with the findings of Asche, Chen, & Smith (2015).

The implication is that we have a quite well-functioning market structure and that the price of cod is determined where quantity supplied equals quantity demanded at all levels of the market. However, there are reasons to believe that regulations affect price levels. The allocation of quota to specific vessel groups could be one of the reasons for the difference in price levels between fresh and frozen cod. There are indications that the smaller fleet, due to its limited mobility, receives a lower premium than the bigger vessels. A management system that allocates more quota to the smaller fleet hence maintains a potentially artificial composition of the fleet. On the other hand,

² For 5 out of 7 regions

market signals that induce the use of less environmental friendly gears should perhaps be subject to greater regulation.

The dissertation starts with price theory, markets and method, followed by a brief history of the Norwegian fishery and management, and an overview of earlier research related to the cod markets. Finally, the four papers in this dissertation are presented.

2. Theory and Method

To understand a market, one must understand the determination of prices. The closer prices move together, the more integrated the market or the product tend to be. According to (Asche et al., 2004), the analysis of price relationships can provide information on: i) whether two markets or products compete; ii) whether they are imperfect substitutes; and iii) whether they are perfect substitutes so that the relative price is constant.

The determination of a market is important for both methodological and policy reasons. For instance, one of the most frequent reasons for engaging in price analysis is to estimate parameters such as price and income elasticities (Tomek & Robinson, 2003). Cross-price elasticities contain information with respect to the relationship between different products, and often the selection of products are based on assumption rather than tests. However, there are exceptions; for instance, Xie & Myrland (2011) use Lewbel's (1996) General Composite Commodity Theorem (GCCT) to test whether different product forms of salmon can be aggregated into one product, salmon, before they estimate an AIDS model (Deaton & Muellbauer, 1980).

In addition Asche, Salvanes & Steen (1997) found that using demand analysis and market delineation studies are complementary and provide more information together. Through tests for market sizes and boundaries, researchers will then know which substitutes to include on a more reliable and consistent statistical basis (Nielsen et al., 2007).

Knowledge of market delineation will hence ease the prediction of effects of different policy measurements, such as trade policies and the management of related species (Nielsen et al., 2007). If one wants to know the effect of a supply change, one needs an adequate perception of the total volume of the relevant market (Nielsen, 2005). If the product under political consideration is in fact part of a bigger market, we then know that policy changes will have less effect compared to a market separate from all other products or markets. Moreover, knowing which market or product is the leader can help direct the policy measurements more precisely. If there does exist a central market/product, then we know that changes in this market/product will have consequences in all the related markets/products, and not vice versa.

2.1 Price Determination

The price of a product determines how much a consumer is willing to buy and how much a producer is willing to produce³, i.e. the quantity demanded/produced is a function of the price. But the relationship between price and quantity is opposite for consumers and producers. The consumers buy less, the more price increases (negative relationship), which is the *general law of demand* (Marshall, 1920). And the producers will produce more with increasing prices (positive relationship). Graphically, this is shown through the downward sloping demand curve and the upward sloping supply curve (as in

³ However, this is not the sole factor at determining supply and demand. Government intervention, such as acreage-control in agriculture and quota restrictions in fisheries, will affect production. Income, advertising and convenience also affect consumption decisions.

figure 1). In a competitive market, the quantity demanded thus equals the quantity supplied and so we find the equilibrium price.

2.1.1 Price Theory: Supply, Demand and Market Structure

Economic theory assumes consumers to be utility maximizers; that is, they will attempt to get the greatest utility possible from spending the least amount of money (*rational*), given their preferences (Deaton & Muellbauer, 1980). It is also assumed that the consumers have a limited budget, spent entirely on a bundle of goods (*nonsatiation*). A change in the price of one good will thus not change the budget, but will lead to substitution for the relatively cheaper good.

In equivalent terms, producers maximize profit using the combination of inputs that provides the planned output produced at the lowest possible cost, or they maximize production given the market prices. The producers produce the quantity of output where marginal revenue equals marginal costs. Revenue is determined by the final price of the product, and there is often a certain time lag between the production decision and the final output. Thus, producers also have to calculate the risk. For instance in agriculture, there can be a lag of several years (Tomek & Robinson, 2003).

Price determination is dependent on the market structure, the number of buyers and sellers, and the degree of product differentiation. The *competitive market* structure is recognized by many buyers and sellers that individually cannot affect the market price, so that the marginal revenue is equal to the price. In a perfectly competitive market, it is costless to enter or leave the

market, and all buyers and sellers has perfect knowledge about all the factors that affect price in the market. An *oligopoly* is recognized by a few sellers selling identical products, where in some cases the firms can influence market price in a profitable matter (e.g. a Cournot oligopoly) and in other cases they cannot (e.g. with the Bertrand oligopoly). When there is only one seller, it is taken to be a *monopoly* and the monopolist determines the price given demand by how much is being produced.

2.1.2 Price Changes

Due to changes in price, changes in the quantity demanded are caused by movements along the demand curve. Other factors, such as income and the prices of competing products, can also change the price by shifting the demand schedule. Similarly, when the quantity supplied changes and the price remains the same, this can be explained by a shift in supply.

Changes in demand are caused by factors such as changes in tastes and preferences, advertising, changes in income and changes in the prices of related goods. Changes in supply are caused by factors such as changes in production technology, weather conditions, the price of input factors and the number of suppliers in the market.

2.1.3 Price Discovery

Price discovery denotes the institutional mechanisms by which buyers and sellers arrive at specific prices and the terms of trade. There are three ways to categorize the price discovery methods according to Tomek & Robinson (2003): negotiations (private or collective), auctions and administrative decisions.

Negotiation involves a seller and a buyer who negotiate directly for some quantity of a product; for instance, at a market place either by individuals or by collective groups. A typical example of a collective negotiation is the labor unions negotiating wages with employers on behalf of their members. In order for a collective negotiation to work, the “free rider” problem has to be eliminated. The “free rider” problem occurs if there is a substantial amount of supply that is not covered by the collective negotiation and some actors are always given incentives to break out. A collective negotiation process can work when it is protected by law and includes everyone. For instance, when negotiating a minimum price, it has to be protected in order to be binding.

An auction establishes prices through bidding. There are several kinds of auctions, with the most common being the ascending bid auction, where the auctioneer suggests a price and the potential buyers bid until they reach a price that no one will bid above. Descending bid auctions, where the auctioneer announces a price and keeps lowering it until someone accepts, are also called Dutch auctions. These auctions might take place at a physical trading place or electronically.

Administrative prices are prices set via the administrative decisions of firm managers or even by government regulations. Prices in retail stores are set by store managers, being that it is too costly to negotiate with each client. Prices are set based on knowledge about economic factors and competition. Governmental policies can influence prices.

2.1.4 Price differences associated with Quality

A commodity is a composition of many different characteristics/attributes. One can argue that it is the combination of the different characteristics of the good that provides utility (Lancaster, 1966). Attributes might be both negative and positive. Attributes include size, color, moisture level, protein and fat content, the fineness of fibers and the proportion of defects or impurities. Even the location of a product is an attribute (Tomek & Robinson, 2003). Specific lots of an agricultural commodity differ in terms of such characteristics. The characteristics have different values and the composition of the attributes determines the price the commodity. These intrinsic properties of different goods are not accounted for in consumer theory; goods are the direct object of utility. Lancaster (1966) criticizes economists for not being true to the theory that goods are direct objects of utility as they for instance explain substitution and complementary goods. He uses the example of butter and margarine, which are assumed to be substitutes. According to the beliefs of the market researcher then, the intrinsic properties of the goods are relevant to the consumers' reaction while these properties remain unaccounted for.

Assuming that these characteristics have economic significance and are measurable, there are separate demand schedules for each of them. Each demand schedule maps how much a consumer is willing to pay for an extra unit/share of the product's characteristics.

The demand for attributes thus follows the usual determinants of demand, where shifts in demand for the different attributes will affect the price or their valuation. There is normally a great degree of substitutability amongst grades of the same commodity; that is, the same product but different varieties of attributes. According to Tomek & Robinson (2003), the main demand shifter is the change in price of one of these substitutes. New uses for a commodity can change the relative demand for the attributes of that commodity. Changes in preferences are hence another source of shift in demand. Greater awareness among consumers might lead to higher valuation of an attribute compared to others, e.g. ecolabels used to signal sustainable production.

Similarly, supply functions may exist for each of these characteristics as a function of relative (expected) prices. An increase in demand for certain attributes will make producers shift resources towards production of that attribute, e.g. increased willingness to pay for ecolabels, as in the fishing industry where there has been an increased valuation of line-caught fish (Sogn-Grundvåg, Larsen, & Young, 2013). However, the requirement is that these price premiums are efficiently transferred back to the producer through the value chain (Asche, Larsen, Smith, Sogn-Grundvåg, & Young, 2015). In addition, it will take time to alter production, and the increased valuation by consumers has to be bigger than the potential increased cost of altering production (Henriksen & Sogn-Grundvåg, 2011). Weather conditions

constitute another factor that influences the supply of different attributes in agriculture and fisheries.

Rosen (1974, p. 34) says that “observed product prices and the specific amounts of characteristics associated with each good define a set of implicit or “hedonic” prices.” Thus, a model that explains the price of a commodity by its attributes is called a hedonic price model. Hedonic models are most useful when the product being analyzed is heterogeneous in nature because we analyze what causes products to be different and have different prices (Studenmund, 2011).

Classic empirical applications of this theory involves the price of residential properties, involving attributes such as location, proximity to schools and recreational areas, square meters, number of bedrooms and so on (G. C. Blomquist, Berger, & Hoehn, 1988; Cobb, 1984; Grether & Mieszkowski, 1974; Kain & Quigley, 1970). In addition, it has been used in a vast area of products, such as wine (Combris, Lecocq, Visser, Journal, & Mar, 2008; Nerlove, 1995; Oczkowski, 2001), breakfast cereals (Stanley & Tschirhart, 1991), cotton (Bowman & Ethridge, 1992), apples (Carew, 2000; Loureiro, McCluskey, & Mittelhammer, 2002) and many others beside. Recently, an increasing number of studies have shown that seafood also have a number of attributes valued at all levels in the chain (Asche, Larsen, et al., 2015; Bronnmann & Asche, 2016; Johnston, Wessells, Donath, & Asche, 2001; Loureiro et al., 2002; Roheim, Asche, & Santos, 2011; Sogn-Grundvåg et al., 2013; Uchida, Onozaka, Morita, & Managi, 2014; Uchida, Roheim, Wakamatsu, & Anderson, 2014; Wessells, Johnston, & Donath, 1999).

