DEPARTMENT OF FOOD AND RESOURCE ECONOMICS
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IFRO Report

Market conditions for organic aquaculture: market and price analysis

RobustFish work package 6.2 report

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SUMMARY

THE VALUE CHAIN, FARM ECONOMIC PERFORMANCE AND PRICE PREMIA

Part 1 of chapter 1 describes in brief some statistics along the value chain for organic aquaculture while highlighting the role of portion sized rainbow trout. We present for Germany, the most important European market and Denmark, an important market for Germany in terms of rainbow trout production. A common observation is that both countries have experienced a growing industry as demand keeps increasing. Fish processors and retailers have expanded their supply portfolio to include organic seafood products, and prices in the retail sector reveals that there is organic fish are premium products serving a niche market. Retail sales show tremendous growth in value and quantities for the case of Denmark. A number of caterers and restaurants are showing growing interest.

In part 2 of chapter 1, the economic performance of organic trout farms are compared to conventional trout and organic agricultural farms. Farm account statistics from Statistics Denmark using financial performance indicators like the degree of profitability and farm solvency ratio show an impressive organic trout sector. Though organic trout farms could not generate enough income from farm assets in 2010 and 2011, they picked up in 2012; the adjusted period. Generally, organic trout farms tend to be equal or better in generating income per unit value of assets and have higher solvency ratios, indicating lower probability of default than alternative conventional trout farms and organic agricultural farms. An average organic trout farm is able to generate incomes of 8% per unit value of assets and a solvency rate of 28% for 2012, a value that economically outperforms other comparable farm units.

In the last part of chapter 1, ecolabeled seafood and agriculture premiums observed in the market and consumers' stated willingness to pay premiums are reviewed. Following is the sensitivity of changes in the price and premiums of ecolabeled seafood. Empirical findings showed that all things being equal, consumers stated willingness to pay reflects in their actual market behavior though they may pay less than stated. Premiums observed in the aquaculture (24-38%) appear to be generally higher than the fisheries (10-13%). Stated premiums for environmentally sound seafood production however ranged from 15-50%. In the agricultural sector, revealed premiums mostly seem to lie in range of 10-50% with few extremes and stated premiums in the range of 4-300%. Fresh and perishable organic food products tend to attract higher premiums. Stated premiums were conditioned on a number of factors but most evident was consumer's level of knowledge about ecolabel programs and the aesthetic quality comparable to conventional products. Though premiums varied by consumer segments, reduction in premiums were associated with increase in the number of consumers eager to switch to organic products. Also ecolabeled agricultural products generally appear to be more elastic than conventional products, an indication that reduction in prices would increase the market demand.

PRICE PREMIUM OF ORGANIC SALMON IN DANISH RETAIL SALE

The year 2016 was pivotal for organic aquaculture producers in EU, because it represented the deadline for implementing the complete organic life cycle in aquaculture production. Depending on the sturdiness of farms already producing, such a shift in the industry may affect production costs of exclusively using organic fry for production. If the profitability of the primary organic

aquaculture producers should be maintained, then farmers must be able to correspondingly receive higher prices, transmitted through the value chain from the retail market. This study identifies the price premium for organic salmon in Danish retail sale using consumer panel scanner data from households by applying a random effect hedonic price model that permits unobserved household heterogeneity. A price premium of 20% was identified for organic salmon. The magnitude of this premium is comparable to organic labeled agricultural products and higher than that of eco-labelled capture fishery products, such as the Marine Stewardship Council. This indicate that the organic label also used for agricultural products may be better known and trusted among consumers than the eco-labels on capture fishery products.

HETEROGENEOUS PREFERENCES, INFORMATION, AND KNOWLEDGE FOR ORGANIC FISH DEMAND

The past decades have experienced growing demand for ecolabels displaying environmental and sustainability information, with associated price premiums. With growing number of ecolabels in the markets, strategic positioning is required to attract value. Nevertheless, consumer preference for other attributes, for example, local products appears to be overshadowing the value for ecolabels. A suitable communication and education strategy for consumers is warranted to counteract this effect. Using stated choice experiment, we test for the effect of different types of information regarding organic aquaculture production principles on the demand for portion size trout in the German market, while considering other important product attributes. The results indicate that consumers prefer organic produced trout to conventional, and ASC certified trout is seen identical to the conventional product in the status quo market. Influencing the market by providing information for consumers related to feed; stocking density; antibiotics use; and GMO, hormones and synthetic additives while linking to environmental, animal welfare concerns or combination of both reveals that, the preference for environmental is identical to the status quo. Animal health and welfare on the other hand increases the preference level and hence, the perceived value. Combination of environmental and animal welfare information shows a decrease from the animal welfare scenario, an indication that too much information claims on what ecolabel represents does overwhelm consumers. The preference for ecolabel is however, found to be inferior to the country of origin, with the highest value attributed to local production from Germany.

DOES ORGANIC SUPPLY GROWTH LEADS TO REDUCED PRICE PREMIUMS? THE CASE OF SALMONIDS IN DENMARK

Consumers buy organic products to increase utility, while farmers invest in organic production to achieve price premiums. However, investors would like to avoid the risk of falling prices when organic supply increases to maintain profit. We suggest the use of market integration tests between non-stationary price series of organic/conventional products to reveal whether increasing organic supply can be expected to reduce price premiums. Increased organic supply will induce price falls if organic/conventional markets are independent. Organic supply growth will leave price premiums unchanged, if prices move together over time, since conventional supply typically is larger than organic. The method is applied to the Danish market for farmed salmonids. Cointegration is identified up- and down-stream, while the Law of One Price only holds upstream in the long run. Upstream, conventional trout is market leader, while impulse-response functions identify significant short run responses from conventional to organic trout prices, but not v*ice versa*. Downstream, market leaders cannot be identified, nevertheless impulse-response analysis show significant short run responses from conventional to organic salmonid prices, however, no significance is detected in the opposite direction. The result indicates that organic salmonid prices are tied to the conventional market and do not develop independently. Hence, it can be expected that price premiums are maintained when investing in organic salmonid farming.

CONSUMER PREFERENCES FOR FARMED ORGANIC SALMON AND ECO-LABELLED WILD SALMON IN DENMARK

Sustainably produced food products have rapidly grown in popularity within the last years. Eco-labeling systems to indicate the environmental sustainability of product have also been implemented in the seafood market, with the MSC label for wild fish as the leading one. However, it is not clear whether consumers really notice the values behind an eco-label and how important these attributes are in their purchasing decision. This study analyzes data from a large household scanner panel to investigate actual consumer purchasing behavior and preferences when faced with competing product attributes such as organic and MSC labeled for salmon in Denmark. To accomplish these objectives and explicitly account for consumer heterogeneity, a mixed logit as well as a latent class model is applied. The results indicate substantial consumer heterogeneity with respect to MSC-labeled wild salmon and organic labeled farmed salmon, with a negative preference on average. The latent class model reveals the picture. In total, we find 5 segments, where 3 segments have no preference for eco-labeled salmon at all. The study shows that there is approximately a combined 50% chance of a consumer belonging to one of the segments that have a preference for eco-labeled salmon.

CHAPTER 1

INTRODUCTION

With an impressive growth rate of 7% since the 1950s, aquaculture currently contributes half of the world fish supplies for human consumption (FAO, 2016). This development has been driven by an increasing need for new food supplies (Demirak *et al.*, 2006) for a growing world population and increased pressure of finding alternatives to the declining wild fish stocks. The rapid industry growth have, however; raised consumers concern about environmental impacts (Asche, Guttormsen & Tveterås, 1999; Nielsen, 2012), food safety issues (Xie *et al.*, 2013), eco-labelling (Ankamah-Yeboah *et al.*, 2016), value addition and product upgrades. These concerns have been the driver towards a more sustainable aquaculture production practices to accommodate consumer demand.

In this regard, the organic agriculture movement has also promoted organic aquaculture production and production has increased rapidly in recent years. The total organic aquaculture production increased from 5,000 ton in 2000 to 53,500 ton in 2009 (Bergleiter, 2011). Survey statistics from FiBL (2013) put the production level over 180,000 ton. Europe is the number one market for consumption of organic aquaculture products and is central to organic agriculture as a whole. Market growth is particularly strong in France and Germany. The development of organic aquaculture standards had initially lacked consensus. The earliest standard was established for common carp in 1994 in Austria, France and UK (Bergleiter *et al*., 2009), and then came alongside various organic movement bodies.

In 2010, the European Union formally implemented the organic aquaculture regulation (EC Regulation 710/2009). According to Commission Regulation (EU) No 1364/2013 the life cycle of all animals in organic aquaculture must be 100 % organic by 1st January 2016. This requirement however presents a challenge for producers. For instance, Denmark is in the forefront of organic aquaculture production; leading in organic rainbow trout with annual production of about 1000 metric ton. The Danish aquaculture however, has serious concerns for trout fry diseases, particularly the Rainbow Trout Syndrome (RTFS). Since the organic production principles only allow very limited treatments against diseases, the robustness of the fish fry to diseases is crucial (Jokumsen, 2017).

While the overall aim of ROBUSTFISH seeks to further strengthen and develop the Danish Organic Aquaculture by focusing on robust trout fry production, this sub-work package seeks to provide knowledge about market conditions for organic aquaculture products, consumer preferences and expansion potential of the organic aquaculture industry. Specifically, we assess development in the industry, the economic performance of organic aquaculture production, market price development over time and consumer preference and valuation of organic fish product attributes. The analyses focus on Denmark, the leading European country in the production of organic aquaculture products, and Germany, which is one of the largest consumption market and the number one importer of Danish trout. Moreover, the project focuses on rainbow trout, but since salmon has a larger market share and is more established on the market, and thereby are able to provide more market data, we draw lessons from salmon as well.

Analytical outputs for the research questions are provided in the subsequent chapters. Chapter 2 is purely descriptive and presents a the statistical description of the organic aquaculture value chain, the economic performance of trout farms in Denmark and a review of price premia in eco-labeled food products. Chapter 3 – 5 are scientific based articles; where chapter 3 presents the analytics of price premia related to organic salmon in the Danish retail chain, chapter 4 presents on German consumer preferences and valuation of organic portion sized trout, chapter 5 presents analytics on the development of price premia over time in Danish market for salmonids (salmon and trout) and chapter 6 presents market segmentation analysis for organic, eco-labeled wild and conventional salmon in the Danish retail. Chapter 7 concludes.

CHAPTER 2

THE VALUE CHAIN, FARM ECONOMIC PERFORMANCE AND PRICE PREMIA[1]

This chapter presents on the description of statistics along the organic aquaculture value chain, focusing on the Danish and Germany in the European market; the economic performance of trout farms in Denmark; and a review of studies related to price premia on ecolabeled products including aquaculture, fisheries and the agriculture industry.

2.1 Value chain description for organic aquaculture: Denmark and Germany

2.1.1 Introduction

Here, we give a brief description of the statistics along the value chain for German and Danish organic aquaculture sector, highlighting the role of organic trout in both markets. Given the lack of certainty on data, we combine extracts from desk study of export reports and national statistical database where available to describe the development in the industry.

Consumer demand for organic food products, the continuing pressure on the aquaculture industry towards sustainable production systems through reduction on the dependence of the industry on fishery resources for feed is driving growth in the organic seafood production. In 2008, the global production of organic aquaculture was estimated at 53,000 metric tonnes, a growth of about 950 percent from the level in 2008 with market value of about 300 million USD. This was produced by 240 certified organic aquaculture operations in 29 countries (Prein *et al*., 2010). FiBL (2016) survey based on reported statistics for the year 2013 puts the production levels at 181, 146 metric tonnes[2].

China leads production statistics by over 116,000 metric tonnes. Europe is the largest consumption market for organic food products and for (organic) seafood demand. In 2014, Europe organic products grew by about 7.4%, and per capita consumption of 110% from 22.4 euros to 47.4 euros (IFOAM).Part of the demand for organic seafood is met domestically, though demand excessively exceeds supply. Ireland for example has about 70% of domestic salmon production being organic, with Norway and UK contributing smaller shares, Denmark, France and Ireland contributes with trout among other species. There are more than 80 standards for organic aquaculture worldwide, thereof 18 in Europe (Lasner, 2014) for which all labelling comes with the Euro-leaf ecolabel.

The general value chain for seafood and hence, aquaculture can be depicted as figure 1 where factor markets lie at the very top, then the production, the intermediary and consumption markets. Institutional support for research and development and regulation of environmental, health and ethical issues is linked to each level of the chain. The flows of organic aquaculture products follow the same links as the conventional.

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[2] Not all productions are reported: for example 1870mt are reported for mussels from Denmark, but Denmark also has production lines for organic rainbow trout. Hence these statistics approximate base level.