If these attributes are measurable and information about them is easily and consistently available to both producers and consumers, then we assume that the market is competitive. However, sometimes the attributes are not easily available to both parties. Some attributes might be costly and difficult to measure, and they can require labeling. In addition, the commodities have different uses and different valuation for consumers.

2.2 Market

“A market for a good is the area within which the price of a good tends to uniformity, allowance being made for transportations costs.” (Stigler, 1969, p. 69)

This is one of several definitions of a market, while Cournot (1838) and Marshall (1920) has similar definitions. A market can be defined both geographically and in product space, where quality differences take the place of transportation cost (Stigler & Sherwin, 1985).

A market, according to the geographical concept, is where the same product is sold in several different markets at the same price, due to arbitrage. This is the Law of One Price (LOP) implying that in a competitive market structure with a homogenous good, price differences between regions that trade with each other will equal transportation cost. While in the regions that do not trade with each other, the price difference is smaller than the transportation cost (Tomek & Robinson, 2003). Similarly, if there is a difference in the quality mix between products within a market, the price differences will equal the value of the quality differences.

Defining a market is important in the context of economic theory because most analysis is based on the concept of market. The level of market integration can be determined through the study of the long term relationship between prices. If a relationship exists between prices, then by definition they are in the same market. This implies that any price movement in a product will call forth a response in the market that will restore the equilibrium among prices; either profit maximizing arbitrage on the supply side or substitution of goods on the demand side (Asche et al., 2002).

The degree of market integration determines the extent of this response. When market integration is perfect, the Law of One Price (LOP) holds, defining the market geographically. Asche, Bremnes, & Wessells (1999) show that there is a close relationship between market integration and product aggregation. When the LOP holds, the Hicks-Leontief composite commodity theorem (CCT) holds. The reason for this is that, for the LOP and the CCT to hold, prices must move proportionally over time.

Mathematically the LOP is expressed as followed:

$$P_{1t} = a + bP_{2t} \quad (1)$$

Where a is a constant term that captures transportation costs and quality differences, while b gives the relationship between the prices. If $b = 0$, there are no relationship between the prices and if $b = 1$, the *Law of One Price* holds and the relative price is constant. If $0 < b < 1$, the goods are imperfect substitutes.

Shocks may occur in the short run, which alter the relationship between the prices. Adjustment costs can delay the new equilibrium (Ravallion, 1986), but

if they belong to the same market, then they will follow the same price pattern over time. Thus, testing for the relationship between the prices is a long-run concept. The times series has to follow the same stochastic trend over time and this is illustrated in Figure 1.

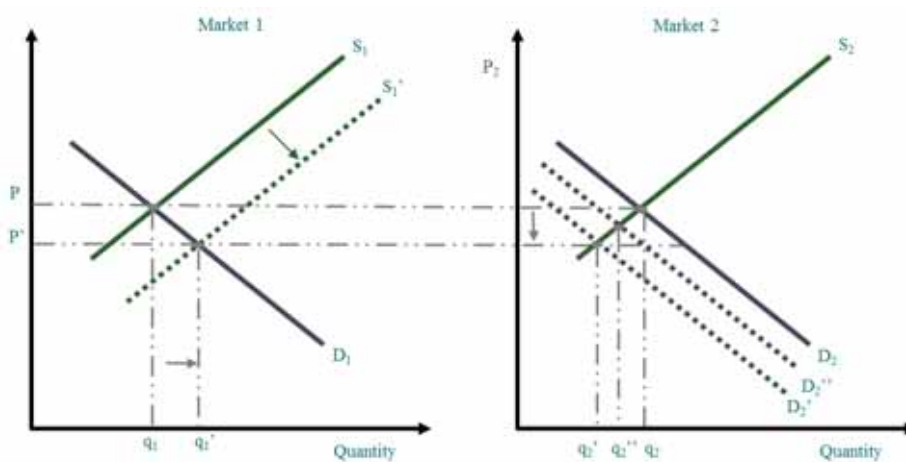


Figure 1 Price shifts between markets. Source: Asche et al. (2004)

The figure represents the equilibrium in two markets at price P and quantities q_1 and q_2 in market 1 and 2 respectively. A supply shock in market 1 leads to a shift in the supply curve to S_1' providing a new price P' and quantity q_1' . The effect of the supply shock in market 1 on market 2 depends on the degree of market integration between these two markets. If the two markets are perfectly integrated, the demand curve in market 2 shifts down to D_2' equilibrating the two markets and the LOP holds. However, if these two markets are not fully but only partly integrated, then the demand curve will shift to D_2'' which is not enough to equate the price in the two markets. If

these two markets are completely independent, then no price change in either of the markets will call forth a response in the other.

Given that most economic time series of prices are nonstationary, the most common approach to empirically testing for market integration and delineation, are cointegration tests (Asche et al., 2004); in particular the Johansen cointegration test (Johansen, 1991; Johansen & Juselius, 1990).

In order for two data series to be cointegrated, there has to be a statistically significant linear relationship between them. Granger (1969) notes that cointegration implies causality because, if there is a linear relationship between them, there must be a causal relationship. Evidence of cointegration implies causality, but it does not need to be bi-directional (Asche et al., 2004).

2.2.1 Central Market

In some cases, the price signals only travel from one market to the other, and not vice versa. This occurs if there is a central market, implying that the price is determined in this central market and transmitted to regional or satellite markets. Price shocks in the latter do not influence prices in the former (Asche, Gjølborg, & Guttormsen, 2012).

Similarly, if a good belonging to a group of goods in accordance with the GCCT is leading the prices of the other goods in this commodity group, then it's a price leader.

A central market is commonly found imposing restrictions on the adjustment parameter for weak exogeneity in the Johansen cointegration test (Johansen

& Juselius, 1990; Juselius, 2006). A price is exogenous if it does not respond to changes in the other prices. The exogenous price is determined by supply and demand conditions outside the system of prices tested. But price changes (due to shocks) in the exogenous market is transferred to the other prices when they are integrated (Asche et al., 2012).

The test for Granger causality (Granger, 1969) can be interpreted as a test for a central market or price leadership (Asche et al., 2012). But Granger non-causality is neither necessary nor sufficient for exogeneity (Asche et al., 2012; Engle, Hendry, & Richard, 1983). Granger causality is carried out by testing for the significance of past values of the dependent variable (Granger, 1969).

Causality concerns links between economic variables, while exogeneity tells us that the variable is being determined outside the model. Weak exogeneity, in combination with the absence of Granger causality, gives strong exogeneity (Asche et al., 2012).

A central market arises for several reason. In some instances, information is more easily available in a central market than in the surrounding market. For instance, Asche et al. (1999) found that the single most important salmon species, Atlantic salmon, is a price leader amongst different salmon species.

Defining a central market, or price leaders, is also important for policy reasons. A central price makes it easier to supervise and influence the price for a given good. In developing countries, the central market can also increase the efficiency of food assistance and so on (Asche et al., 2012).

2.2.2 Price Transmission and Asymmetry in Price signals

In its simplest form, price theory assumes that some buyers or sellers meet directly to trade. However, food usually travels through many levels of a value chain - for instance from a farmer - via producers, exporter/importer, wholesale and through retail to consumers. On this journey, the original product has often been transformed. Thus the price that the consumers pay is often much higher than the price farmers receive. This is called the marketing margin (George & King, 1971).

This margin thus contains processing, storage and transportation costs in addition to profits enjoyed by all agents. When buying bread, a consumer buys flour (wheat) in addition to another input such as labor and transportation. Each of the components of the bread has its own price. A change in any of these will affect the price of the end-product. However, there are usually lags in the price transmission. Often it is not possible to adjust immediately to price changes at different levels in the value chain.

Often policy decisions are influenced by these margins, and it is thus of interest to understand the factors influencing prices (George & King, 1971). It is of additional interest to understand whether these margins change because of changes in farm or retail price. In addition, it is important to understand why margins are larger for some product forms compared to others.

Price changes because of shifts in supply or demand, or both. In a perfectly competitive market, prices would adjust instantly and change correctly (Tomek & Robinson, 2003). Sometimes the magnitude of adjustment will be different for price increases and price decreases.

Most of the empirical analysis of agricultural products has concentrated on the farm and retail prices (Tomek & Robinson, 2003); for instance, dairy products (Goodwin & Holt, 1999; Kinnucan & Forker, 1987; Serra & Goodwin, 2003). It is uncommon that prices in this context are determined simultaneously, while price changes usually run from farm to retail (Serra & Goodwin, 2003). In addition, there seems to be an asymmetric response to price changes, with adjustments to increase in farm prices occurring faster than adjustments decrease (e.g. Kinnucan & Forker, 1987).

There are several reasons for asymmetry in price changes; Tomek & Robinson (2003) list several. Information transfer, when repricing products in retail stores are costly (Levy, Bergen, Dutta, & Venable, 1997). It takes time before new information is transferred to the new market level. Consumers' expectations and inventory adjustment cost, which might be different for price increase and price decreases. Obviously, market power is a possible explanation, while increasing profit by transferring increased costs very rapidly.

2.2.3 Government Intervention

Governments intervene in markets for several reasons. The most common economic justification is market failure, where the free market fails to allocate resources efficiently because one of the assumptions does not hold. Market failure might be related to negative externalities, imperfect competition and information and volatile prices. Another reason for government intervention is because the free market does not succeed in fulfilling political objectives,

such as a more equal distribution of income and wealth. In agriculture, food safety, stable prices, settlement and preservation of cultural landscape are often the goal.

The intervention can be done through legislation and price mechanisms, such as direct payments or subsidies; it can also be done through supply restrictions (e.g. import-, input- and harvest quotas and tariffs) or minimum prices, for instance on labor (minimum wages). One consequence of a minimum price proving too high in a competitive market structure is that it will create a supply surplus.

In Norway, one stated goal is to preserve cultural landscape and settlement in rural areas. Land-based farming is heavily subsidized and most products are sold to consumers at price well below the cost of production. For instance, the cost of producing 1 kg of Norwegian cheese is 80 NOK, exported at prices between 30 and 40 NOK ("Norske subsidier er sløsing," 2010). Norway also operates with very high tariff barriers. In fact, Norwegian agriculture is one the most subsidized agricultural sectors, according to the OECD ("OECD: Ingen subsidierer landbruket sitt så mye som Norge," 2013). The Norwegian landscape and weather conditions make national production particularly challenging; particularly, in conjunction with a high wage level.