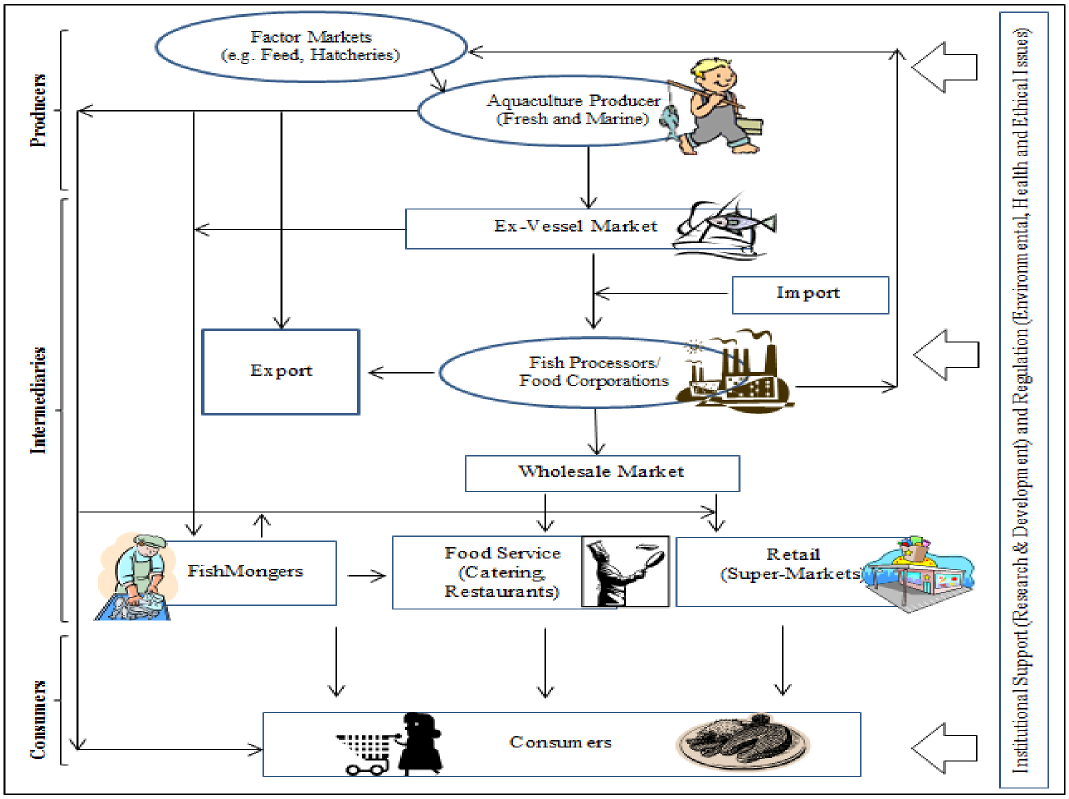

Figure 1. Aquaculture supply/value chain
Source: Concept adapted from Nielsen (2000)

2.1.2 Statistics in Germany

Germany is the largest market for organic food in Europe and had a retail sales growth rate of 4.8% valued at about 8 billion euros in 2014 (Meredith & Willer, 2016). There are about 100 German producers, processors, wholesale traders and retailers with organic seafood portfolio and continuously increasing demand for organic seafood is assumed by retailers. The dominant products in the retail market include salmon and shrimps. About 97% of processed organic seafood are imports (Lasner, 2014), and for trout imports in general, Denmark and Turkey are the two most important market suppliers. Production of trout in Germany is mainly small holdings with few large farms located in Southwest Germany, Baden- Württemberg. The very small organic trout farms struggle with extra costs particularly for feed, while the few large farms that exist are highly profitable (Agribenchmark, 2017). The fraction of the domestic organic aquaculture production is less than 1% of the total aquaculture production.

The following trends have been observed in the German organic aquaculture industry value chain:

- In 2003, there were 15 small fish farms, of which 6 trout and 9 carp farms where certified organic and produced about 125 tonnes of organic trout and 30 tonnes of organic carps. There were 9 processors who processed organic (mostly imported) fish (mostly salmon from UK and Ireland). The market volumes were estimated between 1,500 – 2,500 tonnes (live weight) for the German market (Teufel *et al.*, 2004).

- In 2009, there were 16 small fish farms, of which 9 trout and 7 carp farms certified as organic. Together, the output was about 200 tonnes, of which trout accounts 84 tonnes, carp 99 tonnes and 17 tonnes of accompanying fish if carp culture. Thus, there was no significant change in amount of farms converted but in the volumes and structure. The number of processors also increased to 19 and the volumes of estimated processed fish (mostly imported salmon and shrimps) were pegged at 10,000 tonnes based on processor interviews. In this same period, there were 49 wholesalers and retailers who included organic seafood in their supply portfolio (Lasner *et al.*, 2010).
- In 2012, the numbers of German converted farms from conventional to organic holdings were 22 and in 2013 estimated at 30 certified organic farms. The annual productions of 270 tonnes compared to the conventional output of about 44,000 tonnes in 2011 were also mainly carp and trout (Lasner & Ulrich, 2014).

The German organic aquaculture certifying bodies as at 2001 include Bioland, Demeter, Biokreis and Naturland (Bergleiter, 2001; Tacon & Brister, 2002). In 1995, the first Bioland certified farm started to convert to organic. After the 2010 introduction of the EU-organic certification and regulations, Naturland certifies most German aquaculture products, extending now across national borders (Lasner, 2014).

The organic seafood is a premium market but addresses a niche market. Prices of selected organic seafood in the German retail market as a 2014 is shown in table 2.1 (from Lasner, 2014).

Table 2.1. Organic fish price premium from German retail shops

Product	Organic (Euro/Kg)	Conventional (Euro/Kg)	Difference (%)
Salmon filet	28.95	19.96	45
Shrimps processed	20.79	12.84	62
Trout frozen	19.97	7.98	150
Fish fingers	20.79	7.94	162

Source: Lasner (2014)

2.1.3 Statistics in Denmark

Denmark has long tradition for aquaculture and, rainbow trout (*Orchorhynchus mykiss*) is the most dominant fish species farmed. Annual production has varied above 30,000 tonnes representing more than 90 percent of the total aquaculture production. The EU is the major export market for Denmark and supplies constitute about 32 percent of the total rainbow trout production in Europe. About 90 percent of the total rainbow trout produced is exported with Germany being the most important market (European Commission, 2012). The small species of trout (300-400g) are exported as smoked fillets or live trout, fresh or frozen while the large trout (2-5kg) productions are mainly destined to Japan and to a lesser extend Germany, Canada and Sweden (AQUAFIMA, 2013).

Production of organic rainbow trout made its way on the Danish retail shelves in 2005 (Larsen, 2014) and though growth had not been impressive as a new industry, the *Danish Aquaculture* information campaign in 2009 and 2013 led to increased production in the industry. Production levels (1,600 tonnes in Europe) in 2012 showed that France was the leading producer with about 60 percent share in Europe followed by Denmark. In 2014, Denmark became the leading producer of organic rainbow trout with production capacity of about 1,080 tonnes. Organic productions of other species are also making headway. In figure 2, we show the development trends of the organic and total aquaculture production levels. Table 2.2 presents the current production levels by species.

The increased supply of the organic aquaculture industry now involves intermediaries in the product supply chains, and hence the flow network follows the same channels as the conventional chain. For instance, organic trout is processed by small and large processing firms and supplied to both the international and domestic markets. Germany and Switzerland are the target markets for portion sized organic rainbow trout.

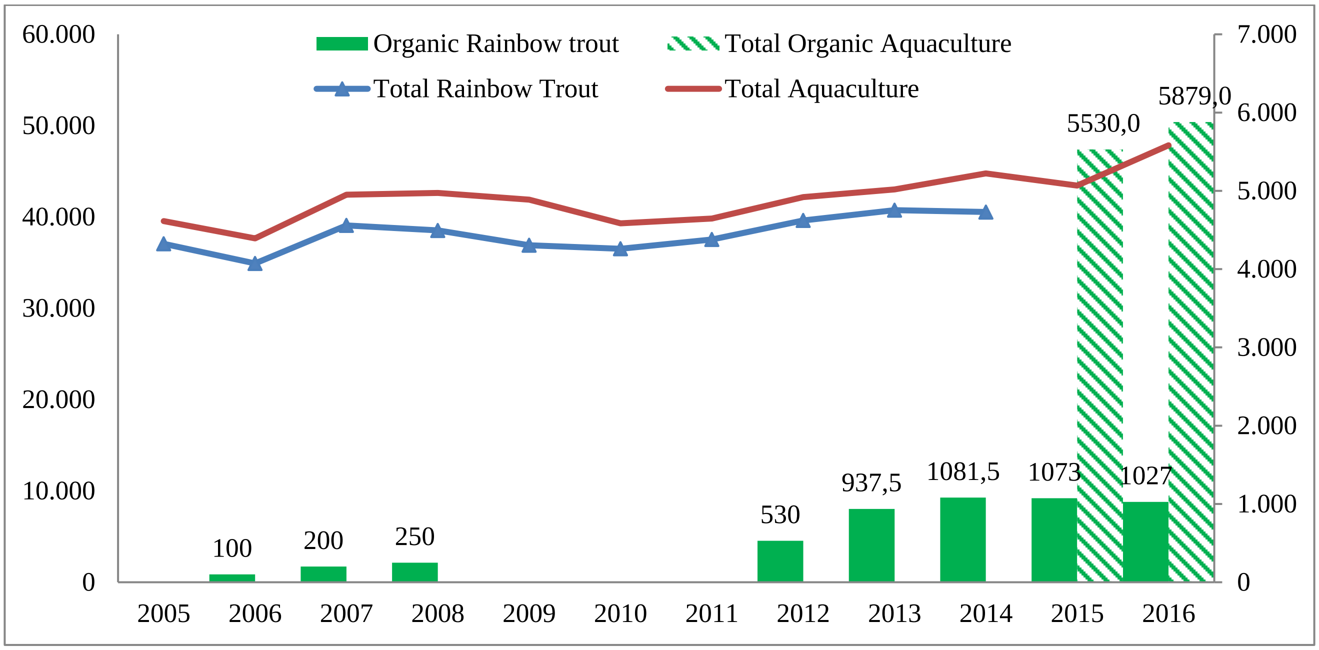

Figure 2. Total and organic aquaculture production trends (tonnes)

Organic production on the right y-axis.

Source: values collected from http://www.okofisk.dk/index.php/2015-01-28-13-15-55/hvor-findes-de-okologiske-opdraetsanlaeg

Table 2.2. Aquaculture production in Denmark (tonnes), 2015-2016

	Organic production		Conventional production		% of Organic production	
	2015	2016	2015	2016	2015	2016
Freshwater	843	797	27,911	30,452	3.0	2.6%
Marine	230	230	12,948	14,329	1.8	1.6%
Line mussel	3,450	3,850	1,076	1,566	>100%	>100%
Seaweed	1,000	1,000	1,500	1,500	66.7%	66.7%
Crayfish	8,5	2	unknown	unknown	-	-
Total	5,530	5,879	43,435	47,847		

The international demand, hence allow firms operate on multiple certification systems. Organic fish products for the domestic market bear the Danish organic logo (red Ø) which is managed by the government. Processing companies such as Danforel who target the German market also operate under the Naturland certification. The organic fish products (fresh and processed) are distributed domestically through fishmongers/specialized stores, supermarkets, food service centers (catering and restaurants) and online shops to consumers.

In table 2.3, retail organic fish product prices were collected from one of the supermarkets (i.e. Irma) website to compare prices. Organic fish products found were trout produced in Denmark and salmon farmed in Norway. For a comparable product type: skinless smoked trout fillet attracted a percentage price difference of about 84 percent while skinless frost salmon fillet attracted about 11 percent. In Germany, organic frozen trout attracts a difference of about 150 percent (table 2.1) compared with the conventional as shown in table 2.3.

Table 2.3. Organic and conventional seafood prices from Irma

Product description	DKK/Kg	Origin (farmed in)	Difference (%)
Organic :			
Skinless frost trout fillet	231.58	Denmark	
Skinless smoked trout fillet	295	Denmark	84
Skinless frost salmon fillet (pcs)	240	Norway	11
Conventional:			
Skinless smoked trout fillet	160	Denmark	
Skinless frost salmon fillet (pcs)	216	Norway	

Source www.irma.dk accessed on 23 September 2014 @ 15:00 – 16:00 pm

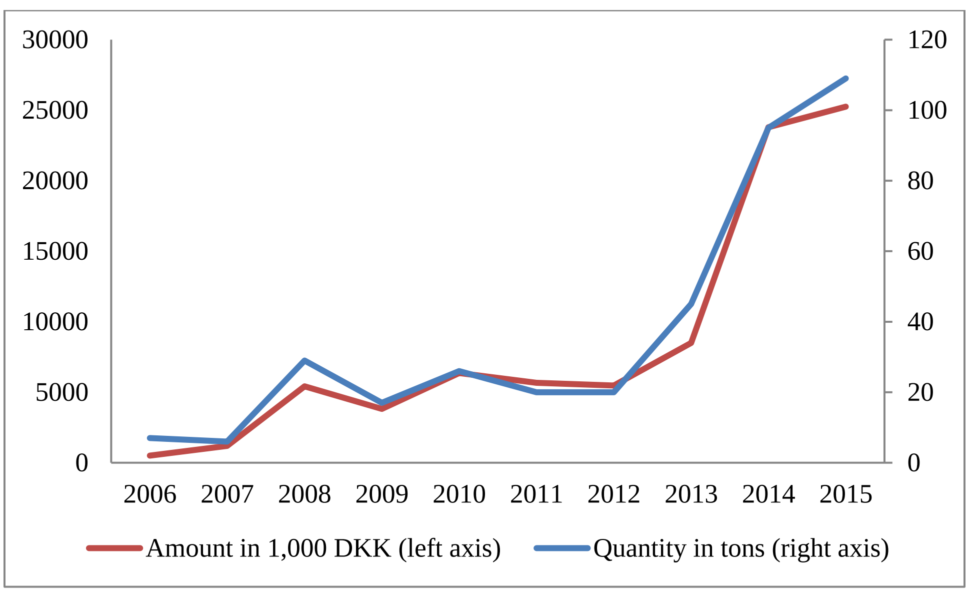

Figure 3. Turnover of organic seafood (total fish and shellfish) in retail shops
Source: Statistics Denmark

Generally, an upward trend can be observed in the growth of the value of organic seafood products (fish and shellfish) in Danish retail shops. Figure 3 shows the trends of value and volume of sales. In 2013 for example, there retail value amounted to about 8.5million DKK from 45 tonnes of seafood. The increase realized in 2015 was over 25 million DKK from over 100 tonnes of fish.

2.2 Financial performance of the Danish organic trout aquaculture

2.2.1 Introduction

Evolving consumer life-styles in developed countries have posed a challenge to producers of various food products. In a common global market, European producers for instance have to compete with producers from countries with lower cost of production while conforming to the stringent European and national regulations regarding the quality, environmental and health aspects of the product. In the case of organic trout production with more stringent environmental legislation, Denmark has managed to position itself as the leading producer in 2014 with a total production of 1080 tonnes by-passing France with a production volume of 952 tonnes in 2012 (Zubiaurre, 2013). The exponential growth in organic aquaculture production indicates the sector has come to stay. But how does the economic performance of production compare with related products? In this section, the economic performance in the production of freshwater organic trout in Denmark is compared to the conventional trout and organic agricultural sector. Economic performance indicators used are the degree of profitability and the farm solvency of aggregated farms. Evidence shows that organic trout farms tend to be equal or perform better than alternative conventional trout and organic agricultural farms. The average organic trout farm was able to generate income of 8% per unit value of assets and a solvency rate for 28% for 2012, values that outperform related farms in the same year. The succeeding sections are organized by giving a brief overview of the aquacultural sector followed by the financial flow and performance and finally the conclusion.

2.2.2 Overview of the aquaculture sector

Denmark, like many other European countries faced declining output in aquaculture production over the last decade. The total production of about 42,000 tonnes in 2009 decreased to about 39,700 tonnes in 2011. A recovery was realized in 2013 with production of about 38,000 tonnes of which rainbow trout constitute 40,700 tonnes. This reduction was due to regulation in the industry leading to reduced number of farms. However, the value of production increased from DKK 840 million to DKK 915 million in 2009 and 2011 (Statistics Denmark). The main species produced in Denmark is the rainbow trout (*Oncorhynchus mykiss*), occupying about 90 percent in weight and value of production. Production of trout takes place in freshwater and marine systems. The land based freshwater typically produce small portion size trout weighing 200-400 grams and the production techniques used are traditional ponds and recirculation systems (also called model 1 and model 3 farms)[3]. The portion size trout are sold as smoked fillets, live, fresh or frozen products. The large trout weighing 3-4 kilograms and trout eggs (roe) are mainly produced in marine (sea cage) farms. The roe is the most important economically but the meat is also marketed.

[3] Fish farm technologies that have the ability to reduce nitrogen discharges from aquaculture to the environment and at the same time increasing the production volume per farm compared to the traditional system.

The most important market for large trout from Denmark is Japan while Germany and Netherlands represent significant market for the portion size trout. The exports of Denmark represent about 32 percent of the total rainbow trout production in Europe.

The production of organic rainbow trout in the country has also shown promising development despite the strict national legislation. The first certified organic trout product hit the market shelves in 2005. With a total production of 100 tonnes in 2006 (Dansk Akvakultur, 2008), this increased to 530 tonnes to be the second largest producer after France in 2012 and then 1080 tonnes in 2014 when Denmark became the largest producer. The Danish organic aquaculture industry is about 3 percent of the total aquaculture production volume. There are currently 2 marine farms (not included in this analysis) and 11 freshwater farms certified under organic[4] (Dansk Økologisk Fiskeopdræt, 2014). Germany is the most important organic trout market for Denmark. According to Statistics Denmark, a total of 100 tonnes of seafood were exported with a value of DKK 11 million in 2012. Out of these, 51 tonnes were destined to Germany, 6 tonnes to France and Monaco and the remaining to other countries. These records exclude exports from smaller production units and hence underestimate the true export volume. About 90 percent of organic seafood productions serve the export market (Larsen, 2014).

2.2.3 Data source and methods

The data used in this report were sourced from the Statistics Denmark. The accounts are based on a sample of farms in the whole farm population. Following Danmarks Statistik (2012) the economic performance indicators compared across farms were the degree of profitability (a variant of return on assets) expressed respectively for aquaculture and agriculture in equation 1 and 2 as

$$DegreeProfitability = ((Oper.Profit - OwnerRemuneration)/Assets)*100 \quad (1)$$

$$DegreeProfitability = ((Oper.Profit + Gen.Subsidies - OwnerRemuneration)/Assets)*100 \quad (2)$$

The difference between the two equations lies in adjusting for the general subsidies provided to the agricultural sector. This measure indicates the efficiency with which farm management has used its resources to obtain income. It reflects farm earnings before interest and taxes. The other measure used is the farm solvency ratio which tells if farms cash flow is sufficient to meet its short term and long term liabilities. The lower the solvency coefficient the greater the probability of a farm will default its debt obligations. The solvency ratio is also expressed as

$$FarmSolvency = NetCapital/Assets \quad (3)$$

Thus, the ratio of net capital at the end of year to assets at the end of the year.

2.2.4 Output and financial performance of organic trout compared to other farms

The total financial cash flow and output for freshwater trout production in Denmark is presented in this section for the Danish farms. As discussed earlier, a significant reduction in the number of farms was observed in the traditional trout farms as shown in table 2.4 due to regulation, structural adjustment and economies of scale closing down smaller farms. In 2010, the 177 farms that produced traditional trout reduced to 157 farms in 2012. Fish produced for consumption is the

[4] There are also 2 farms producing organic mussels with production capacities of up to 200 tonnes per year.

most important contributor to farm cash inflow. In 2010, the volume of organic trout produced for consumption for 5 farms amounted to a total of 193 tonnes compared to 12029, 3034, 7228 tonnes for traditional, model 1 and model 3 farms respectively. Considering the number of farms and the tonnages produced, it is evident that the model 3 trout farms are larger considering the production output. Production of organic trout increased to 339 tonnes with an increase in the number of sampled farms to 6 in 2012.

Table 2.4. Volume of freshwater trout production 2010-2012 for sampled farms

	Organic			Traditional			Model 1			Model 3		
	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012
# of farms in the population				177	162	157	19	17	16	13	13	13
# of farms in the sample	5	5	6	89	73	72	10	11	10	12	13	9
----------tonnes (metric)----------												
PRODUCTION												
Fish for consumption	193	246	339	12,029	9,438	11,158	3,034	1,857	2,869	7,228	6,444	5,021
Fry and fingerlings	1.8	2.6	3.9	3,418	4,200	5,066	694	1871	1,336	700	1,003	696

Source: Statistics Denmark

The total turnover for the organic farms in 2010 was about DKK 4.6 million and total cost of DKK 4.2 million (refer to table 2.5). The corresponding average farm turnover and cost was DKK0.915 million DKK0.836 million per farm. The total turnover and costs in the conventional farms in 2010 was highest in the traditional followed by the model 3 and then the model 1 trout farms. However, the average per farm turnover in 2010 for model 3 was about DKK11 million, model 1(DKK4 million) and traditional (DKK 2 million) and their respective average costs were model 3 (DKK 9.8 million), model 1 (DKK 3.5 million) and traditional (DKK1.9 million). This trend reveals that the level of sophistication of a farm is directly associated with the amount of cash flows. The organic farms technology is more comparable to the traditional trout farms as they are less capital intensive compared to the recirculation farms. Generally, increases in turnover from 2010 through to 2012 tend to be followed by increases in cost for all farms and vice versa.

Turning to the Economic performance indicators, the degree of profitability[5] for organic farms in 2010 was the same as the model 3 trout farms with a value of 5 percent. This value is higher than the traditional farms which has a value of less than 1 percent and 3.7 percent for model 1 farms. In practice, organic farms were able to generate income of DKK0.05 per DKK1 of assets value, the highest among all farms for 2010. In 2012, farms improved in their efficiency with the rate at which they generate incomes from assets relative to 2010 except for model1 which decreased to less than 1 percent. The story in 2011 was different for organic trout farms with a solvency ratio of negative 6 percent. Farms were on the average operating at a loss as reflected in the operating profit. Deductions from the composition of the cost in Appendix 1 shows that fish cost (i.e. the cost of purchasing fry and fingerlings) is among the important costs of production but the observation from 2010, 2011 and 2012 was a dramatic increase of 367% from 2010-2011 followed by a fall of 43% in 2012. This might be attributed to the buildup of stocks of fingerlings

[5] As a rule of thumb, it is estimated that investment professionals want to see Return on Assets come in at no less than 5%.

to be used in the following year's production hence driving the total average cost up to override the turnover. The percentage composition of costs (also in Appendix 1) presents an interesting case. Feed cost is the most substantial cost across farms ranging from 38-46% per farm, increasing according to the level of sophistication: organic-traditional-model 1-model 3. The personnel cost is also among the important cost and increases according to the labour-capital intensities. Following the above order of farm types, organic has the highest personnel cost since it requires more manual labour and accounts for 20% while model 3 which is more capital intensive has the least personnel cost of 8.5%.

Table 2.5. Financial performance of organic and conventional trout farms (total cash flows)

	Organic			Traditional			Model 1			Model 3		
	2010	2011	2012	2010	2011	2012	2010	2011	2012	2010	2011	2012
	Million DKK											
Turnover	4.58	6.18	8.24	378.81	394.61	427.64	74.00	83.08	88.55	142.28	159.74	124.46
Costs	4.18	6.30	7.34	348.32	357.26	389.22	66.40	77.12	84.85	128.59	149.16	108.82
Operating profit	0.26	-0.32	0.61	30.49	37.35	38.42	7.60	5.96	3.71	13.69	10.58	15.63
Profit on ordinary activities	0.10	-0.49	0.40	11.81	24.62	25.09	4.47	3.48	1.35	4.17	2.03	12.26
Net profit	0.09	-0.66	0.32	8.76	20.38	19.83	6.13	3.06	1.23	4.42	2.04	11.62
Assets, end of year	4.43	6.20	6.88	586.11	502.11	543.96	88.89	117.80	127.40	236.57	230.34	149.55
Net capital, end of year	0.98	2.12	1.95	114.16	105.96	145.89	16.19	18.35	22.05	38.64	43.94	28.41
Economic indicators:												
Degree of profitability %	5.0	-6.0	8.0	0.4	2.4	2.6	3.7	2.1	0.5	4.8	3.8	8.9
Farm solvency %	22.0	34.0	28.0	19.5	21.1	26.8	18.2	15.6	17.3	16.3	19.1	19.0

Source: Statistics Denmark

The solvency of trout farms presents coefficients that appear to favor organic trout farms in all the years under consideration. In 2010, organic and traditional farms showed coefficients of 22 percent and 19.5 percent respectively while model 1 and 3 showed 18 and 16 percent solvency rate. Considering organic trout farms, they appeared to have a lower probability of defaulting debts in 2010 compared to the other farms. The probability of debt default decreased further in organic farms, model 3 and traditional farms which contrast model 1 farms for 2012. In general, though organic trout farms could not perform well in 2011 regarding income generation from assets, they have picked up again and are performing equally or better than alternative trout farms as reflected in the economic indicators for the various years.

How then does the organic trout farms compare to the traditional organic agricultural farms? Table 2.6 presents the total cash flows and financial performance for the organic trout and the organic agricultural sector (for full time holdings by type of farm). Table 2.6b presents the continuation of the farm types presented in table 2.6a. The turnover for the various farm types increased from 2010 to 2012 just as observed in the organic trout farms. Likewise, the total costs mimicked the pattern of turnover development.