There are many examples of the use of minimum prices in agriculture. For instance, Brazil used to have an agricultural minimum price program until the 1980s. The aim was to stabilize prices, stimulate production of supported commodities and to regulate stocks (Fox, 1979). However, the program was criticized for only benefitting a few large users, where regional inequalities were reinforced instead of alleviated. The minimum price regime was hence

repealed in the 1980's ("Agriculture in Brazil," 2016). For a time, there was also a minimum price for Norwegian salmon into EU markets.

Sometimes minimum prices are set in order to reduce consumption, e.g. on cigarettes and alcohol. In Scotland, an attempt was made to set a minimum price on alcohol because per capita consumption was above the recommended level. However, the European Court recommended setting a tax instead ("Minimum pricing for alcohol could be illegal," 2015). In British Columbia they found that increases in minimum prices on alcohol reduced consumption (Stockwell, Auld, Zhao, & Martin, 2011). Minimum prices on cigarettes in some US states were originally set to protect small independent retailers from predatory pricing strategies of large corporate competitors (Feighery, Ribisl, Schleicher, Zellers, & Wellington, 2005). There is also evidence of less cigarette consumption with increased prices (Chaloupka & Wechsler, 1995).

Minimum prices can distort market equilibrium, leading to an excess supply that no-one is willing to purchase at the prevailing price. Sometimes government are willing to provide demand for and to finance the supply surplus. For instance, the sole reason for exporting Norwegian cheese is to support the milk price. The guaranteed prices to European farmers introduced in 1962 resulted in *wine lakes, butter mountains and the \$2 a-day cow* ("The Common Agricultural Policy," n.d.). Minimum prices might lower incentives to provide sufficient quality and they can reduce the competitiveness of the producers in an international market.

3. The Norwegian Cod Fishery

Like most fisheries, Norwegian cod fisheries have strong seasonality with the biological cycle as the basic cause. The coastal fleet catches more than 80% of their quota from January to April during the seasonal migration of the cod, figure 2. During these months, the Barents Sea cod reaches the Norwegian coast to spawn, primarily around Lofoten, but it also stretches north to Finnmark and south to Møre. This makes the cod more easily accessible to the fishermen and has made the Lofoten fishery the most important for centuries (Hannesson et al., 2010). There has also been substantial fishing from harbors on the southwestern coast of Norway. With longer distances to the major fishing grounds, fishermen from these areas often operate ocean-going vessels. In addition, non-commercial home-fishing has always been very important, providing food for households. The number of home-fishers has decreased substantially over the last years.

The cod spawns about 20 times with two to three days in between (Jenssen, 2012). The roe and the liver are valuable byproducts. After spawning, the cod is emaciated and the quality is reduced. The coastal fleet is also sensitive to the weather and cannot fish in too much wind and high waves.

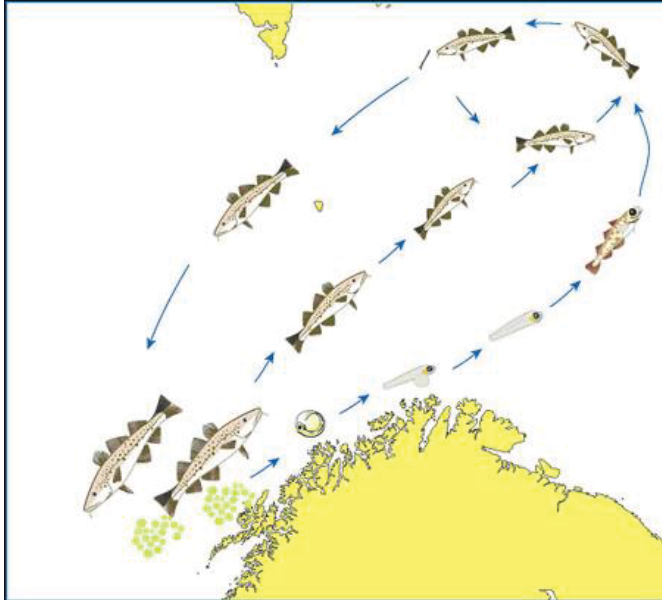


Figure 2 The migration of the Cod. Source: imr.no

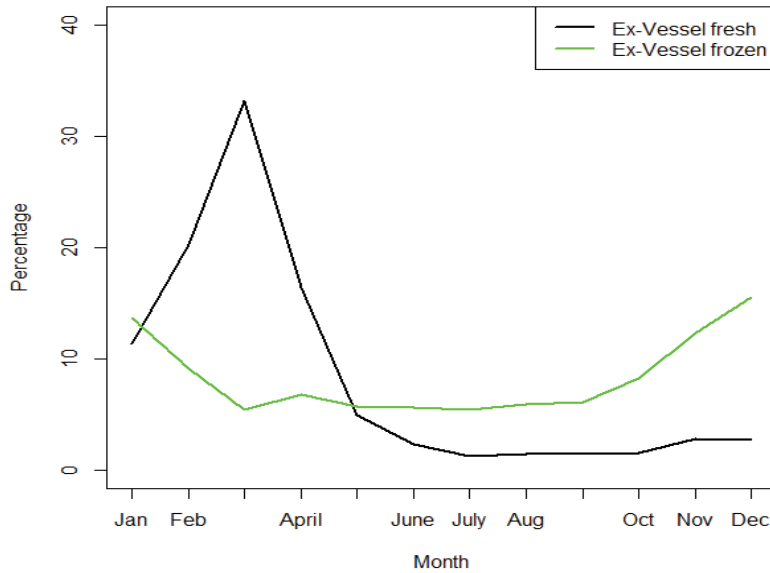


Figure 3 Average monthly Landings of Cod in Norway (fresh and frozen), 2000-2014

The seasonality for the ocean-going fleet is less pronounced. They can access the fish while it is in the Barents Sea in the summer and fall. In addition, the ocean-going fleet is less sensitive to bad weather and is perceived to be a stable supplier of fish (Lorentzen, Ottesen, Grønhaug, & Svorken, 2006). The ocean-going fleet primarily uses longline (automatic line) and trawl; during the 1990's more and more of these vessels were equipped with onboard freezing capacity (Henriksen, 2013). According to Larsen & Dreyer (2012), only 17% of the total catch from the trawlers is fresh. Figure 3 shows the seasonality of fresh and frozen cod.

The seasonality is a challenge for the fleet, processing industry and the market. The fishermen fish when they receive the higher revenue and when costs are the lowest (Henriksen, 2013). Optimal production requires all year round operations. This is also important in order for the industries to be competitive in the labor market and can be seen in the filet industry especially, where this has been a challenge since the beginning (Finstad, Henriksen, & Holm, 2012).

3.1 History and Background

Northern Norway has limited farmland and has never been able to make its inhabitants self-sufficient with agricultural products. But rich access to fish resources has provided for the settlement and livelihood. Fish was exported in exchange with other food products; in particular, grains. During the Pomor Trade, the fish was traded with the Russians for grains and other useful goods such as iron, timber, tar and sometimes luxuries such as candy and soap.

Northern Norway became an early part of the international market. International price movements affecting the grain/fish exchange ratio have also affected the north Norwegian inhabitants extensively. The unfavorable development in the grain-fish price ratio during the 16th and 17th century therefore led to a decrease in the population growth in Northern Norway during the same period (Fulsås, 1996). At times, the Pomor trade was crucial for the survival of the region. During the 18th century there were several crop failures with hugely increasing grain prices, food blockade and supply barriers during the Napoelon wars, when the Russians provided the northern fishermen with cheap flour in exchange for fish ("Pomorhandel," n.d.). When

the Pomor trade ended with the Russian revolution, it had a great impact on the inhabitants of Northern Norway.

3.1.1 Trade Regulations

The first known Norwegian fish exporter was sailing from Lofoten in 875 and England was amongst the first markets. However, during the beginning of the previous millennium, the Catholic Church required abstinence from meat during Lent, which led to new markets such as Spain, Italy, Portugal and Germany (Jenssen, 2012). Trade with the Russians had been going on since the Viking Age, but was stopped due to the monopolization of the trade by the Hanseatic during Medieval times.

The Hanseatic had a monopoly in all the cod exports for centuries, operating from Bergen. Norwegian merchants organized the trade and transportation to and from Bergen. The north Norwegian fishermen were supplied with food and equipment in advance, and were obliged to deliver the fish to the merchants to which they were in debt. This bond was legalized from 1572 (Fulsås, 1996).

For a long period of time, the reigning idea was that all trade should be organized from the southern cities. However, this system failed to secure sufficient livelihoods for the inhabitants in Northern Norway and, after several complaints, this monopoly regimen was diluted. In 1770, local merchants were allowed and were given a monopoly to organize trade within each district (Fulsås, 1996). A substantial growth in the fisheries during the 19th century was also part of the reason why a local trading class managed to establish itself

in Northern Norway. In 1789, the region got its first trading centers - Vardø and Hammerfest (Fulsås, 1996). Over a few decades, around 200 trading centers were established (Jenssen, 2012). These local fish buyers, called “væreiere”⁴, were the intermediary between the fish buyers in Bergen and the local fishermen. They soon grew into a stronger position and, in 1866, the local fish buyers were also allowed to export.

However, the fishermen did not manage to grow a stronger position. The dependency that they used to have on the Bergen merchants, they now had on the local fish buyers. The local fish buyers supplied the fishermen with equipment and food, and in return they were expected to deliver their fish to them. Most fishermen had, in reality, no control over their own production. With the *Lofot-act* of 1816, the position of the local fish buyers was further significantly strengthened. The fishing grounds were separated for different use, while the right to access these different fishing grounds was attached to the use of “Rorbu”, a traditional type of seasonal house used by fishermen during the fishing season. These houses were usually owned by the fish buyers (Jenssen, 2012). In practice, they now owned the rights to use the fishing grounds. Some fishermen were so heavily indebted that when they died, their belongings were auctioned out to cover debt. At times, when fishing failed, the fisherman had no means to pay their debt and could end up having to sell everything they owned and end their life in poverty (Jenssen, 2012).

⁴ A «væreier» was more than a fish buyer as he usually «owned» the entire community and the right to fish in the ocean outside his area. In addition, he was a local merchant, creditor, employer and held important positions in the local community (Jenssen, 2012).

3.1.2 The Fishing Fleet and Gear Types

The first fleet consisted of small open boat driven by sails and oars. All the fish were caught using hand line. For the Norwegian fishermen, the fisheries were primarily a part of the household economy and the priority was to trade the fish for commodities as their own production could not cover them. In Europe on the other hand, the fishing fleet became capitalized early on, with decked, ocean-going vessels, and the fishermen being regular employees. Even following the industrialization and population growth on the continent in the 19th century, and a significant increase in demand and price of Norwegian fish products, the introduction of new gears and boats happened slowly in the Norwegian Fishery.