Table 2.6. Financial performance of organic trout and agricultural farms (total cash flows)

a.		Organic trout			Agriculture			Dairy cattle		
		2010	2011	2012	2010	2011	2012	2010	2011	2012
1	Number of farms in the pop.				640	655	637	386	386	393
2	Number of farms in the sample	5	5	6	183	224	191	123	140	128
		Million DKK								
30	Turnover	4.58	6.18	8.24	2,580.48	2,957.98	3,384.38	1,910.70	2,178.58	2,457.82
50	Costs	4.18	6.30	7.34	2,295.04	2,567.60	2,897.71	1,720.40	1,906.07	2,152.07
70	Operating profit	0.26	-0.32	0.61	285.44	391.04	486.03	190.30	272.52	306.15
100	Net profit	0.09	-0.66	0.32	14.08	163.10	171.35	8.49	115.80	99.04
110	Assets, end of year	4.43	6.20	6.88	26,639.36	27,511.97	27,845.18	17,607.39	17,140.72	17,832.38
138	Net capital, end of year	0.98	2.12	1.95	7,431.68	5,005.51	4,348.80	4,773.66	2,709.33	2,449.57
	Economic indicators:									
152	Degree of profitability %	5.0	-6.0	8.0	5.0	2.0	2.0	1.7	2.4	2.1
153	Farm solvency %	22.0	34.0	28.0	28.0	18.0	16.0	27.0	16.0	14.0

b. Continuation		Other cattle			Pigs			Crop production		
		2010	2011	2012	2010	2011	2012	2010	2011	2012
0000	Number of farms in the pop.	77	76	62	..	26	28	79	87	75
0005	Number of farms in the sample	11	22	11	..	11	13	30	32	24
		Million DKK								
0290	Turnover	96.71	126.39	110.42	..	217.75	281.29	144.41	193.66	245.40
0470	Costs	98.79	130.80	106.76	..	177.14	224.25	124.82	147.73	186.75
0655	Operating profit	-2.08	-4.41	3.60	..	40.61	57.06	..	45.94	58.58
0720	Net profit	-8.86	-19.30	-1.18	..	25.92	34.44	-0.03	21.14	10.28
0995	Assets, end of year	2,920.76	2,661.44	1,938.12	..	1,004.90	1,267.36	3,547.81	4,726.28	4,797.83
1170	Net capital, end of year	1,004.70	689.32	409.20	..	109.20	137.26	1,123.14	1,098.64	965.10
	Economic indicators:									
3530	Degree of profitability %	0.2	0.3	0.2	..	4.6	4.6	1.4	2.1	2.1
3542	Farm solvency %	34.0	26.0	21.0	...	11.0	11.0	32.0	23.0	20.0

Source: Statistics Denmark

Again, the organic trout farms in 2010 had higher degrees of profitability that was equivalent to the organic agriculture, a value of 5 percent income generation over assets. This was higher than alternative organic farms like the dairy cattle (1.7), other cattle (0.2) and crop production (2.1). Agriculture and other cattle could not improve while dairy cattle and crop production improved slightly. Pig performance appears to be stable in all years. The farm solvency ratios however indicate that in 2010, organic trout farms had the highest probability of debt default while other cattle and crops had the lowest probability of default with a respective solvency value of 34 and 32 percent. The changes in 2012 however showed the contrary as organic trout farms had 28 percent solvency rate, the highest compared to other organic agricultural farms. At least in 2012, the economic indicators revealed that the organic trout farms are performing better financially than other organic nonseafood sectors. Putting things in perspective, this has been possible due to the prevalence of price premiums in the organic sector. The organic trout production is quite small representing about 2.7 percent of trout production and 2.5 percent of total aquaculture production[6]. This means that with such a smaller share, price premiums become essential for the financial sustenance of the sector.

2.3 Comparison of seafood and agricultural ecological premiums

2.3.1 Introduction

Ecolabelling is a voluntary market based incentive created to reward producers who practice environmental or ecological sound principles. Consumers have generally shown positive attitudes towards the patronage and valuing of eco-food products. However, skepticism remains whether consumers have translated their willingness into real purchasing behavior. In this paper, evidence on consumers' willingness to pay premiums and the real premium paid on ecolabeled seafood products are gathered and compared along with other ecolabeled agriculture premiums. Furthermore, empirical evidence regarding the sensitivity of consumers to price premiums and the price elasticity of demand or price flexibilities for ecolabeled products are considered. This is important because information on price differentials between ecolabeled and conventional products are useful but not sufficient for policy purposes, needed in addition is the price sensitivity of demand. It gives information on whether the barrier of high ecolabel prices can be reduced to increase demand. The price elasticity is theoretically assumed to be equal to the reciprocal of the direct price flexibility estimated from inverse demand systems. However, in practice the reciprocal of the price flexibility is absolutely less than the true elasticity for reasons not discussed here (Houck, 1965; Nielsen, 1999). Also of interest is the deduction from literature if the degree of premium paid varies with the degree of attributes associated with the ecolabel. For instance, are consumers' valuations of ecolabels with few attributes such as the MSC the same as Organic labels which have more strict requirements and principles? Sustainable or ecolabeled food products considered in this study are defined as products that have been produced under a set of standards that address environmental issues, animal welfare and/or social justice concerns, making it fit for a seal or logo.

The aquatic environment has not been immune to the movement of sustainability from various factions consistently raising concerns about the overexploitation of resources and its effect on the environment. The demand for seafood[7] is on the increase as the per capita global fish consumption changed from 10kg to 19kg from 1960 to 2012 (FAO, 2014). However, fish stocks in the oceans are depleting. This is driven by the fact that traditional command and control techniques are insufficient on their own to effectively address the challenges facing the fisheries industry, especially overexploitation (Roth *et al.*, 2001). In attempt to meet the global demand for fish food, aquaculture has also evolved and production growth has been quite tremendous. It is anticipated that within the next few years fish demand from aquaculture would bypass the capture

[6] Market share is calculated using 2014 organic trout production volume against 2013 aquaculture volumes based on the assumption that the production output for aquaculture in 2014 would not change significantly.

[7] Seafood - although has the word sea, which denotes marine origin – typically refers to all fish products such as shellfish and row, irrespective of the source ; aquaculture or wild caught, marine or freshwater (Cooke et al., 2011)

sector (ibid). The practice of fish farming has also come with various negative externalities that have been documented in literature (rf. Biao & Kaijin, 2007; Xie *et al*., 2013).

In order to maintain ecological balance, ecolabelling that rely on independent third-party verification that products meet certain environmental standards (Wessels, 2001) has been the tool used to create market based incentives for better management of the environment (Roheim *et al*., 2011). Ecolabels can be classified under one of the purposes of food labelling identified by Albert (2014); protect and promote health, protect the environment and promote sustainable production, promote social well-being and protect culture and in relation to new technologies. Ecolabels can also be classified by the degree or intensity of requirements needed to be observed. Within the seafood industry, Thrane *et al*. (2009) distinguish between single attribute and multi-attribute ecolabels. An example of the single attribute is Dolphin Safe Tuna which minimizes/avoids by-catch in fisheries. The multi-attribute was also disaggregated into those focusing on the environmental impact at the fishing stage (e.g. MSC) and those focusing on the entire life-cycle of the product chain (e.g. KRAV in Sweden). An organic label in the seafood industry is only possible in aquaculture and also focuses on the entire product chain. In most countries, aquaculture and agriculture fall under the same labelling system possibly due to high level of consumers' confidence in known labels (e.g. the red-Ø in Denmark, KRAV in Sweden, Naturland in Germany). The KRAV and Naturland which are organic in origin have also designed standards for fisheries. A question left for future inquiry is that given these different standards under the same label/logo, would consumers value organic aquaculture the same as fisheries ecolabels or as organic agriculture?

Other known labels are the Soil Association (UK), Label Rouge (France), Marine Ecolabel Japan and the now up and coming Aquaculture Stewardship Council founded in 2010. The most celebrated and studied seafood ecolabel is the MSC founded in 1997 with the coalition of World Wildlife Fund and Unilever. In 2014 for instance, the number of fisheries engaged in the MSC program was over 300 collectively accounting for 10 percent of global annual harvest of wild capture fisheries. The retail market value grew to $4.8billion in over 100 countries (MSC, 2014). MSC is attributed a success in the creation of sustainable fish market rather than sustainable fisheries (Ponte, 2012), due to its inability to prove that its certification system has had positive environmental impacts and the marginalizing of fisheries in low income countries (ibid; Ponte, 2008).

Complying with the standards set for ecolabels comes with tradeoffs for producers that could result in reduced output, increased input costs and hence lost profits. Besides, the certification process also comes with associated costs. The implication is that consumers who opt for the environmentally friendly products need to compensate producers for the extra costs internalized to ensure continual protection of the ecological base. Hence, the necessary condition for price premiums is consumer's ability to differentiate products at the retail level (Blomquist *et al*., 2014) which is achieved with ecolabels. However, one should note that observing a premium at the downstream does not necessarily imply transmittal to the upstream level (Roheim *et al*., 2011; Sogn-Grunvåg *et al.*, 2013), neither does it provide any information about the supply chain cost structures (Sogn-Grunvåg *et al.*, 2013). The existence of premium on ecolabels is an indication that consumers obtain higher utility when they consume ecological food products. Likewise firms make higher profits and though sustainable production may not be achieved as pointed by Ponte (2012), it seems rational to keep providing food products with ecolabels to the market. The concerns raised at the beginning of the paper are addressed and where possible, intuitions and motivations for the observed premiums given. In the next section, a brief description is given about the structure or methods under which the study is organized, followed by the empirical evidence review and finally the conclusion of the paper.

2.3.2 Methods

This review was purely based on desktop literature search of peer reviewed journals and on few cases working papers or grey literature were included if found relevant. Much concentration was given on the European countries and where lacking other geographic areas added. The premiums reviewed were grouped under revealed and stated premiums for seafood and nonseafood (agriculture) products. Revealed premium shows those estimated from actual market purchases while the stated are estimated from consumers' willingness behaviors without actually purchasing the product. Data for the revealed approach were generally obtained from firms, retail scanner data and in-store personal observation while the stated ones were from consumer surveys and choice experiments done in person, mail, telephone or online. Consumer responses to price premiums were reviewed from stated preference studies while price elasticity/flexibility of demand was estimated from total market demand methods. Studies for ecolabelled agricultural products dominate the literature while the seafood is limited. No study was identified in relation to price elasticity of ecolabelled seafood possibly due to the fact that the ecolabelled seafood market is still young limiting data availability.

2.3.3 Empirical evidences of ecological price premiums

In this section, evidence on ecological premiums and price sensitivity are presented by grouping them under revealed and stated valuation findings as well as under seafood and non-seafood products. The order begins with revealed-seafood, revealed-agriculture, stated seafood and stated-agriculture.

2.3.3.1 Revealed seafood premiums along the value chain

This subsection puts together empirical evidence from the seafood market on observed premiums along the value chain. Aarset *et al*. (2000) appears to be the first seafood gray literature to estimate price premiums for organic salmon. The analysis was first based on the application of the LOP in a product space such that price differences between conventional and organic salmon result in non-integrated market if the two products are different (not considered substitutes). Aggregation for data characterized by irregular spacing of observations in time presented statistical problem. However, comparing actual price averages from 1996-1997 of the Norwegian producer Giga reveals that fresh organic salmon commanded a premium of *24%* while smoked organic salmon attracted a premium of *38%* compared to their conventional alternatives. Regression of the price differences on the destination countries (Germany, Japan, Belgium and Switzerland), distribution channels (retailer and restaurants) and product categories reveals less clear cut results on the respective premiums. But the authors observed that Germany and Switzerland were high premium buyers, signaling the value of ecolabels attached to salmon products in the countries compared. Norwegian restaurants and retailers were also attractive than importers, wholesalers and exporters. Nonetheless, a value added product (smoked salmon) attracted higher premium than fresh product which could be explained by the relative easiness in their preparations for consumption.

The succeeding analysis of ecolabeled seafood products using actual data have concentrated on the hedonic theory of explaining price formation based on the Lancastrian economics (Lancaster, 1966). The model assumes that the consumer has a demand function for each attribute inherent in a product and maximizes the utility linked to each attribute subject to a given budget constraint. Based on Rosen (1974), the product price is specified as a function of product attributes. Though such models have been used in disentangling product attributes, its application in the seafood sector using actual data started[8] with Roheim *et al*. (2011). Alternative ways identified in estimating the marginal willingness to pay premiums using observed market data is by inferring from inverse demand systems (Baltzer, 2004; Smed, 2005).

Roheim *et al*. (2011) made use of IRI[9] Infoscan data in the London metropolitan market area. This analysis was a retail level data measuring product flow through supermarkets. The authors assessed how much premium is being paid by consumers of the MSC-certified seafood ecolabel specifically for frozen processed Alaska pollock products. The revealed premium was pegged at *13.3%* after controlling for product attributes like brand, product form, package sizes and process form. As opposed to our intuition from the results of Aarset *et al*. (2000) on value addition, the high value added products "breaded and battering" attracted low premium compared to "smoked". This is explained by the fact that value addition could be perceived as masking less quality products generated along the supply chain Roheim *et al*. (2011). They raised the fact that, observing premiums at the retail level does not indicate the prevalence of premiums at the producer level nor its transmittal. This could be explained by the existence of oligopsony market power in the ecolabelling supply chain exercised by supermarket retail chains. Thus the retail chains claim certification if they should purchase. This restricts producers who want to sell to certify their products even without premiums.

Blomquist *et al.* (2014) addressed this concern on premium transmission in the Swedish market for MSC-certified Baltic cod. Knowing the necessary condition for price premiums at the producer level is product differentiation at the retail level, the authors used personal observed in-store data to estimate a joint premium for ecolabels[10] of seafood at *10%*. At the upstream, *no* significant premium (-0.3%) was observed for MSC certified landings for fishermen in the cod fishery after conducting robust analysis on data from log books and landing tickets obtained from SwAM[11]. No general conclusion can be made on the flow of price premiums along the chain but at least for the Swedish cod fishery, this is the mystery revealed. One should treat this evidence with caution since the retail data was based on a simple difference test whiles the landings data was based on a more robust hedonic analysis. However, if this is indeed the case then one become curious whether the premium paid by consumers are retained by the retail chains who likely have market power or somewhere else along the supply chain.

In contrast to the production level evidence from Blomquist *et al.* (2014), Asche and Guillen (2012) had already studied price differences in the monthly data categorized according to the type

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[8] We are unaware of any gray literature that existed on hedonics of ecolabelled seafood before Roheim *et al*. (2011).

[9] Information Resource Inc.

[10] MSC and KRAV (a Swedish ecolabel)

[11] Swedish Agency for Marine and Water Management.

of fishing gears in the Spanish hake market in Barcelona. It is known that MSC certifications are also associated with the type of fishing gear method, but this study was not based on MSC certified products. It is included due to its relevance in capturing the premium for various fishing gears. The more detrimental gears, trawl and gillnet were discounted at a premium of 1.74 euros and 4.39 euros per kg (approximately 15% and 50% respectively) compared to the long-line capture. Asche and Guillen (2012) indicate the implication is that, the perceived quality reduction when a trawl is used is assumed to be substantially less than the effect of gillnet.

A major limitation on the use of scanner data is its inability to provide the type of ecolabel affixed to the product, requiring Roheim *et al.* (2011) to resort to arduous means to discover such information. Hence Sogn-Grunvåg *et al.* (2013) made use of in-store observations from seven different retail supermarkets in the UK. Premiums were estimated for one of the sustainable capture methods, "line-caught" and MSC-certified chilled pre-packed cod and haddock products. Hedonics estimation revealed "line-caught" was rewarded for its sustainable concept with a premium of *18%* and *10%* for cod and haddock respectively. The MSC-ecolabel commanded marginal values of 10% premium on haddock products, a value that corroborates Roheim *et al*. (2011). Similarly in another study in the UK-Glasgow, Sogn-Grunvåg *et al.* (2014) conducted another in-store observation on cod and haddock. Considering the same sustainable features of the products, line-caught attracted a high premium of 24.6% over the fishing gear trawl. MSC labels were commanding a premium of 12.7%, also closer to previous estimations. The exceptional feature of this study was distinguishing between the value placed on private uncertified ecolabels such as "Forever Food" and "Birds Eye". These products turned out to be 10% cheaper than products without the ecolabels. An indication that there are some hidden complexities in the supply-demand relationships within and among the major processors or alternatively indicates a significant sensitivity to third party verifications.

The organic seafood (farmed fish) market in the UK was studied by Asche *et al*. (2012). Evidence revealed organic fish attracted a premium of *25%* while MSC labelled products had a premium of *13%* for a wide range of fresh chilled and frozen farmed and wild salmon products. This differential in premiums between the two ecolabels is expected as it is more costly to provide organic seafood given its comprehensive requirements. The authors observe however, a substantial variation in MSC premiums across retail chains while organic premiums remained stable. The summary of findings for revealed and stated empirical studies for seafood is shown in Appendix 2 while the premium range for this subsection is presented in table 2.7.

How sensitive are consumers to price premiums of ecolabeled seafood. Studies analyzing quantity-price sensitivities in the framework of demand systems for sustainable seafood rarely exist. However, it could be inferred that sustainable fishery practices could lead to better fish quality in the context of EU freshness grading. Hence Roth *et al*. (2000) explored the demand for fish quality in Denmark using an inverse almost ideal demand system to estimate price flexibilities. It was revealed that for cod and salmon, own price flexibilities were larger for Quality-Extra (-0.8 and -1) than A-quality (-0.4). The reverse was seen for plaice and mackerel with the respective Quality-extra of (-0.3,-0.8) and A-quality (-0.7,-0.8) own price flexibilities. By inversion, the lower the price flexibility the higher the elasticity and a value of less -1 indicate that price is flexible.

Table 2.7. Summary: Revealed premium range for seafood

Type of ecolabel	Premium range (%)
Organic aquaculture	24 - 38
MSC in fisheries	10 - 13
Fishing methods	10 - 50

2.3.3.2 Revealed agriculture price premiums and demand elasticities

How much premium has been paid on agriculture food products produced from ecologically sound practices? Beginning with the hedonic related modeling of price premiums, Galarraga and Markandya (2004) observed prices from five UK retail markets between 1997 and 1998. Analysis of the data revealed consumers were paying a premium of about 10.7% for fair-trade/organic coffee compared to their conventional counterparts. On the Italian market, Carlucci *et al*. (2013) identified yoghurt to be a highly differentiated product such that the products price formation was influenced by a number of functional attributes. Among these, it was evident that consumers pay a marginal price of 28% if the yoghurt was labelled as organic in the retail stores.

In a comparative study of the actual household demand for organic food products in Denmark and Great Britain, Wier *et al*. (2008) estimated the average premium of organic products as compared to the conventional variants of the same product and for different user groups. The average price premium for organic milk was considerably higher in Britain (40%) than Denmark (15%) and the difference was explained by the excess supply of organic milk due to favorable government subsidies in Denmark at the time. In Denmark, the highest premiums were organic fruit (43%) followed by eggs (40%). In Britain eggs accounted for the highest premium of 133% followed by vegetables (73%). Generally, premiums ranged from 25 to 133% in Britain and 13 to 43% for Denmark. These countries compared to other European countries sell greater share of organic food products through the mainstream conventional retail channels. As indicated by Hamm *et al.* (2002) supermarket chains in Denmark have been much quicker including organic product lines in their shelves than other countries and this has the advantage of selling at a lower price premium. According to Økologisk Landsforening (2013), 90% of organic food in Denmark is sold via discounters, supermarkets and warehouses along with conventional while less than 10% are sold in specialized organic food alternative joints.

Baltzer (2004) use actual purchasing weekly data from COOP Denmark A/S to estimate the marginal willingness to pay for egg varieties in the framework of the Almost Ideal Inverse Demand System. Among the varieties of eggs, organic eggs commanded the highest marginal willingness to pay premium of 58%, barn eggs, 43%, free-range eggs 15% and pasteurized eggs 28%. The barn eggs and free-range varieties indicate various degrees of animal welfare in the production process, which is valued less compared to the organic. Similarly, Smed (2005) identified consumer willingness to pay organic premiums for Gfk scanner data for the period 2000-2002 for skimmed milk to be 7%, 21% and 8% in three periods where different milk varieties were introduced to the market. Respectively, organic light milk attracted 9%, 14% and 7% while organic whole milk attracted 12%, 11% and 21% premiums in the periods. At least in Denmark and most countries, the premiums on ecolabeled products are estimated to be positive, indicating consumers are rewarding production practices that internalize environmental costs.

But how sensitive are consumers to the price of ecolabeled products? Wier *et al.* (2001) estimated elasticities for organic foods using the GfK store level scanner data from 1997-1998. Results showed that quantities demanded were more sensitive to own price changes for organic foods (-2.27) than for conventional foods (-1.13). A sensitivity analysis showed that a decrease in the price premium of 20% increases the consumption share of organic dairy and meat products from 10% – 15% , bread and cereal products increase from 5% - 7%, fruit and vegetable products increase from 4% - 6%. This indicates that price is an obstacle to organic consumption as lower price premiums induce considerable portion of consumers to buy more organic products. In both a standard and variety demand models, Baltzer (2004) show evidence of elasticities greater than unity for all egg varieties. At low levels of demand, organic eggs were valued highly than welfare (barn and free-range) and pasteurized eggs while at high demand levels, egg varieties appear to converge at low price premiums. Similarly in the Danish milk market, Smed (2005) showed that the elasticity of demand for organic light and skimmed milk were higher than their conventional substitutes except for whole milk.

Does the above trend apply to other European markets? Jonas and Roosen (2008) used GfK data from the period 2000-2003 from the German milk market to determine price elasticities. In their result, own price elasticities for conventional milk was almost unity (-1). The demand for organic milk on the other hand was estimated to be highly price-elastic product (-10). Monier *et al.* (2009) similarly explores the French market for organic milk and eggs from the TNS Worldpanel data for 1998-2005. For the two products, conventional demand were more or less unitary price-elastic (-0.78 for eggs and -1.02 for milk). In the organic market, situations contrasted as demand was more price elastic for eggs (-2.38) and price-inelastic for milk (-0.38). The French market typically contrasts the German milk market for organic milk. In a more recent market analysis Schröck (2012) also contrasts the findings of Jonas and Roosen (2008) in the German milk market using the same GfK Homescan panel data but for a latter period (2004-2008). Estimated own price elasticities for both organic and conventional milk were less than unitary. Though the contrasting elasticities in Jonas and Roosen (2008) and Schröck (2012) could be due to differences in methodologies and assumptions towards elasticity estimation, one could also ask if consumer behavior is changing over time due to some structural changes.

Fourmouzi *et al.* (2012) relied on the Taylor Nelson Sofres (TNS) British household panel data from 2005-2006 to analyze demand systems for organic and conventional fruits and vegetables. The conventional and organic groups of each product appeared to be direct substitutes, and the organic were seen as luxury goods. With respect to each product's own price elasticities, conclusions showed organic vegetables and fruits were highly price elastic compared to their non-organic counterparts. The respective estimated own price elasticities for organic fruits and vegetables were -1.59 and -1.39. The conventional on the other hand was -0.50 for both products. Generally, the sensitivity of demand to prices varies from consumption markets due to differences in methodological estimations and consumer preference heterogeneity. However, evidence revealed here suggests that the demand sensitivity to prices of ecolabeled food products is higher[12] than the conventional substitutes. Implying that the ecolabeled product price development

[12] Except for the French milk market in Monier et al. (2009) and Shrock (2012) in Germany.

presents an interesting mechanism as significant fall in prices would increase demand, all things being equal.

Table 2.8. Summary: Revealed premium range for agriculture

Type of ecolabel	Premium range (%)
Organic in agriculture	10 - 50 (133)
Welfare related	15 - 40

Value in parenthesis is extreme upper bound premium

2.3.3.3 Stated seafood ecological premiums

Knowing how much consumers have been paying on food products labelled to be ecological, we review evidences on the stated premiums. Thus, how much did consumers indicate they were willing to pay on food products that address their concern relating to environmental and ethical issues? Beginning with Olesen *et al*. (2010), the authors applied a non-hypothetical choice experiment to evaluate how much consumers in Norway were willing to pay for organic and welfare-labelled farmed salmon. All things being equal, consumers were willing to pay a price premium of *15%* and *17%* respectively for organic and welfare-labelled salmon as compared to the conventional alternatives. Premium for the organic salmon however varied by color, such that, a paler organic salmon[13] resulting from the restrictive pigment additives in feed led to a price less than the conventional and welfare-labelled salmon. The colour of food is used as an indication for food quality and so though premium foods may be desired by consumers, a resulting reduction in the aesthetic property could significantly lead to discounts. As further indicated by Olesen *et al*. (2010), the *2%* premium difference is an indication of close substitutability and/or diminishing marginal returns for added attributes, given the comprehensive nature of the organic salmon compared to the welfare. On the colour effects, Alfnes *et al*. (2006) found the effect of colour on willingness to pay for salmon was concave in nature as colour changes from paler to redder colour. This indicates that the optimal colour to achieve a good price as a producer lies between the extremes; possibly equivalent to the known conventional salmon colour.

Looking at the tradeoff of Canadian consumers in Ontario are willing to make between the types of production and health attributes of salmon, Rudd *et al*. (2011) considers attributes like the local impacts on the environment, level of omega 3 fatty acids, level of PCBs in flesh and the region of origin. Based on internet survey choice experiments, it was shown that producers who reduced the environmental impacts of salmon production attracted modest premiums, thus consumers cared less about the environmental soundness of salmon production. However, they were strongly averse to increased levels of PCBs, such that their wiliness to pay tradeoff for reduced PCBs was within the range of *35%-50%*. This implied the promising market for salmon production using reduced levels of fish meal and fish oils. In a qualitative study in the neighboring US, O'Dierno *et al.* (2006) estimated qualitatively that about 14 percent of consumers were willing to pay 50% or more premium on organically grown seafood through a telephone survey for selected markets. On the other hand, 21 percent were willing to pay up to 50% more premium

[13] Salmon fed from feed approved by the British Soil Association with strict restriction on pigment additives i.e. allow only natural additives.

over a conventional seafood costing $1 per pound (identified in females with larger household size). Thus, more consumers are attracted to lower premiums, than higher ones.
Price premiums paid on ecolabeled seafood were shown to be inhibited by the lack of information dissemination to consumers in Uchida *et al*. (2014b) for Japanese consumers. Using a sealed bid second price auction to elicit the willingness to pay for consumers in Tokyo, it was revealed consumers were willing to pay a premium of *20%* for MSC ecolabeled salmon. This premium was only observed after participants were provided information on the global status of fish stocks and the purpose of MSC label program. Hence, the key to unlocking the potential in ecological seafood products according to Uchida *et al*. (2014b) is to inform consumers about the need for ecolabelling.

Similarly in Denmark, Daugbjerg *et al*. (2014) and Smed and Andersen (2012) confirm this information effect that in order to promote green consumption effectively or increase the probability of organic volume shares, ecolabelling schemes must be accompanied by information campaigns on the production aspects covered by the label to ensure consumer understanding or provide information regarding the negative aspects of the conventional systems. The lack of adequate knowledge may undermine the potential of eco-labelling as an environmental policy instrument. According to Uchida *et al.* (2014a), the ways in which consumers perceive information (positively or negatively) affect their valuation of the ecolabeled product. Perceived positive information (information accepted to be interesting and credible) increases ecolabeled seafood products while exaggerated information has insignificant effect on the willingness to pay. Consumers in Japan were found to be willing to pay 26% for ecolabeled salmon, 44% if ecolabeled salmon was produced locally in Hokkaido.