According to Hallenstvedt (1982), this lack of innovation was due to the non-existing economic ability of the fishermen because of their debt to the fish buyers. In addition, the fish buyers themselves were lacking incentives. According to Fulsås (1996), the fish buyers seldom had adequate access to capital, as they were still often dependent on their contacts in the south. However, the major reason was that the lacking motives of the traders. A traditional fishery was able to keep up with the increased demand because of the rich access to fish and increased work effort. During some 50 years in the 19th century, Norway was able to increase the exported quantity of cod fivefold.

During the 17th century, those who could afford it experimented with gillnet and line⁵. However, fishers using hand line claimed that gillnet and line scared the fish away and these were forbidden during the Lofot-fishery. But as gillnet and line were much more efficient than handline, the prohibition was only partly respected, until it was finally legalized through “Lofotloven” in 1816 (“Regulering og lovgivning i lofotfiske,” n.d.). However, this law was not adapted to the erratic nature of fishing and was repealed in 1857 by a new law which insured free fishing. This act allowed basically anyone who could row a boat to fish (Jenssen, 2012).

There were 24 000 fishermen participating in the Lofot-fishery in 1860, with 1895 as the peak year with 32 600 participants (“Regulering og lovgivning i lofotfiske,” n.d.). High activity, a high number of fishermen and the entry of steam boats and purse seiners (a fishing gear) challenged the existing act. Confrontations took place between fishermen using traditional, open boats and the modern capitalists using steam boats and purse seiners, leading to a ban on the use of purse seiners in 1893. Finally, in 1897, a new act was implemented “The New Lofotlov”. Up to now, the community owners had been in charge; now the fishermen themselves could finally organize and set the rules for managing fishing.

In the very beginning of the 20th century the fishing fleet was motorized, and the fishing industry was revolutionized in turn. This eased the work of the fishermen, making them more mobile and efficient. However, this also made the fishermen more indebted and heavily dependent on well-function

⁵ Line is a fishing technique which uses a long line, with shorter lines with baited hooks attached at intervals. The hooks are attached manually at land before the catch.

markets. When the markets collapsed and prices decreased, the fishermen responded with increased catches, which in turn decreased the prices even more (Hallenstvedt, 1982).

3.1.2.1 Quality Associated with the Choice of Gear

The choice of gear affects the quality of fish. According to Lorentzen et al. (2006), the trawl- and gillnet fleet is the part of the fleet that provides the lowest quality fish. Fish in net often has external damage, and the fish normally dies in the net with the result of the poorer bleeding and durability. The trawl catches may have sufficient quality, but because of the distances to the fishing grounds these vessels stays longer at sea which makes the deliveries less fresh (Egeness, Bendiksen, Nilssen, & Nøstvold, 2011). However, Henriksen & Svorken (2011) find that there has been an increase in the use of gears, such as gillnet and Danish Seine, which are known for their low quality, while there is a decrease in the use of handline and line. The Danish Seine often have quality problems because the catches are often too big, which makes it difficult to bleed the fish before this affects the quality. Akse, Joensen & Tobiassen (2014) conducted random checks on catches from different gears and found that 46% of the catches from Danish Seine, more than 50% of the Gillnet catches and less than 30% of the line-caught fish had reduced quality.

However, Danish Seine is the most commonly used gear for live-caught cod, as a high share of the fish is alive when taken onboard, if the catches are not too large. Grundvåg & Henriksen (2011) claims that there is a market failure

at the first whitefish amongst others because costal fishing with line is in decline. A minimum price premium of 30% is available for line-caught haddock, but there is no such premium for line-caught cod. The same authors also claim that fishermen themselves have observed that the low-quality fish is being paid the same prices as the high quality cod.

In addition, there seem to be a willingness to pay among consumers for line-caught fish. Japanese consumer, for instance, prefer pot or line-caught sablefish as these gears produces higher quality fish (Squires, Herrick, & Hastie, 1989), and Sogn-Grundvåg et al. (2013) found that U.K. consumers prefers line-caught cod and haddock.

3.1.3 The Fishermen's Sales Organization

The relationship between the fishermen and the fish buyers was skewed far into the 20th century, with too many fishermen per fish buyer, long distances and low mobility. In addition, the fish buyers had long held a law-protected position and there is no doubt that the fishermen were exploited. However, this relationship between the local fish buyers and the fishermen also had some element of mutual dependence. It was in the interest of the local fish buyers to keep at least some fishermen in business, usually implying that they were paid sufficiently to both feed their family and maintain equipment (Hallenstvedt, 1982). But the prices were not so high that the fishermen could free themselves of the debt, nor invest in better boats or gears. In addition, since both live in the same community, there was a social cost related to this mistreatment of the fishermen.

During the end of the 19th and beginning of the 20th century the ties between the fishermen were loosened. They became more and more exposed to the open, more impersonal market. At the same time, the number of travelling fish buyers increased. They were not bound by social requirements nor had any need to keep the fishermen in business. The free market led to higher prices for the fishermen over certain periods, but there was no longer any price floors and the prices were pushed down. In particular, this turned out to be a vicious circle during the main season when the fishermen were eager to sell and the fish buyers expected the prices to drop (Hallenstvedt, 1982). Many fishermen were left with all the risk. If the fish buyer could not resell the fish, then the fishermen were left unpaid and had no means of retrieving their money.

Between 1917 and 1920, the Norwegian government obliged themselves to buy all fish at guaranteed prices. The upshot was huge storages of especially herring, which were then pushed out in the market, destroying the reputation of Norwegian fish. On top of this, a large number of exporters were left fighting for market shares, so underbidding each other (Hallenstvedt, 1982). In addition, non-drinkers contributed to stronger regulation concerning imports of alcoholic beverages. Each time there had been a mutual agreement between Norway and the main markets that they would buy the Norwegian fish provided that Norway bought their wine. Hence, Norwegian import restrictions for wine led to import restrictions for cod in the most important markets (Jenssen, 2012).

This crisis demonstrated the need for organization. The seafood export constituted a fourth of the total Norwegian export. As the fishermen were hit

the hardest, they were the first to organize. The only way to ensure reasonable prices was thus to stand together.

The first to organize were the herring fishermen in 1927. Minimum prices were established in addition to cash sales and required bank guaranties. Further organizations were established but none of these were protected by law and fishermen were lacking incentives not to break out of the agreement. In 1929, a law was constituted stating that exports of herring were forbidden that had not been bought through a fishermen organization. Through this act, the government signaled that they did not believe the market itself was the best way to insure the correct prices.

Finally, the cod fishermen also made attempts to organize. They made several attempts to set minimum prices, but they were only valid for certain areas and visiting fish buyers were not obliged by these agreements. Fishermen thus lacked incentives not to break out of agreements (Hallenstvedt, 1982).

In order for the minimum prices to be enforced, protection by the law was required. In the 1938 the Rawfish Act was passed which ensured that exported fish had to be bought through a sales organization. This act implied that all buyers of fish had to get a permission through this sales organization to buy fish. In addition, the sales organization was entitled to set a minimum price in negotiation with the buyers. The Fishermen Sales Organization (Norges Råfisklag) was established and the first negotiations took place in 1939.

The purpose of the government acts was to insure reasonable prices to the fishermen during the seasonal fisheries, and insure relatively equal and stable prices along the coast. These acts ensured that the sales organizations were entitled to set the minimum prices and sales terms ("råfiskloven," n.d.). The

minimum price was to be set in negotiation between the fishermen sales organization and the buyer representatives. If they did not agree, then the fishermen sales organizations had the final word. The organizations were also permitted to choose sales forms.

Today, in the Norges Råfisklag district, the fishermen are free to choose the sales form themselves. The most common approach for fresh fish is direct sales between the fishermen and the buyers. Auctions are also organized, but mainly for fish frozen at sea. Another important task of the sale organization is to insure payment for the fishermen; no fish buyer can buy without bank guaranties, securing payment under any circumstance.

The price of cod is usually set in negotiation between the fishermen and the individual buyer of fish. However, the price cannot go below the minimum price negotiated between the fishermen sales organization and the buyers' representatives. This minimum price is protected by law, so that everyone is limited by it. The only situation where the fish can be priced below the minimum price is when the quality is not satisfactory and then the price can be reduced by up to 40%.

To begin with, the Norges Råfisklags district covered the counties from Finnmark in the North, up to and including Sogn og Fjordane in the South. But the fishermen south of Nord-Møre opposed selling through Norges Råfisklag. In 1945, Sunnmøre og Romsdal Fiskesalgslag (SuRoFi) was founded, followed by the constitution of several other organizations further south.

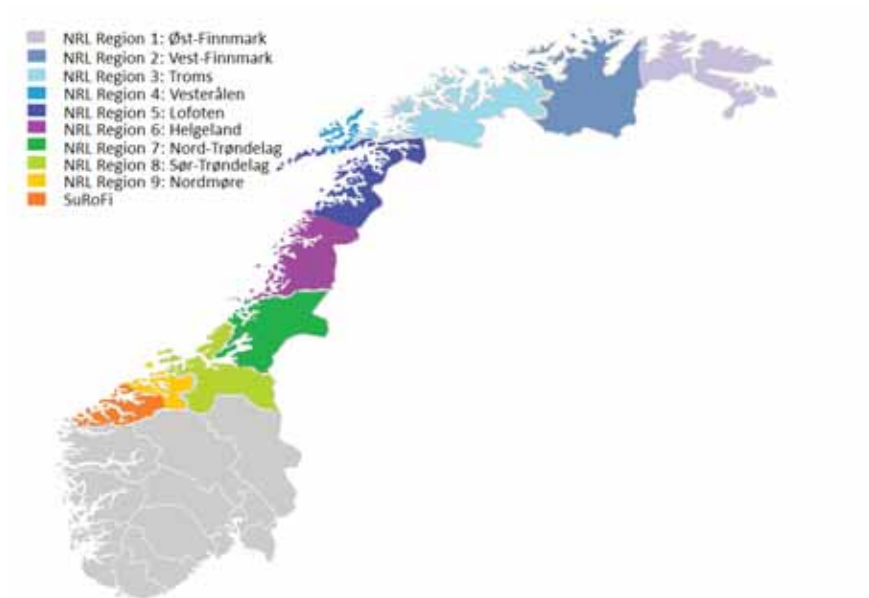


Figure 4 The regions of NRL and SuRoFi

Today, there are six officially approved sales organizations in Norway; one organizing first hand sales of pelagic species⁶ and five⁷ organizing the first hand sales of whitefish and shellfish. The geographical locations of the buyers determine through which sales organization the fish is to be sold. Norges Råfisklag and SuRoFi cover about 90% of all sales of cod. The three remaining sales organizations organizing whitefish sales are omitted from my studies, partly because the quantities are relatively small and because access to data is not easily available.