Though price premiums on ecolabeled food products may serve to encourage the adoption of sound and ethical production practices, consumers react to the magnitude of the premium. For example, Johnston *et al.* (2001) found in a comparative contingent valuation study that at no premium, the probability of choosing certified ecolabeled salmon and cod was 88% for US consumers and 74% for Norwegian consumers. However, an increase in price premium to 50% for the ecolabeled seafood reduced the US consumers' probability of choosing the premium food to 68% and Norwegians to 32%. This reveals that the sensitivity of consumers to price premium changes is quite heterogeneous across geographic markets. Wessels *et al*. (1999) also used similar approach and found a positive premium price difference averaging $1.5 between certified and uncertified cod and salmon in the US. Further analysis showed that consumers were less likely to choose certified products over uncertified products for an increase in premium. This effect was shown to be greater for cod than for salmon. Estimates from a conjoint analysis from Jaffry *et al.* (2000) indicate that consumers in Denmark and UK were willing to pay a premium of £ 0.7 pounds for seafood certified as coming from sustainably managed fishery, thus, an MSC-like certification system.

Most studies using the stated preference approach provide the general backing that consumers have positive attitudes towards ecologically friendly seafood products. These studies usually estimate the probabilities of choosing such foods, consumers' perception and motivations. For example evidence in the UK suggests that the presence of a label conveying a fish coming from sustainably managed fishery, for cod fillets increases the probability of being chosen by 7% compared to a fish with quality label. This was the largest effect among all attributes and fish species that were investigated (Jaffry *et al*., 2004). Other studies include Donath (1999), Brécard *et al.* (2009), Salladarré *et al.* (2010) and Johnston and Roheim (2006) who show consumers have varying positive attitudes towards ecolabelled seafood products but few estimate willingness to pay premiums for various environmental/ecological attributes.

Table 2.9. Summary: Stated premium range for seafood

Type of ecolabel	Premium range (%)
Organic	17 - 50
Chemical residues	35 - 50

2.3.3.4 Stated agriculture ecological premiums

For studies based on consumers' willingness to pay premium for agriculture products, a lot of studies have been conducted in many EU countries and around the world. Stated premiums reported from consumers have generally shown a positive support with varying motives and perceptions. Diving peripherally on evidences, Wier and Calverley (2002) provide a review of earlier[14] studies on consumer willingness to pay premiums. It is indicated that 5-30 percent of consumers buy organic food when the premium is higher than 30%, premiums of 10-30% attract 10-50 percent of consumers whiles premiums between 5-10% attract 45-80 percent of consumers. This illustrates that though consumers indicate positive willingness to pay premiums, they are quite sensitive to prices as lower premiums will increase the patronage of ecolabelled food products.

Among the Danish households, consumer preferences for organic and locally produced apples compared to an apple imported from outside the EU was investigated by Denver and Jensen (2014) in an online panel survey. For high perceived organic consumers, the willingness to pay premium was 12.20DK/kg (174%) for organic apples and 22.60DK/kg (323%) for locally produced apples compared to a price of 7DK/kg for conventional apple from outside of EU. The average and neutral perceived organic consumers on the other hand have respective premiums of 5.40DK/kg (*77%)* and 19DK/kg (*271%)* for organic and local apples. Janssen and Hamm (2012) advice for organic products to be labelled with well-known organic certification logos that consumers trust. The study which covers selected European countries estimated the willingness to pay premiums for organic eggs and apples. In Denmark for instance, the government organic logo commanded the highest premium of 52% and 54% respectively for apples and eggs as compared with the old EU and Demeter logos for organic. Similar trend was observed in Germany (51%, 92%) and Czech Republic (56%, 53%) respectively for apples and eggs. For UK, Switzerland and Italy, the highest premium was observed for labels that were well-known and trusted with perceived strict organic standards and control systems.

In the cities of Navarra and Madrid in Spain, Gil *et al.* (2000) used a direct contingent valuation method to estimate consumers' willingness to pay premiums for organic food products. For both potential and actual organic consumers, willingness to pay premiums were similar ranging from 15%-25% while the "unlikely consumers" were reluctant to pay premiums. Among the range of products, the premium was higher for meat, fruits and vegetables indicating that organic attributes are more valued in fresh and perishable products. The valuation of meat was attributed to the food scares that had taken place in Europe, like BSE and dioxins. Ureña *et al.*

[14] 2000 and beyond.

(2008) investigated regular food shoppers for home consumption in Castilla-La Mancha (Spain). Among products analyzed, fruits and vegetables were products for which a higher percentage of consumers were willing to pay a premium with very extreme price sensitivity. Thus, at 5% premium on organic fruits, 83.7% of the respondents were willing to pay a price premium while at 20% premium, only 42.2% showed some willingness to pay. The highest premiums observed for all consumers were fruit (17%), dairy (16%) and vegetable and tubers (15%). Dried fruits, jam and medicinal/aromatic plants attracted lower premiums of 4%, 6% and 7% respectively. The distribution of premiums varied with the type of consumers (regular or irregular organic consumers). The result corroborates the findings of Gil *et al.* (2000) that, valuation of organic products depends on the degree of perishability of the product; as fresh products tend to attract higher premiums.

Table 2.10. Summary: Stated premium range for agriculture

Type of ecolabel	Premium range (%)
Organic	10 - 100
	(4 - 330)

Value in parenthesis is extreme lower-upper bound premium ranges

CHAPTER 3

PRICE PREMIUM OF ORGANIC SALMON IN DANISH RETAIL SALE

3.1 Introduction

The year 2016 will be pivotal for the European Union organic aquaculture sector. According to Commission Regulation (EU) No 1364/2013, the full life cycle from the time the fish hatches to when it is slaughtered must be 100 percent organic from 1st January 2016, if the product is to be recognized and marketed as an organic certified product. Today only grow out stages of aquaculture production need to be organic to achieve this label. The regulation of exclusively using organic fry is expected to challenge the organic aquaculture producers in that the organic rules only allow limited use of antibiotics and requires specially made organic feed. As such, the new regulation will most likely induce higher cost in terms of higher fry mortality, feed costs and management effort.

In light of this transition, the existence of a price premium could incentivize producers and facilitate subsequent conversion of conventional farms into organic farms and maintain already existing organic farms. The necessary conditions for the price premium existence are consumers ability to identify organic goods at retail sale (i.e., through labeling), and the willingness to pay extra price relative to the conventional salmon. Furthermore, the price premium must be transmitted through to all actors in the value chain, i.e. if the organic salmon market is to be maintained, all actors in the chain must gain from it (Asche *et al.*, 2015).

The purpose of this article is to reveal whether a price premium exists for organic farmed salmon products in the Danish retail market. The magnitude of the estimated price premium is discussed in light of the premium attributed to other eco-labels such as in organic agriculture, fisheries (e.g., the Marine Stewardship Council) and aquaculture eco-labels (i.e., organic and the Aquaculture Stewardship Council) found in literature. The workhorse for the study is the hedonic price model.

The study provides an important contribution to the hedonic literature on eco-labels for seafood mainly conducted in the United Kingdom. In contrast to stated preference studies which identifies hypothetical willingness to pay, this study provides evidence of "revealed" organic price premiums; an evidence important for fish farmers and actors in the value chain in an emerging organic aquaculture market. Although this study has direct benefits for producers in Norway[15], Scotland and the Faroe Islands in the case of salmon, it informs producers about the market potential of substitute products such as organic trout where Denmark is the leading producer.

Environmental friendliness has for the last 2-3 decades been a major part of the food production process and consumer food choice decisions, more recently also being introduced in the seafood sector. Despite the established importance of seafood as a global source of protein, nutrition and other health benefits (Brunsø *et al.,* 2008; Daviglus *et al.*, 2002; FAO, 2012), there has been growing concerns about the environmental impact of the production process (Asche & Bjørndal, 2011; Asche *et al.*, 2015; Roth *et al.*, 2000). The traditional "command and control" fishery

[15] Norway, though not a member, follows the EU rules on organic aquaculture, because the EU market is the most important export market.

and aquaculture management instruments have been recognized as inadequate in their own in terms of addressing these concerns. Thus, market-based incentive regulation such as individual transferable quotas (Anderson, 1994; Nielsen, 2011; 2012; Nielsen *et al.,* 2013; Smith, 2012; Turner, 1996) and the use of information, such as eco-labelling, have been called upon as an alternative to traditional methods of regulating environmental externalities.

Eco-labelling helps to establish product differentiation by making the credence attribute production method (organic/conventional) visible to the consumer and mitigates any potential inefficiencies resulting from imperfect information (e.g. information asymmetry between producers and consumers) about the environmentally friendly production processes of a good. Because such production processes are typically more costly than conventional standards, producers undertaking these methods need increased earning. Hence, the aim of eco-labelling is to increase profits by attracting environmentally responsible consumers who are willing to pay a price premium to support a costlier production process, while attaining utility.

The most dominant and studied eco-label in the seafood sector is the Marine Stewardship Council (MSC) in the fisheries sector (MSC, 2014; Roheim *et al*., 2011). The Aquaculture Stewardship Council (ASC), established in 2010, is also emerging for farmed fish (ASC, 2014) but yet to be studied. Following the introduction of EU Regulation 710/2009 in 2010, the EU organic aquaculture eco-label was also introduced. However, there are many other national and private aquaculture labels. To build on consumer confidence, certified organic farmed fish in Denmark are labelled with the well-established and well-known label, a red Ø, which is issued, enforced and controlled by the Danish government.

Most studies rely on stated preference methods to establish willingness to pay for eco-labelling in the seafood market (e.g. Olesen *et al*., 2010). Those relying on actual market data (i.e., revealed preference methods) are limited, but evidence provided in the fishery sector include the existence of an approximately 13% price premium for salmon (Asche *et al.,* 2015) and cod and haddock (Sogn-Grunvåg *et al.,* 2014), a 10% premium for chilled haddock (Sogn-Grunvåg *et al.,* 2013) and a 14% premium for frozen Alaska pollock (Roheim *et al*., 2011) in the UK market for MSC-labelled fish. A mean price difference of 10% is estimated for MSC Baltic cod in Sweden (Blomquist *et al.,* 2015). For organic salmon, an approximately 25% price premium is found in the UK (Asche *et al.,* 2015). Price premia of 24% and 38% for organic fresh and smoked salmon respectively, have been identified in Norway (Aarset *et al*., 2000). On eco-labelled agricultural products, there is evidence of price premiums ranging from 15-60% in the UK and Danish markets for various products (Baltzer, 2004; Wier *et al*., 2008). Generally, organic price premiums for agricultural products appear to be larger than the range of 10-14% identified for fishery eco-labels.

Using consumer panel data, this study establishes that there is a price premium of approximately 20% for organic salmon. The magnitude of the premium might indicate that consumers value organic farmed fish as in the same range as agricultural products, rather than in the same range as fishery products. The magnitude might also indicate that the Danish organic Ø-label is better-established and more accepted among Danish consumers than the MSC-label. The higher cost of producing organic fish has to be compensated by a higher willingness to pay from consumers. Hence, the high price premium of organic salmon on 20 % is good news for producers, provided the price premium is transmitted from consumers, through the value chain to primary producers.

The article is organized as follows. The next section introduces the Danish seafood market, followed by a description of data used for the analysis. The theoretical model and the empirical specification are then discussed. Next the empirical results are presented. Finally, section 7 presents the conclusion.

3.2 The Danish seafood market

Denmark is the eighth largest exporter of fish and fishery products in the world (FAO, 2014) with about 80 percent of Danish exports staying in the EU. It is a major importer of raw materials used for further processing and then re-exported. In 2013, export of fish and fishery product was DKK 21.5 Billion, where import formed DKK 15.5 Billion. Most imports originate from the countries surrounding the western part of the North Atlantic Ocean with Norway being the largest. Hence, Denmark is an intermediate market in the seafood value chain, with substantial seafood processing but also with important primary fishery and aquaculture sectors. Seafood processing and wholesale in Denmark is mainly made for the EU market, implying that the Danish home market becomes a residual market that is only supplied with a small fraction of what is produced in Denmark (Nielsen, 2005).

The Danish aquaculture sector has a well-established tradition of fish production that dates back more than a century (Hessel, 1993). Aquaculture production concentrates on rainbow trout, farmed freshwater. Blue mussels, sea trout, chars and pike perch are produced in modest quantities, with several marine fish and mussel farms. The total annual production is approximately 43,000 tonnes, of which 90 percent is rainbow trout (Statistics Denmark, 2014). The EU is the most important market with Germany being the largest destination market (Nielsen *et al.*, 2011; 2012). In 2014, Denmark became the largest producer of organic trout, passing France with a production volume of 1080 tonnes. Organic mussel farms produce approximately 400 tonnes per annum.

Production of salmon is modest and no organic salmon is produced locally. Norway and the Faroe Islands are the most important fresh salmon markets serving the Danish import demand. The import of salmon is fairly evenly divided into fish that are re-exported with little or no processing and fish that are used for processing, and mostly re-exported in processed form. As a result, Denmark is the second largest exporter of salmon in Europe after Norway (Asche & Bjørndal, 2011). According to Statistics Denmark, more than 80% of the volume of salmon imports into Denmark is farmed fresh or chilled Atlantic salmon. The local market for fish consumption is limited due to its small population; however, the per capita consumption of 24 kg/year/per capita is relatively high.

Domestic supply outlets include supermarket chains, independent fish-mongers/specialized stores, online retailing, restaurants and catering services. Supermarket outlets command the largest share, accounting for 85% of the total domestic supply. According to Brunsø *et al*. (2008), the most frequently consumed fish species and their shares of consumption are herrings (22%), tuna (19%), mackerel (17%), salmon (11%) and plaice (10%). Canned, marinated and fresh fileted fish are the three most frequent product categories. The total domestic fish consumption in 2008 was approximately 127,000 tonnes. Salmon was estimated to be the most consumed fish in terms of value in Denmark followed by cod with respective values of DKK

1.2 Billion and DKK 940 million. The value shares of salmon were 44% for fresh salmon, 39% for smoked salmon and 17% for frozen salmon (Anon, 2011).