⁶ Norges Sildesalgslag

⁷ Norges Råfisklag, Sunnmøre og Romsdal Fiskesalgslag, Vest-Norges Fiskesalgslag, Rogaland Fiskesalgslag and Skagerakfisk.

The herring-act (sildeloven) of 1929 and the Rawfish-act of 1938 were replaced by a new rawfish-act in 1951. This act was replaced by a fish sales-act (fiskesalgslagsloven) of 2014, which is the current act. This new act requires the parties to undergo mediation in the cases they disagree, but the final decision is still with the sales organization. The new act also emphasizes stronger requirements for the minimum price to be market based. The goal is to insure a reasonable and fair distribution of revenue along the value chain. In addition, both parties are required to submit sufficient evidence of their views in the negotiations.

The sales organizations have always been challenged and there is opposition against them. Some have challenged the fact that the sales organizations are owned solely by the fishermen and have pointed out the imbalance in the fact that only one party has the protection of the law in imposing rules on their business counterpart. A banker in Tromsø claims that, "Råfiskloven is the ancestral sin of the fish buyers" (Nilsen, 2012. p. 232)⁸. Others have suggested that the minimum price is set by an independent third party (Nærings- og fiskeridepartementet, 2014).

3.1.4 Regulations today

Today the Norwegian fishing fleet consist of about 1900 vessels (Nærings- og fiskeridepartementet, 2014). The structure of the fleet is heterogeneous, from small boats up to ocean-going vessels and with a wide variety of different

⁸ The banker was Nils Peder Beck, according to Øystein Jørgensen, a former fish buyer interviewed in the book.

gears. The most common gears in the coastal fleet are handline, line, gillnet and Danish seine. The ocean-going fleet uses longline and trawl. Trawlers were already in use in the 16th century, but with hand-held equipment and only in small scale (Jenssen, 2012). The coastal fleet was opposing it, and the use of trawlers was restricted by law in 1939 (Finstad et al., 2012). However, with need to serve the fillet industry and with the increasing number of foreign trawlers in the Norwegian waters, the act was softened. However, several trawlers today are bound by a *supply obligation*. When allocated a permission to trawl, some are obliged to deliver the catch, or part of the catch to a certain company, commune, district, region or a county. These companies has to have local production and the aim is ensure local processing, in particular out of the main season (“Leveringsvilkår,” n.d.).

There are several regulations and incentive schemes related to the fleet, where the purpose is to smooth the season, securing jobs and rewarding quality among others. The *quota bonus* is a regulation whose purpose is to stimulate the catch of live cod. In theory the quota bonus allows the fisherman to catch twice as much of his existing quota. Another regulation is the *district quota* whose main purpose is to smooth the season and secure raw material to fish processors in the districts. It requires that the fish be landed fresh and that the receiving sites have to process them. This quota had little effect and was abandoned for the coastal fleet, which instead took up the *bycatch arrangement* to stimulate an increased catch of saithe, haddock and cod in the fall. Finally, the *fresh catch quota* gives trawlers and vessels over 21 meters extra quotas if they deliver fresh cod; this was established to give incentives to deliver fresh raw material outside the main season.

In addition, the fishery is regulated by quota. The first quota restrictions applied to only some fisheries, primarily the ocean-going fleet. The coastal fleet could operate almost without restriction up to the 1990s when the North-East Atlantic cod stock was weakened (“Norsk fiskerihistorie,” n.d.). The weakened stock led to a sharp decrease in the quota, which in turn led to a crisis in coastal fisheries. Conflict increased over the allocation of quotas between the coastal and the ocean-going fleet. Through the sales organizations, the fishermen suggested creating a trawl-ladder, which then was implemented by the government. The trawl-ladder has been developed so that when the total quota decreases, the share to the coastal fleet increases and, with an increasing quota, the share to the trawlers has increased.

The Norwegian fishing fleet has changed significantly over the last decades, which has led to a rapid decrease in the number of vessels. The vessels are getting bigger and new regulations have had to be implemented. Initially the size of the allocated quotas were related to the size of the vessel, but owing to over-capacity for some vessels and under capacity for other vessels, not all the quota of fish was caught. Several attempts were made to resolve this problem, including an overbooking system increasing the individual vessel quotas to ensure that it is bigger than the Total Allowable Catch (TAC). There was clearly a need for restructuration of the coastal fleet to towards fewer and bigger vessels. Hence for a time fishermen that replaced the their smaller vessels with a bigger vessel (up to 28 meters), would get a new quota according to the length of the new vessel. This led to an increase in the number of bigger vessels within the coastal fleet. The overbooking system in conjunction with decreasing quotas in the 1990s led to conflicts between the smaller and bigger vessels within the fleet. In order to insure an equal division

of quota and reduce the rate of overbooking, the coastal fleet was divided into four distinct length groups according to the “Finnmark-model”. Finally, a structure quota has been introduced, which allowed quotas from several vessels to be merge into one vessel, provided that the others were taken out of active fishing (Standal, Sønvisen, & Asche, 2016). The division of the quota to day is about 65% to the conventional fleet and 35% to the trawling fleet, where the majority of the quota in the conventional fleet is allocated to the coastal-fleet.

The gear types used are also changing towards the more cost efficient gears, such as gillnet and Danish Seine at the expense of mainly line. The latter has lower catch rates of cod and the alternative costs are higher compared to alternative gears (Grundvåg & Henriksen, 2011). There is also an increase in the number of vessels with onboard freezing capacity, especially amongst the trawlers, but also among the larger vessels in the coastal fleet. Standal et al. (2016) discuss how larger coastal vessels increasingly blur the difference between the two fleets. Currently, the only regulated difference between the coastal fleet and the ocean-going fleet seems to be the cargo capacity; the cod trawler can have up to 2500 cubic meters, while the coastal fleet up to 500 cubic meters (Nærings- og fiskeridepartementet, 2014).

3.1.5 Product Forms

Since the 10th century, there has been substantial production of stockfish (dried cod) in Lofoten. The production was run by the fishermen themselves, drying the cod on fish flaks (fiskehjell). Not until the 19th century, the

production of clipfish (dried and salted) was initiated. Being that the clipfish was quite production intensive, the fishermen no longer processed the fish themselves (Fulsås, 1996). This is the first separation of fishery and processing; from this point it was primarily the fish buyers taking charge of the processing. For a long time, there were only two groupings in the Norwegian fisheries; fishermen and fish buyers until far into the 20th century. The codfish processors, as an independent industry group, first organized themselves in 1935 (Hallenstvedt, 1982).

The Germans were the first to start inside drying clipfish were in the beginning of the 20th century (Jenssen, 2012). Soon the Norwegians had to follow, with the first indoor drying facility established in Ålesund⁹ in 1919. Today, all the drying of clipfish is performed indoors. From the end of the 19th century, Norway was the largest exporter of clipfish and stockfish (Fulsås, 1996).

⁹ A city located on the west coast of Norway.

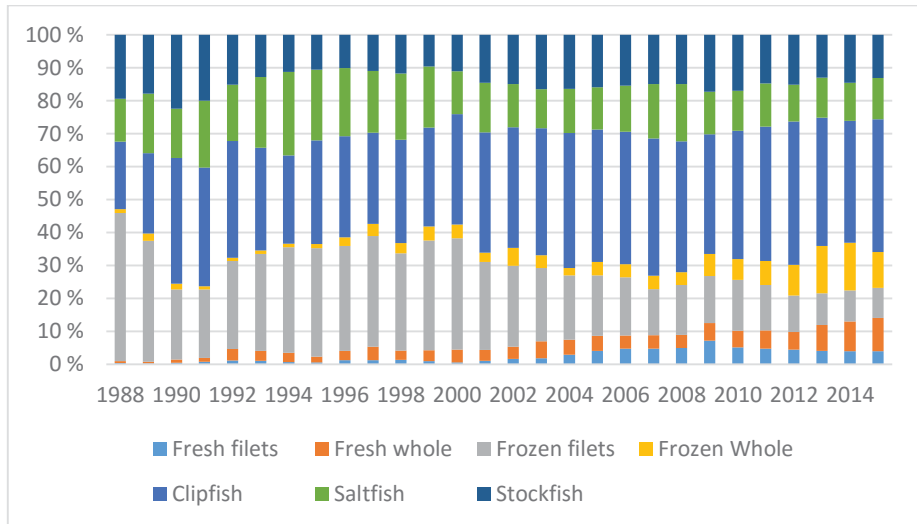
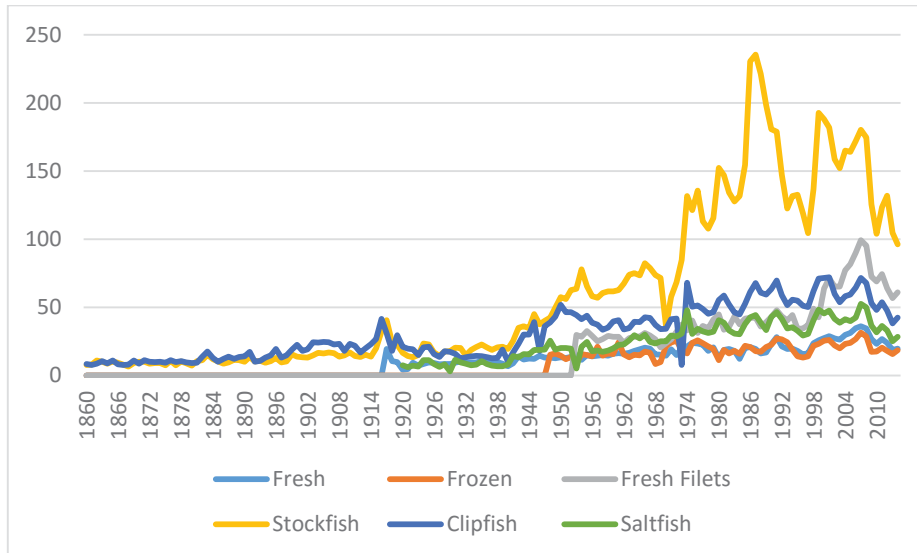


Figure 5 Share of Cod Products exported from Norway, 1988-2014

As a tool in the modernization of northern Norway, filleting was introduced as the main processing method for whitefish. At the beginning of the 20th century, one could observe the Englishmen, with a far smaller catch, extracting a lot more value from the cod than the Norwegian fishermen were able to (Finstad et al., 2012). The conventional production of clipfish and stockfish was considered old-fashioned as it served the countries with a lower willingness to pay. The filet industry was never profitable and had to compete with other substitutes and lower producing cost in other countries (Finstad et al., 2012; Nærings- og fiskeridepartementet, 2014). Despite the political support and subsidies for filet production from the beginning of the 20th century, their market share is now very low. The number of Norwegian companies producing fillets has sunk from about a 100 in the 1970s to 10 in 2012 (Finstad et al., 2012).

The Norwegian Cod Fishery



Figur 6 Prices of Cod Products exported from Norway, 1860-2014, real prices

Despite earlier attempts to alter production towards more filets, the majority of the production today goes into clipfish, salted and stockfish, see figure 5. In addition some of the cod is also exported whole and frozen. From figure 6 it can be seen that the conventional products receives the highest prices. The fish is either exported to the markets or for further processing before it enters the new markets. Nonetheless, the majority of the Stockfish is produced in Lofoten. In total there are about 50 Stockfish producers. The fish is hung out to dry until it reaches the preferred water content. The main market is Italy, but Africa is also important. The clipfish is salted for a period before it is dried to achieve a desired level of water content. The most important market is Portugal. Today clipfish and saltfish are most important products, followed by frozen cod, which is directly exported without further processing. Around 100 companies in Norway produce salt fish from the north to the south of the

Norwegian coast. About 35 produce clipfish, and more than half of the total clipfish production is done by 3-4 companies on the coast of Møre. The production of clipfish is based both on fresh and frozen cod, while stochfish is produced only from fresh cod.

Both the clipfish and stochfish are sorted into different grades and sizes before being exported. Some parts of the market are very particular about the demands concerning quality attributes. For instance, some clients in Italy will only buy line-caught cod with the best quality (Jenssen, 2012).

3.2 The Global Market for Cod

There is a big interest in market integration studies; for cod and whitefish there are numerous studies investigating the level of market integration across borders, different levels of the value chain and between different species and product forms (Asche et al., 2004; Asche, Gordon, et al., 2002; Gordon & Hannesson, 1996; Nielsen et al., 2009; Nielsen, 2005). Over the last decades several studies have investigated the market for cod and other whitefish. Gordon & Hannesson (1996) have tested for short- and long-run linkages between the prices of fresh and frozen cod fish in Europe and U.S. They found no evidence of price linkage between fresh cod in U.S. and Europe, but they found evidence of a global market for frozen cod fillets.

In addition, Asche et al. (2002) found that there is a well-integrated European market for different species of whitefish. In the same study they investigated and found no evidence of a single market for salmon and whitefish. In 2004, the same authors found that whitefish species in France belong to the same

market (Asche et al., 2004). Nielsen et al. (2009) also found a partly integrated market for fresh whitefish in Europe, and with cod as a market leader in the whole fresh fish market. Finally, Helstad, Vassdal, Trondsen, & Young (2005) tested for market integration between direct sales and auction sales of fresh and frozen fish at the ex-vessel level in Norway, finding that they are integrated. Nielsen (2005) concludes that there is a well-integrated first-hand market for whitefish between Norway, Iceland, Denmark, UK and Sweden.

Asche et al. (2002) study price transmission and relationships between prices at different levels of the market. They found that the ex-vessel price of cod in Norway is fully integrated with fresh and dried salted cod prices at the export level. There is also evidence that price signals are transmitted between the cod retail price in Portugal and the ex-vessel price of cod in Norway; they also between retail cod in Portugal and dried salted cod exported from Norway (Asche et al., 2007).

In conclusion, there is evidence of a global market for cod and other whitefish, while it has been shown that price signals travel between the different levels of the markets.

3.3 Price Differences Associated with the Quality of Cod

There has also been an increasing interest in the hedonic price models within cod and whitefish markets, where attributes such as freshness, sizes, labeling and many others have also been investigated. The hedonic price model has been applied to both to first-hand and retail level.

Kristofersson & Rickertsen (2004, 2007) and investigated premiums for cod at Icelandic fish auctions and found premiums for bigger sizes and discount for storage. Asche et al. (2015) have investigated the value of different attributes of ex-vessel cod, landing spot, sizes, seasons, gear types, seasons in one Norwegian region. They found that size is the most important factor in pricing; in addition, they found evidence of heterogeneity in attributes between different landing spots. J. Blomquist, Bartolino & Waldo (2015) have also found significant premiums for different size groups for Baltic Cod in Sweden. However the smaller cod received the highest premium, unless it was of high quality then the bigger cod received a higher premium. Thus, contrary to several findings at the retail level, they found no price premium for eco-labelling. Hammarlund (2015) has also found that the larger cod sizes received the highest premiums. Meanwhile, Lee (2015) has estimated the value of attributes such as size, freshness and gear at the wholesale fish auction in Northeast U.S. He finds that there are premiums for gears, such as handline, longline and trawl relative to gillnet-caught cod.

Roheim, Gardiner & Asche (2007) estimated the value of brands and other attributes at different retailers in the U.K. and found that cod was among the higher valued species. Sogn-Grundvåg et al. (2013) investigated the value of attributes among other chilled cod in U.K. supermarkets and found significant premiums for line-caught fish, but also differences between supermarkets. Bronnmann & Asche (2016) found that consumers in Germany are willing to pay more for cod than for salmon.

From these studies it seems that, in general, the larger sizes pay off, freshness and quality is rewarded, but there is heterogeneity in pricing between regions,

both at the retail and first-hand level. In addition, premiums exist for eco-labeling at the retail level which is not found at the first-hand level.

4. Summary of the Papers in the Dissertation

This dissertation consists of four papers, all related to the study of the price formation in the first-hand market for cod in Norway. The first paper uses the Johansen cointegration method (Johansen & Juselius, 1990) to study the level of market integration between the different regions in the Råfisklaget district and SuRoFi, and for market integration between fresh and frozen cod at the same level. Finally, this paper investigates whether a leading market or product exists. The second paper uses the same data and a hedonic price model to evaluate the different attributes of fresh and frozen cod at the ex-vessel level, attributes such as gear type used, where the fish is landed, with size in the different regions. The third paper employs the Lewbels Generalized Composite Commodity Theorem (GCCT) to evaluate whether the different product forms of cod at the Norwegian export level might be viewed as one commodity - "cod". The relationship between the exported "cod" and the first hand price of cod is estimated by the means of Granger Causality. Finally, we investigate whether there are asymmetries in the price signals. The fourth and final paper investigates the relationship between the exported "cod" commodity found in the third paper and the minimum price for first hand cod, using two approaches. First, we investigate to what degree changes in market prices affect the level of the minimum price in the following period. Secondly, we estimate the effect of a cod price index (from paper 3), as well as the exchange rate, labor and transport cost index on the margin between the first-hand price and the minimum price.

4.1 “Testing for Market Integration between Ex-vessel Markets for Cod in Norway”

Several studies has found that there exist a global market for whitefish (Asche, Gordon, et al., 2002; Gordon & Hannesson, 1996; Nielsen et al., 2009), in particular the relationship between cod and other whitefish species has been investigated (Asche et al., 2004; Asche, Gordon, et al., 2002; Gordon & Hannesson, 1996; Nielsen, 2005; Nielsen et al., 2007, 2009). In addition, there has been some focus on the Norwegian market for cod, both at the first-hand, export level and across the supply-chain (Asche et al., 2015; Asche et al., 2004, 2007; Asche et al., 2002). In this paper we use highly disaggregated data and investigate the level of market integration between 10 different ex-vessel markets for fresh cod in Norway, operated by two different sales organizations. This paper will thus also answer whether these two sales organizations leads to different price determination processes.

Finally, we also investigate the relationship between fresh and frozen cod; this is of interest as fresh cod is a highly perishable good, while frozen cod is storable and the market for frozen cod is quite well-functioning (Helstad et al., 2005). All the price series are non-stationary, thus using the Johansen cointegration method (Johansen & Juselius, 1990) and conduction pairwise and multivariate cointegration tests. By adding restrictions on the cointegration vectors we were able to test whether the Law of One Price (LOP) holds. In addition, by adding restrictions on the adjustment parameters, we tested whether there was one price being determined outside the system, hence leading the other prices. We found evidence of an integrated market for fresh cod in Norway, between all regions and both organizations. However,

the market is not fully integrated (the LOP doesn't hold for all regions), but there is evidence of fully integrated markets between the five northernmost regions.

We also found that the market for fresh and frozen cod is integrated, but the LOP doesn't hold. In addition, the frozen cod price leads the price of fresh cod. This finding is in line with Asche, Menezes, and Dias (2007) who found that the cod price is determined at the trade level for frozen cod. Hence, there is evidence that the price of cod in Norway is being determined on a global market level.

4.2 “Hedonic Price Analysis of Ex-vessel Cod in Norway”

Lately, more and more studies have been using the hedonic price model to estimate price differences for attributes in integrated markets for seafood; these are attributes such as size, quality, processing and so on. Several studies has focused on the cod price both at retail level (Bronnmann & Asche, 2016; Roheim et al., 2007; Sogn-Grundvåg et al., 2013) and at the level of first-hand markets (Asche et al., 2015; J. Blomquist et al., 2015; Hammarlund, 2015; Kristofersson & Rickertsen, 2004, 2007). These differences primarily focus on differences in product space; however (Asche et al., 2015) also found heterogeneous pricing between different communities at the first-hand level in the northernmost region in Norway. In this study we used the same disaggregated data, as in the first paper, for cod landings in different regions in Norway, allowing us to further investigate whether there is evidence of heterogeneous pricing between regions. We used the Hedonic price model as

outlined by Lancaster (1966) and decomposed the cod price by its attributes; its size, quality, gear type and processing form. An F-test indicates that fresh and frozen cod are separate products; hence they were modeled separately.

Moreover, to account for the fact that attributes can influence each other, we include interaction terms in particular to capture potential variation between regions. The results largely conform to the findings of earlier literature, where there are price differences associated with quality, gears, sizes and so on. In addition, we find that there the different regional markets value the attributes differently. Hence, there evidence that this market is heterogeneous, in geographical space as well, and this is particularly interesting in light of discussions around the sales organizations setting minimum prices. The finding of heterogeneous pricing between regions confirms the findings of (Asche et al., 2015) that the minimum price cannot be binding.