Danish consumers have a long tradition for buying organic food products. The country continues to rank second in terms of per capita organic food consumption (DKK 1223/person) and first in terms of organic market share (8%) in the retail market worldwide (Willer & Lernoud, 2015). The most important organic fish species produced in Denmark, trout, hit the retail market in 2005 (Larsen, 2014). Domestically produced organic fish are labelled with the Danish red-Ø label, which is well known and accepted among consumers. MSC and ASC eco-labels can also be found on retail shelves. The consumption of fish among Danes is motivated by health benefits, availability, convenience, taste, traditions and in contrast, high prices deter consumers from purchasing (Nielsen, 2000). The frequency of fish consumption of elderly people is at least twice that of young people (Olsen, 2004). On average, the consumption frequency is 1.4 times per week compared to the European average of 1.5 and the recommended level of two times per week (Brunsø *et al*., 2008).

3.3 Data

Consumer scanner data were used to determine the existence and magnitude of the retail price premium for organic labelled salmon products. The use of scanner data from the retail sale of products became widely employed in the 1980s (Roheim *et al.,* 2011). The data used in this study originate from GfK Panel Services Denmark, which maintains a demographically representative consumer panel of Danish households. We consider an emerging organic fish market for which observations have been recorded only since 2011. Hence, observations span from 1 January, 2011 to 31 December, 2013. The data contain the daily purchases of over 2,000 households, with approximately 20% of the households replaced each year by a similar type of households. The data are a *refreshed panel data*[16]. Unlike traditional panel data, we observe repeated time values that cannot be aggregated over time to provide unique values (i.e., households report multiple purchases at a single point in time for salmon products with different characteristics)[17]. Aggregation would lead to a loss of information, especially for organic products because they represent a small fraction of the total observations. Because households do not purchase goods in a continuum of time, say every week, observations are reported in irregularly spaced time intervals to reflect shopping trips and purchasing behaviour over time.

For each shopping trip, the household reports food purchases, including the date and time of the purchase, the shop name, the expenditure and the volume of the product purchased. For each unit of salmon purchased, households report information on whether the product was labelled as organic; a brand or private label; fresh or frozen; smoked, marinated, breaded, stuffed or processed in another form; filleted or whole fish; and, purchased on a special offer or at the normal price. Summary statistics for the data and descriptions of the variables obtained to estimate the model are presented in table 3.1. The GfK data does not identify the type of organic label (e.g.,

[16] See Fitzmaurice *et al.* (2012) and Frees (2004) for a discussion of features of data types with repeated observation.
[17] This presents a challenge in modeling the time series property of the data such as autocorrelation. Autoregressive models are less appealing for unequally spaced data.

the Danish Ø-red logo) indicated on the product[18]. Likewise, the name of the brand or private label is not identified. The private and brand label attributes have no relation with organic or any environmental labels, but does identify whether the package label was that of the supplier (i.e., brand label) or customized to the retailer (i.e., private label).

Table 3.1. Summary statistics and variable descriptions

Variables	Mean	Std. dev.	Variable description
Price DKK/kg	158.73	65.50	Price measured in DKK per kg
Organic price	190.98	109.06	Price of organic salmon in DKK per kg
Conv. price	158.63	65.31	Price of conventional salmon in DKK per kg
Ln(price)	4.98	0.44	Log of price
Volume (Vol)	0.28	0.23	Volume purchased in kg
Organic (Org)	0.003	--	Dummy variable: 1 if organic, 0 otherwise
Brand (Br)	0.77	--	Dummy variable: 1 if brand label, 0 private label
Fresh (Fr)	0.86	--	Dummy variable: 1 if fresh, 0 frozen
Pr smoked (Prc)	0.50	--	Dummy variable: 1 if smoked, 0 otherwise
Pr marinated (Prc)	0.22	--	Dummy variable: 1 if marinated, 0 otherwise
Fm fillet (Fi)	0.90	--	Dummy variable: 1 if fillet, 0 whole fish
Spec. offer (Sp)	0.45	--	Dummy variable: 1 if on special offer, 0 normal price
Year 2012	0.36	--	Dummy variable: 1 if year 2011, 0 otherwise
Year 2013	0.34	--	Dummy variable: 1 if year 2012, 0 otherwise
Year 2011	0.30	--	Dummy variable: 1 if year 2013, 0 otherwise
Season1 (Se)	0.23	--	Dummy variable: 1 if quarter 1, 0 otherwise
Season2 (Se)	0.26	--	Dummy variable: 1 if quarter 2, 0 otherwise
Season3 (Se)	0.23	--	Dummy variable: 1 if quarter 3, 0 otherwise
Season4 (Se)	0.24	--	Dummy variable: 1 if quarter 4, 0 otherwise

Notes: The abbreviations in parentheses were used in the model expression (see below)
Source: Authors own calculation

After subsampling household salmon purchases and removing unusable observations (such as observations without any descriptive information and, errors/outliers in the data), we were left with 18,471 observations from 2,342 households. The volume of the purchase measured in grams was converted to kilograms, and the value of purchase was divided by the volume to retrieve the price per kilo (DKK/Kg). The means of the dummy variables shown in table 3.1 represent the fraction of the total observations for the respective attributes. For instance, organic salmon products represent approximately 0.3% of the total number of observations used in the analysis. Salmon fillets make up approximately 90% relative to whole-fish purchases. The organic market share of the data was approximately 0.5% of the total salmon market sales in volume. Inflation over the study period was quite low; hence, we do not expect it to affect food prices much in this short period. Therefore, the model was estimated with the nominal market prices.

[18] The ASC and MSC eco-labels though available on retail shelves were not identified in the GfK data. Also no distinction could be made for wild and farmed salmon. However, since most of Denmark's imports are farmed Atlantic salmon coming from Norway, Scotland and Faroe Islands, we do not expect any influence on the conclusion of the results.

3.4 The hedonic price model

Recognizing the inability of neoclassical theory of consumer demand to explain why consumers derive utility from commodities and predicting the demand for new products, the characteristics theory (hedonic price model) was proposed by Lancaster (1966; 1971) to address some of these inherent limitations (Smith *et al*., 2009). Although Bartik (1987) notes that the first formal contributions to hedonic price theory were made by Court (1941) and Tinbergen (1951; 1956), an earlier application has been attributed to Waugh (1928), who studied the quality factors influencing the prices of vegetables. The introductory section by Waugh (1928) also makes note of earlier applications for other agricultural commodities. However, the application of the hedonic model was pioneered by Rosen (1974) and has since been widely used in the literatures on housing, environmental economics and, labour markets and has gained attention in marketing and industrial organization (Bajari & Benkard, 2005). The Lancastrian theory presumes that consumption is an activity for which goods, singly or in combination, are inputs and the output is a collection of characteristics. This theory plays a crucial role in and lays the necessary conceptual framework for the development of modern hedonic analysis (Huang & Lin, 2007). Rosen further refined this theory with a particular emphasis on market equilibrium.

The hedonic approach postulates that goods are made up of a myriad of attributes that combine to form a bundle of characteristics that consumer's value. The demand for various desired characteristics can be estimated from consumers' willingness to pay for a product. As such, the marginal or implicit values can be imputed for each attribute at the observed purchase price linked to the myriad of attributes contained in the good. The hedonic model operates on the premise that consumers and producers consider the same set of attributes when valuing a good. As a result, the choices each group makes lead to an equilibrium condition that neither have any incentive to change. The equilibrium price determination introduced by Rosen (1974) requires simultaneous estimation of both supply and demand equations. Following Wilson (1984), we make the implicit assumption that the supply of product attributes is perfectly inelastic with respect to its marginal implicit price in any given time period. Given such an assumption, the empirical hedonic price model requires only market clearing prices rather than both demand and supply schedules (Kim & Chung, 2011).

The retail market for salmon meets consumers' needs by differentiating products. Products are presented with different brand labels, eco-labels, processed forms and other desirable characteristics. Due to the heterogeneous nature of the products, the determination of an organic premium from observations of prices alone becomes a challenge. The hedonic framework permits the estimation of a price premium for organic characteristic that is distinct from the other characteristics. Consider a consumer's purchase of a unit of salmon. Salmon consists of n component characteristics: $z = z_1, z_2, \dots z_n$. Consumers maximize utility subject to a nonlinear budget constraint[19] where utility is a function of a numeraire good, x, and the purchase of the differentiated good, z (the vector of characteristics). Thus,

$$\max U(x, z) \quad s.t. \quad m = x + p(z_k) \tag{1}$$

[19] The nonlinearity of the budget constraint fulfils that arbitrage of characteristics is not possible. Hence, product attributes cannot be disentangled and repackaged.

where m represents the total income available and the consumer is assumed to choose a bundle of good and the goods in which the good's characteristics maximize utility. Utility is maximized when the marginal rate of substitution between a characteristic (z_k) of the product and the composite good is equal to the marginal price of z_k. The solution to the first-order conditions from the constrained optimization for price yields the standard hedonic price equation:

$$p_i = f(z_k) \quad (2)$$

where the price of a heterogeneous good is a function of product characteristics. The derivative of price with respect to the kth characteristics yields, ceteris paribus, the implicit marginal price of that characteristic. Our goal is to estimate equation 2, also known as the first-stage hedonic price function. In this stage, the observed market clearing prices are regressed on the product characteristics[20]. The derivative of price with respect to an attribute gives the marginal implicit price of that attribute.

3.5 Empirical model specification

Generally, economic theory does not provide guidance for the specification of the functional form of the hedonic price model. Although some researchers make assumptions of the functional form, this can lead to incorrect conclusions; therefore, using the data to determine the appropriate functional form is recommended (Faux & Perry, 1999). The Box-Cox transformation of the dependent variable which improves the normality of a variable (Box & Cox, 1964; 1982), was used in this paper to test for the functional form where the log-linear model is selected over other alternatives. This functional form makes it easier to interpret parameter estimates and shows the nonlinear relationship between prices and product attributes. Following this, we expand the hedonic price function in equation 2 in a log-linear form of the salmon price for product i at time t, represented as follows:

$$lnp_{it} = \alpha + bVol_{it} + \beta Org_{it} + \delta Br_{it} + \emptyset Fr_{it} + \sum_{n=1}^{p-1} \gamma_n Prc_{it} + \varphi Fi_{it} + cSp_{it} + \sum_{j=1}^{s-1} \theta_j Se_{it} + e_{it} \quad (3)$$

The equation above is estimated by ordinary least squares where the descriptions of the variables are as presented in table 3.1. Because the data spans multiple years, it is possible to include year dummies to exploit year to year price changes. The estimation of equation 3 is based on the assumption of independent observations.

The data represent a structure where the reported observations or purchases of salmon are nested within households. In such a situation, observations from household units are most likely non-independent. Thus, observations from the same household are more likely to be similar than observations from different households. The estimation of non-independent observations with ordinary least squares methods leads to incorrect conclusions because the parameter estimates and their standard errors become biased and inefficient (Andreß *et al.*, 2013; Musca *et al.*, 2011). We therefore consider the class of longitudinal models able to account for such a nesting structure in the data and operate on the assumption of independence across household units but not within each household's observations. The basic idea in this application is that there may be some natural

[20] The derivative of the variable Volume describes the responsiveness of price in relation to the average purchased value (to the size of the purchase), i.e., not to total quantities supplied. Hence, it has nothing to do with own price flexibilities as defined by Anderson (1980) and as estimated e.g., in Nielsen, Smit and Guillen (2012).

unobserved household heterogeneity that allows households to choose prices that may be above or below the average market price. For instance, households may be naturally attracted to shops with higher/lower salmon prices than the average. Alternatively, organic consuming households are more likely to choose organic products on subsequent shopping trips than non-organic households.

The choice of models used to handle the unobserved characteristic (i.e., household heterogeneity) is usually the fixed effect and random effect models. Whereas fixed effects analysis supports only inferences about the sampled households, random effects analysis allows one to make inferences about the entire population from which the sample was drawn. The random effects analysis appears to fit our purpose because we are estimating the hedonic model to derive an organic premium for a representative population in Denmark. Therefore, we consider a variant of the random effects model called the mixed linear model (MLM)[21]; a general class of models that takes into account the nesting structure (i.e., non-independence) of the data. The mixed linear model with 2 level modelling; observed salmon prices (level 1 unit) nested in households (level 2 unit) is considered. Most often both the unconditional and conditional models are estimated to estimate the amount of variation explained by the independent variables. The unconditional random intercept model can be written as follows:

$$\ln P_{ij} = a + u_j + e_{ij}\,;\; i = 1....n \quad products, \qquad j = 1.....m \quad households \tag{4}$$

The conditional model with the product attributes is also specified by expanding equation 4 as follows:

$$\ln P_{ij} = a \; + bVol_{ij} + \beta Org_{ij} + \delta Br_{ij} + \phi Fr_{ij} + \sum_{n=1}^{p-1} \gamma_n \mathrm{Prc}_{ij} + \varphi Fi_{ij} + cSp_{ij} + \sum_{h=1}^{s-1} \theta_h Se_{ij} + u_j + e_{ij} \tag{5}$$

In equations 4 and 5, we change the notation of subscripts to denote household j (level 2 unit) observing the purchase of product i (level 1 unit) at multiple occasions. In simple terms, if one considers an intercept only model of equation 3, then the purchase of product i by household $j$is given by a function of the market wide price a plus a differential u_j for each household j (referred to as unobserved household heterogeneity or level 2 unit or household residuals): $\alpha = a + u_j$. The right side of equation 5 can therefore be divided into two parts in the language of mixed models: (1) fixed effects (comprising of the parameters to be estimated) and (2) random effects (made up of the level 2 residuals and the idiosyncratic error/level 1 residuals, e_{ij}). The error terms are assumed to be normally distributed: $u_j \sim N(0, \sigma_u^2)$ and $e_{ij} \sim N(0, \sigma_e^2)$.