4.3 “A cod is a cod, but is it a Commodity?”

All the cod trade at the first-hand level is organized through sales organizations. These sales organizations are entitled to set minimum prices, which are set in negotiations with industry representatives. The new legislation of 2014 required the minimum price to be market based.

The majority of the cod in Norway is caught fresh and delivered gutted, without head. Despite some evidence of heterogeneous pricing between regions (Asche & Pettersen, 2015), the first hand cod is a quite homogenous product compared to the cod that leaves Norway. Cod is exported in several

different product forms, such as fresh, frozen, salted, salted and dried, and dried. This makes the comparison between the first-hand price and the export price difficult.

Using Lewbel's Generalized Composite Commodity Theorem (GCCT) (Lewbel, 1996), we conducted an empirical test of whether the seven major product forms of exported cod products could be aggregated into one representative price index, finding that they could. In addition, using the Johansen cointegration test (Johansen, 1991; Johansen & Juselius, 1990) we found that the first-hand price of cod and the cod index form a stable long-term relationship. Furthermore, the first-hand price of cod is Granger-causing the export price (Granger, 1969) and not the other way around. Finally, we found asymmetry in the price transmission, where price increases at the first-hand level were transmitted to the market price twice as fast as a decrease in price.

So – is a cod a commodity? Yes! The finding of this representative index could be important in helping the decision makers to set the correct minimum price.

4.4 “The Cod and the Minimum Price”

The fishermen's sales organizations have legally set minimum prices since their establishment in 1938. The reason was the need to protect the fishermen against extremely volatile and low prices, especially during the main season where there are a lot of fishermen eager to sell their fish. In addition, too many exporters coupled with a crisis in the market have led the exporters to underbid each other, leaving even less for the fishermen (Hallenstvedt, 1982).

There are ongoing discussions which questions the sales organizations right to set minimum prices and also questions their ownership (they are owned by the fishermen). Pettersen & Myrland (2016) found that the first-hand price of cod is Granger-causing the market price. In addition, we have found asymmetry in the price transmission, where price increases were transferred faster than the price decreases. It was questioned whether this asymmetry could be explained by some power with the fishermen's sales organization beyond setting the minimum price.

In this paper we have used the seven major exported product forms of cod (as in Pettersen & Myrland (2016)) and modeled how these market prices influenced the minimum price. We found a link between most of the market prices, indicating that the level of the minimum price is in fact set using market prices. Furthermore, we have found high correlation between the minimum price and the first-hand prices indicating that they were basically the same price in different level. Thus we have used the Fisher index from Pettersen & Myrland (2016) together with exchange rate effect, a transport and labor index and monthly dummies, to estimate the effect of these on the margin between the minimum price and the first-hand price. The effect of the market price (Fisher Index) was the largest, to find that the price signals in the market are transmitted in a 1:1 relationship.

5. References

- Agriculture in Brazil. (2016). Retrieved April 10, 2016, from https://en.wikipedia.org/wiki/Agriculture_in_Brazil
- Akse, L., Joensen, S., & Tobiassen, T. (2014). *Kvalitetsstatus for råstoff av torsk og hyse - Registrering av fangstskader og kvalitetsfeil i 2014. Nofima Report*. Retrieved from <http://nofima.no/en/pub/1201293/>
- Asche, F., Bremnes, H., & Wessells, C. R. (1999). Product Aggregation, Market Integration, and Relationships between Prices: an Application to World Salmon Markets. *American Agricultural Economics Association*, 81, 568–581.
- Asche, F., Chen, Y., & Smith, M. D. (2015). Economic incentives to target species and fish size: prices and fine-scale product attributes in Norwegian fisheries. *ICES Journal of Marine Science*, 2.
- Asche, F., Flaaten, O., Isaksen, J. R., & Vassdal, T. (2002). Derived demand and relationships between prices at different levels in the value chain: A note. *Journal of Agricultural Economics*, 53(1), 101–107.
- Asche, F., Gjølberg, O., & Guttormsen, A. G. (2012). Testing the central market hypothesis: A multivariate analysis of Tanzanian sorghum markets. *Agricultural Economics*, 43, 115–123.
- Asche, F., Gordon, D. V., & Hannesson, R. (2004). Tests For Market Integration and the Law of One Price : The Market For Whitefish in France University of Calgary. *Marine Resource Economics*, 19, 195–210.
- Asche, F., Gordon, D. ., & Hannesson, R. (2002). Searching for price parity in the European whitefish market. *Applied Economics*, 34(1969), 1017–1024.
- Asche, F., Larsen, T. a., Smith, M. D., Sogn-Grundvåg, G., & Young, J. a. (2015). Pricing of eco-labels with retailer heterogeneity. *Food Policy*, 53, 82–93.
- Asche, F., Menezes, R., & Dias, J. F. (2007). Price transmission in cross boundary supply chains. *Empirica*, 34(5), 477–489.

References

- Asche, F., & Pettersen, I. K. (2015). Hedonic Price Analysis of Ex-vessel cod in Norway. *Not Published*.
- Asche, F., Salvanes, K. G., & Steen, F. (1997). Market delineation and demand structure. *American Journal of Agricultural Economics*, 79, 139–50.
- Blomquist, G. C., Berger, M. C., & Hoehn, J. P. (1988). New Estimates of Quality of Life in Urban Areas. *The American Economic Review*, 78(1), 89–107.
- Blomquist, J., Bartolino, V., & Waldo, S. (2015). Price Premiums for Providing Eco-labelled Seafood: Evidence from MSC-certified Cod in Sweden. *Journal of Agricultural Economics*, 66(3), 690–704.
- Bowman, K. R., & Ethridge, D. E. (1992). Characteristic Supplies and Demands in a Hedonic Framework: U.S. Market for Cotton Fiber Attributes. *American Journal*, 74(4), 991–1002.
- Bronnmann, J., & Asche, F. (2016). The Value of Product Attributes, Brands and Private Labels: An Analysis of Frozen Seafood in Germany. *Journal of Agricultural Economics*, 67(1), 231–244.
- Carew, R. (2000). A hedonic analysis of apple prices and product quality characteristics in British Columbia. *Canadian Journal of Agricultural Economics-Revue Canadienne D Agroeconomie*, 48(3), 241–257.
- Chaloupka, F. J., & Wechsler, H. (1995). *Price, Tobacco control policies and smoking among young adults* (No. 5012). Cambridge.
- Cobb, S. (1984). The Impact of Site Characteristics Cost Estimates. *Journal of Urban Economics*, 15, 26–45.
- Combris, P., Lecocq, S., Visser, M., Journal, T. E., & Mar, N. (2008). Estimation of a Hedonic Price Equation for Bordeaux Wine: Does Quality Matter? *The Economic Journal*, 107(441), 390–402.
- Cournot, A. (1838). *Researches into the mathematical principles of the theory of wealth*. London: The Macmillan Company.
- Deaton, A., & Muellbauer, J. (1980). An Almost Ideal Demand System. *The American Economic Review*, 70(3), 312–326.
- Egeness, F., Bendiksen, B. I., Nilssen, F., & Nøstvold, H. (2011). *Fersk fisk fra Nord-Norge til Europa- Forutsetninger, vareflyt, barrierer og*

- markedsmuligheter. Nofima Report*. Retrieved from [http://www.nofima.no/filearchive/Rapport 19-2011.pdf](http://www.nofima.no/filearchive/Rapport%2019-2011.pdf)
- Engle, R. F., Hendry, D. F., & Richard, J.-F. (1983). Exogeneity. *Econometrica*, *51*(2), 277–304.
- Feighery, E. C., Ribisl, K. M., Schleicher, N. C., Zellers, L., & Wellington, N. (2005). How do minimum cigarette price laws affect cigarette prices at the retail level ? *Tobacco Control*, *14*, 80–85.
- Finstad, B. P., Henriksen, E., & Holm, P. (2012). Fra krise til krise – forventninger og svik i norsk fiskerinæring *. *Økonomisk Fiskeriforskning*, *22*(1), 33–54.
- Fox, R. (1979). Brazil's Minimum Price Policy and the Agricultural Sector of Northeast Brazil. *International Food Policy Research Institute (IFPRI)*, *9*.
- Fulsås, N. (1996). Kvifor fekk ikkje industrikapitalismen fotfeste i Nord-Norge? In E. O. Eriksen (Ed.), *Det nye Nord-Norge - Avhengighet og modernisering i Nord* (pp. 39–66). Bergen: Fagbokforlaget Vigmostad & Bjørke.
- George, P. S., & King, G. A. (1971). *Consumer Demand for Food Commodities in the United States with Projection for 1980. Monograph* (Vol. 26).
- Goodwin, B. K., & Holt, M. T. (1999). Price Transmission and asymmetric adjustment in the U.S. beef sector. *American Journal of Agricultural Economics*, *81*, 630–637.
- Gordon, D. V, & Hannesson, R. (1996). On Prices of Fresh and Frozen Cod Fish in European and U . S . Markets The University of Calgary. *Marine Resource Economics*, *11*(1993), 223–238.
- Granger, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica*, *37*(3), 424–438. doi:10.2307/1912791
- Grether, D. M., & Mieszkowski, P. (1974). Determinants of real estate values. *Journal of Urban Economics*, *1*(2), 127–145.
- Grundvåg, G. S., & Henriksen, E. (2011). Markedssvikt på første hånd. *Økonomisk Fiskeriforskning*, *21*(1), 60–69.
- Hallenstvedt, A. (1982). *Med lov og organisasjon*. Tromsø:

Universitetsforlaget.

- Hammarlund, C. (2015). The big, the bad, and the average: Hedonic prices and inverse demand for Baltic cod. *Marine Resource Economics*, 30(2), 157–177. doi:10.1086/679972
- Hannesson, R., Salvanes, K. G., & Squires, D. (2010). Technological change and the tragedy of the commons: The Lofoten fishery over 130 years. *Land Economics*, 86(November), 746–765.
- Helstad, K., Vassdal, T., Trondsen, T., & Young, J. A. (2005). Price Links between Auction and Direct Sales of Fresh and Frozen Fish in North Norway (1997 – 2003). *Marine Resource Economics*, 20, 305–322.
- Henriksen, E. (2013). *Lønnsom foredling av hvitfisk i Norge – hva skal til ? Oppsummering av foredragsserie holdt for LO , supplert med relevant litteratur. Nofima Report*. Retrieved from <http://brage.bibsys.no/xmlui/handle/11250/284045>
- Henriksen, E., & Sogn-Grundvåg, G. (2011). *Linefisk fra kystflåten: Høyt etterspurt i markedet, men kan vi levere? Nofima Report*. Retrieved from <http://www.nofima.no/filearchive/Rapport 49-2010.pdf>
- Henriksen, E., & Svorken, M. (2011). *Fangstregulering og råstoffkvalitet i kystflåten - ferskt råstoff til fiskeindustrien i Nord-Norge. Nofima Report*. Retrieved from <http://www.nofima.no/filearchive/Rapport 25-2011.pdf>
- Jensen, F. A. (2012). *Torsk Fisken som skapte Norge*. Oslo: Kagge Forlag AS.
- Johansen, S. (1991). Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models. *Econometrica*, 59(6), 1551–1580.
- Johansen, S., & Juselius, K. (1990). Maximum Likelihood estimation and inference on cointegration - with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52(2), 169–210.
- Johnston, R. J., Wessells, C. R., Donath, H., & Asche, F. (2001). Measuring Consumer Preferences for Ecolabeled Seafood: An International Comparison. *Journal of Agricultural and Resource Economics*, 26(1), 20–39.

- Juselius, K. (2006). *The cointegrated var model, methodology and applications*. Oxford University Press.
- Kain, J. F., & Quigley, J. M. (1970). Measuring the Value of Housing Quality. *Journal of the American Statistical Association*, 65(330), 532–548.
- Kinnucan, H. W., & Forker, O. D. (1987). Assymetry in Farm-Retail Price Transmission for Major Dairy Products. *American Journal of Agricultural Economics*, 69, 285–292.
- Kristofersson, D., & Rickertsen, K. (2004). Efficient estimation of hedonic inverse input demand systems. *American Journal of Agricultural Economics*, 86(November), 1127–1137.
- Kristofersson, D., & Rickertsen, K. (2007). Hedonic price models for dynamic markets. *Oxford Bulletin of Economics and Statistics*, 69(3), 387–412.
- Lancaster, K. J. (1966). A New Approach to Consumer Theory. *The Journal of Political Economy*, 74(2), 132–157.
- Larsen, T. A., & Dreyer, B. (2012). *Norske torske trålere - Struktur og lønnsomhet. Nofima Report*. Retrieved from [http://www.nofima.no/filearchive/Rapport 12-2012.pdf](http://www.nofima.no/filearchive/Rapport%2012-2012.pdf)
- Lee, M. (2015). Hedonic Pricing of Atlantic Cod: Effects of Size, Freshness, and Gear. *Marine Resource Economics*, 29(3), 259–277.
- Leveringsvilkår. (n.d.). Retrieved March 8, 2016, from <https://www.regjeringen.no/no/tema/mat-fiske-og-landbruk/fiske-og-havbruk/fiskeflaten-listeside/leveringsvilkar/id434502/>
- Levy, D., Bergen, M., Dutta, S., & Venable, R. (1997). The magnitude of menu costs: direct evidence from large U.S. supermarket chains. *The Quarterly Journal of Economics*, 112, 791–825.
- Lewbel, A. (1996). Aggregation Without Separability: A Generalized Composite Commodity Theorem. *American Economic Review*, 86(3), 524–543.
- Lorentzen, L. T., Ottesen, G. G., Grønhaug, K., & Svorken, M. (2006). Hvilke utfordringer opplever bedriftene? *Økonomisk Fiskeriforskning*, 16, 39–47.
- Loureiro, M. L., McCluskey, J. J., & Mittelhammer, R. C. (2002). Will

References

- Consumers Pay a Premium for Eco-labeled Apples? *Journal of Consumer Affairs*, 36(2), 203–219.
- Marshall, A. (1920). *Principles of Economics* (8th ed.). London: Macmillan and Co.
- Minimum pricing for alcohol could be illegal – but Ireland’s pressing ahead. (2015). Retrieved March 15, 2016, from <http://www.thejournal.ie/alcohol-minimum-pricing-european-court-2517139-Dec2015/>
- Nerlove, M. (1995). Hedonic price functions and the measurement of preferences: The case of Swedish wine consumers. *European Economic Review*, 39(9), 1697–1716.
- Nielsen, M. (2005). Price Formation and Market Integration on the European First-hand Market for Whitefish. *Marine Resource Economics*, 20, 185–202.
- Nielsen, M., Setälä, J., Laitinen, J., Saarni, K., Virtanen, J., & Honkanen, A. (2007). Market Integration of Farmed Trout in Germany. *Marine Resource Economics*, 22(2), 195–213.
- Nielsen, M., Smit, J., & Guillen, J. (2009). Market integration of fish in Europe. *Journal of Agricultural Economics*, 60(2), 367–385.
- Nilsen, R. (2012). *Havets gull. Fiskekjøpere i Nord-Troms og Finnmark*. Fiskekjøpernes Fond, Lundblad Media AS.
- Norsk fiskerihistorie. (n.d.). Retrieved March 9, 2016, from https://snl.no/Norsk_fiskerihistorie#menuitem7
- Norske subsidier er sløsing. (2010). Retrieved April 10, 2016, from <http://forskning.no/landbruk-landbrukspolitik-ekonomi/2010/09/norske-subsidier-er-slosing>
- Nærings- og fiskeridepartementet. (2014). *Sjømatindustrien - Utredning av sjømatindustriens rammevilkår (NOU 2014:16)*.
- Oczkowski, E. (2001). Hedonic Wine Price Functions and Measurement Error. *The Economic Record*, 77(239), 374–382.
- OECD: Ingen subsidierer landbruket sitt så mye som Norge. (2013). Retrieved March 15, 2016, from

References

- <http://www.dn.no/nyheter/politikkSamfunn/2013/09/18/oecd-ingen-subsidierer-landbruket-sitt-sa-mye-som-norge>
- Pettersen, I. K., & Myrland, Ø. (2016). A cod is a cod, but is it a Commodity? *Forthcomming: Journal of Commodity Markets*.
- Pomorhandel. (n.d.). Retrieved March 8, 2016, from <https://no.wikipedia.org/wiki/Pomorhandel>
- Ravallion, M. (1986). Testing Market Integration. *American Journal of Agricultural Economics*, 68, 102–9.
- Regulering og lovgivning i lofotfiske. (n.d.). Retrieved March 12, 2016, from <http://www.kyst-norge.no/?k=2909&id=14143&aid=6789&daid=1978>
- Roheim, C. A., Asche, F., & Santos, J. I. (2011). The Elusive Price Premium for Ecolabelled Products: Evidence from Seafood in the UK Market. *Journal of Agricultural Economics*, 62(3), 655–668.
- Roheim, C. A., Gardiner, L., & Asche, F. (2007). Value of Brands and Other Attributes : Hedonic Analysis of Retail Frozen Fish in the UK. *Marine Resource Economics*, 22, 239–253.
- Rosen, S. (1974). Hedonic Prices and Implicit Markets : Product Differentiation in Pure Competition. *The Journal of Politcal Economy*, 82(1), 34–55.
- råfiskloven. (n.d.). Retrieved March 12, 2016, from <https://snl.no/r%C3%A5fiskloven>
- Serra, T., & Goodwin, B. K. (2003). Price transmission and asymmetric adjustment in the Spanish dairy sector. *Applied Economics*, 35(18), 1889–1899.
- Sogn-Grundvåg, G., Larsen, T. a., & Young, J. a. (2013). The value of line-caught and other attributes: An exploration of price premiums for chilled fish in UK supermarkets. *Marine Policy*, 38, 41–44.
- Squires, D., Herrick, S. F., & Hastie, J. (1989). Integration of Japanese and United-States Sablefish Markets. *Fishery Bulletin*, 87(2), 341–351.
- Standal, D., Sønvisen, S. A., & Asche, F. (2016). Fishing in Deep Waters: the development of a deep-sea coastal fleet in Norway. *Marine Policy*, 63(1), 1–7.

References

- Stanley, L. R., & Tschirhart, J. (1991). Hedonic Prices for a Nondurable Good: The Case of Breakfast Cereals. *The Review of Economics and Statistics*, 73(3), 537–541.
- Stigler, G. J. (1969). *The theory of Price*. London: Macmillan.
- Stigler, G. J., & Sherwin, R. A. (1985). The extent of the market. *Journal of Law and Economics*, 28(3), 555–585.
- Stockwell, T., Auld, M. C., Zhao, J., & Martin, G. (2011). Does minimum pricing reduce alcohol consumption? The experience of a Canadian province. *Addicton*, 107, 912–920.
- Studenmund, A. H. (2011). *Using Econometrics, A practical Guide* (6th ed.). Boston: Pearson Education, Inc.
- The Common Agricultural Policy. (n.d.). Retrieved March 17, 2016, from http://www.economicsonline.co.uk/Global_economics/Common_Agricultural_Policy.html
- Tomek, W. G., & Robinson, K. L. (2003). *Agricultural product prices* (Fourth ed.). New York: Cornell University Press.
- Uchida, H., Onozaka, Y., Morita, T., & Managi, S. (2014). Demand for ecolabeled seafood in the Japanese market: A conjoint analysis of the impact of information and interaction with other labels. *Food Policy*, 44, 68–76.
- Uchida, H., Roheim, C. a., Wakamatsu, H., & Anderson, C. M. (2014). Do Japanese consumers care about sustainable fisheries? Evidence from an auction of ecolabelled seafood. *Australian Journal of Agricultural and Resource Economics*, 58(2), 263–280.
- Wessells, C. R., Johnston, R. J., & Donath, H. (1999). Assessing consumer preferences for ecolabeled seafood: the influence of species, certifier, and household attributes. *American Agricultural Economics*, 10(2), 1084–1089.
- Xie, J., & Myrland, Ø. (2011). Consistent Aggregation in Fish Demand: A Study of French Salmon Demand. *Marine Resource Economics*, 26(4), 267–280.

PART II

List of papers

Paper 1

Pettersen, I. K., Asche, F. & Myrland Ø.

“Testing for Market Integration for Ex-vessel Cod between different regions in Norway”

Paper 2

Asche, F. & Pettersen, I. K.

“Hedonic Price Analysis of the Ex-vessel Cod in Norway”

Paper 3

Pettersen, I. K. & Myrland, Ø. (Forthcoming).

“A Cod is a Cod, but is it a Commodity?” *Journal of Commodity Markets*

Paper 4

Myrland, Ø. & Pettersen, I. K.

“The Cod and the Minimum Price”

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