The model can be expanded by including the household unit characteristics as explanatory variables, but this is not the focus of this study because we are modeling equilibrium prices based on the assumption that the consumer and producer are operating optimally such that none can alter prices. Additionally, the first stage of the hedonic model is traditionally an estimation of prices on product characteristics. A major problem often associated with panel data is the issue of temporal autocorrelation. Though the mixed linear model provides more opportunities to estimate various covariance structures with time variation (autoregressive models), we are limited because

[21] Estimation was done in Stata where MLM is able to handle singleton observations within panels unlike the traditional random effects model, which is important to prevent loss of information.

the repeated time structure of the data does not permit us to test for the presence of autocorrelation[22]. However, given that the data are a rotating panel where some households appear once in the three years, it is intuitively plausible to rule out the presence of autocorrelation. Estimation of Equation 5 is based on the assumption that the value of the organic eco-label is independent of the retail chain as found in Asche *et al.* (2015).

3.6 Estimation results

Reports on the coefficient estimate and goodness-of-fit of the models estimated from equations 3 (OLS) and 5 (MLM) are shown in table 3.2. Overall, both models were highly significant; a joint test of all independent variables significance shows a P-value < 0.01 using an F-test for OLS and Chi-square test for the MLM. The OLS model showed an R^2 of approximately 0.48, indicating that the independent variables explain approximately 48% of the total variation in prices. The MLM model presents two different R^2 for the level 1 and level 2 units. The computed Snijder and Bokser (1999; 1994) R^2 indicates that the independent variables explain approximately 48% of the variation in prices while the unobserved household heterogeneity (level 2 unit) explains approximately 52% of the variation in prices. A likelihood ratio test of $Ho\colon \sigma_u^2 = 0$,[23] rejected the null indicating that a model with unobserved household heterogeneity provides a better fit. The intra-class correlation not reported in the MLM estimation output was 0.29, indicating the correlation of prices reported by the same household. Variants of the models were estimated with the inclusion of year dummies and, weekly and monthly trends to control for price changes. However, these were not significant and therefore have been dropped from the model.

The values reported for the Akaike Information Criterion[24] for the two models presented in table 3.2 indicate that the MLM provides the better fit. Given this selection, we restrict the interpretation of the parameter estimates to the MLM model. However, one can see that there is robustness in the parameter estimates between OLS and the MLM except for the organic variable. The parameters were estimated by acknowledging the presence of heteroscedasticity; hence heteroscedastic (cluster for MLM) robust standard errors were estimated.

[22] In repeated time value data with sparse observations, it is unappealing to use time series operators such as lags or differences.
[23] If $\sigma_u^2 = 0$, then the linear regression model (OLS) provides a better fit (thus the u_j should be omitted from the model).
[24] Bayesian Information Criterion values not reported show a similar pattern.

Table 3.2. Parameter estimates

Variables	---------------OLS-------------- Coefficient estimate	Robust std. error	---------------------- MLM --------------------- Coefficient estimate	Cluster rob. std. error	Percent premium
Volume (kg)	-0.505***	0.021	-0.503***	0.028	
Organic	0.363***	0.033	0.180***	0.061	19.7%
Fresh	0.294***	0.008	0.263***	0.011	30.1%
Pr_marinated	0.265***	0.008	0.258***	0.011	29.4%
Pr_smoked	0.248***	0.007	0.239***	0.011	27.0%
Fm_fillet	0.072***	0.008	0.053***	0.010	5.4%
Brand label	0.015***	0.006	0.021***	0.008	2.1%
Special offer	-0.240***	0.005	-0.198***	0.007	-17.3%
Season1	-0.001	0.007	-0.005	0.006	-0.5%
Season2	-0.014**	0.006	-0.013**	0.006	-1.3%
Season3	0.034***	0.007	0.026***	0.006	2.6%
Constant	4.712***	0.015	4.718***	0.019	
σ_u^2			0.030		
σ_e^2			0.074		
AIC	9777		6941		
Prob(LR: $\sigma_u^2 = 0$)			0.000		
Prob > F/(x^2)	0.000		0.000		
R_1^2	0.477		0.476		
R_2^2			0.515		
Observations	18,471		18,471		
# of Households			2,342		

***, **, * indicates significance at p<0.01, p<0.05, p<0.1. MLM, mixed linear model. θ is parameter estimate.

All parameter estimates of product attributes appear to have the expected sign, according to economic theory or logical reasoning. Considering the volume of salmon products purchased, we observed a negative parameter estimate that is significant at the 5 percent level. The negative relationship between volume and the natural logarithm of price is an indication of a nonlinear price- discount due to the size of the purchase. The larger the quantity of a product purchased, the lower the marginal increase in price. Depending on the initial volume of salmon purchased, the extra kilogram purchased could be discounted by approximately 50 percent, *ceteris paribus*.

We interpret the parameters of the dummy variables as the percentage premium as recommended by Halvorsen and Palmquist (1980) and computed as: $Percent\ Premium = (exp^{\theta} - 1) * 100$, where θ is the estimated parameter of the respective variables. The parameter for the organic variable indicates that there exists a price premium for organic salmon in retail markets in Denmark given that it is highly significant at the 1 percent level. Households in Denmark therefore pay a premium of 19.7% over the conventional salmon price after accounting for other good attributes. Estimates from the OLS indicates consumers would pay a premium of approximately 44% for organic salmon if one were to discard the assumption of non-independence arising from repeated observations from the same households.

A premium of approximately 20%, as shown by the MLM estimation, is substantial compared to the premium that has been identified in literature with the MSC eco-label in the fisheries sector, which is in the range of 10-14%. The value however, appears in the range of organic agricultural price premia identified in the Danish and UK retail market. Although it remains a matter of speculation, one possible explanation for this result might be that the organic label is well-established and that consumers are well-aware of it, while their knowledge on specific fish eco-labels, like the MSC and ASC eco-label, might be less. That might be backed up by the finding of Grunert *et al.* (2014) that most consumers only have a limited use of sustainability labels which might well include the well-known organic label and exclude the specific fish labels, MSC and ASC.

Salmon products were presented as either fresh or frozen products and the estimation indicates that households tend to attribute a higher value to fresh salmon products compared to frozen products. As shown above, fresh products commanded approximately 30% extra in price over frozen ones, *ceteris paribus*. Likewise, some value is added to products to meet the heterogeneous preferences of consumers by further processing. Processed product groups identified in the data were marinated, smoked, breaded, stuffed and other unidentified products. The last three of these processed products were not significantly different in price valuations, so they were combined as the reference group. The results indicate that salmon consuming households in Denmark have a greater preference for smoked and marinated salmon. The smoked and marinated salmon product commanded approximately 27% and 29% extra in price, respectively, compared to the stuffed, breaded and other processed products, holding other attributes fixed. Roheim *et al*. (2011) argued based on similar results that the so called "value added" products such as breading, battering or stuffing could actually be a process form that masks some of the quality control issues generated along the supply chain, thereby belittling the level of consumer trust.

Product branding has in the last decades become a marketing tool for differentiating products by retailers. Salmon products are identified with supplier brand labels. However, retail chains have preferences for their own custom private labelling from the main producers. The data therefore distinguishes products with brand labels from private labels. Our analysis reveals that significant differences exist between the two labels, with consumers valuing the brand labels by approximately 2% extra after controlling for other product attributes. Brand and private labels are a competition strategy in the retailing market. As stated in Sogn-Grunvåg *et al.* (2014), private labels strategically may come as economy packs that seek a 'value for money' position with a low price and acceptable quality similar to the supplier brands. Alternatively, they may be used as premium labels to present the consumer with a greater choice and build retailing image. The former appears to be the case for Danish retailers in the salmon market.

Moreover, consumers tend to like salmon fillets more than whole-fish because they appear to place a value worth approximately 5% on fillets. This could be explained by the fact that fillets are more convenient and easier to prepare. As explained earlier, convenience is a major determinant for seafood consumption among Danish consumers, and it is no surprise one would pay more for fillets compared to whole-fish. Sometimes, salmon products were sold in the retail chains at a discount for various reasons. The magnitudes of the discounts differ with retail shops and as they near the expiry dates. Controlling for discounted salmon products revealed that products were, on average, approximately 17% cheaper than the normal average market prices if discounted.

Lastly, we used quarterly dummies to account for seasonality, as defined in table 3.1. It was evident that prices observed in the first season (January - March) were not significantly different from the reference season, season four (October - December). However, we observed that prices were significantly lower in season two (April - June) and higher in the third season (July - September). The third season appears to suit the summer season, when prices were higher than all the other periods. An expanded form of the model was estimated to examine the individual month-to-month variation in salmon prices[25]. Prices were not significantly different from November to February and in March and April. Prices were significantly higher in the remaining months. The highest prices were observed in July and August, with respective premiums of 5 percent and 6 percent above the reference December prices. This was not surprising in that salmon to some extent is a seasonal commodity with most growth occurring in summer/early fall[26]. As with other seasonally perishable commodities, volatility is greatest just prior to the period of harvest due to low stocks (Oglend, 2013). Hence, the generally held notion of boosted Christmas prices is not a general rule for the salmon market in Denmark, or Norway (Forsberg & Guttormsen, 2006).

3.7 Conclusion

In this study, a hedonic price model was used to disentangle the marginal values of salmon product attributes with the aim of identifying whether a significant price premium exist for organic products. A scanner data from consumers of salmon in the Danish retail market is used to estimate a random effect model and an ordinary least squares model. The former is selected based on model selection criteria. The findings indicate that there is an approximately 20 percent price premium for organic salmon compared to the conventional alternative.

It was also revealed from the estimation that the issue of convenience leads to valuing fillets more than whole fish. Fresh products are valued higher than frozen. Marinated and smoked products are valued higher than breaded and stuffed product forms because these processed forms can mask the quality of fish along the supply chain. As a competition strategy, retailers make use of private labels as opposed to brand labels to provide consumers with economy valued products.

Valuing organic fish in the retail market presents first-hand motivating information for organic aquaculture producers given the potential change in the cost structure following the EU's full implementation of the organic aquaculture life cycle in 2016. However, because organic aquacultures supply an emerging market, it is expected that the size of the price premium will decrease, both with an increase in the supply of organic salmon and with a reduction in production costs over time following economies of scale. For farmers to receive the price premiums, the market must exhibit competitive behavior through the value chain, where premiums are transmitted to producers. Also, the governance structure along the global salmon value chain will determine the impact of the organic price margin to the chain actors.

In light of the literature on price premia for eco-labels in the fishery sector (i.e. MSC) and the agricultural sector (i.e. mainly organic), the value of the estimated premium is higher than the former and comparable to the latter. Although not studied and remaining a task for future research,

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[25] This model was not presented since it neither changed the estimates of the other parameters nor the model fitness significantly.

[26] Peak harvest periods occur in September and October.

this might indicate that consumer awareness and trust in the well-established and well-known organic label is transmitted to farmed fish from other food products. If this is correct and further assuming that Danish consumers have less knowledge and trust in the newer, specific fish labels MSC and ASC, the price premium of these are expected to be lower than for organic salmon.

Although the model specification appears good more research attention can increase the precision of the results and extend the scope of interpretation. First, price premiums are identified at the retail market, without assessing whether the premiums are transmitted through the value chain to fish farmers. Knowledge on the implication for organic salmon farmers and other businesses in the value chain on the existence of a price premium in retail sale, requires more knowledge on the nature of price transmission (i.e., speed and size), the global value chain governance structure of the organic salmon market and whether the size of the premium can cover extra costs. Second, the lack of data and evidence from the literature on MSC eco-labels in Denmark compelled us to compare the estimated price premium to fishery eco-labels in a different market (i.e., UK), a situation that is suboptimal. However, the similarities between the Danish and UK retail markets permit us to make this comparison to some extent. As portrayed by Wier *et al*. (2008), the two markets in Europe have greater shares of organic products distributed through mainstream conventional retail chains. They have concentrated organic food markets based on high proportions of imports and, in some cases, highly processed, large-scale units of production, processing and distribution.

CHAPTER 4

HETEROGENEOUS PREFERENCES, INFORMATION, AND KNOWLEDGE FOR ORGANIC FISH DEMAND[27]

4.1 Introduction

While organic production may not always mean the most environmental friendly production system, consumers link organic to a number of cues in their cognitive processing and among these are environmental and animal health and welfare concerns. Various definitions of organic are set by the different organic movement associations but also vary by the consumers understanding (Peterson & Li, 2011). The organic principle differentiates itself from the conventional by having respect for the environment, nature and livestock welfare (Alrøe, Vaarst & Kristensen, 2001). Nevertheless, consumers' perception of what a product's attributes are influences the product value and hence, an important factor in determining market prices.

With increasing demand for specialty products that exceed the minimum regulatory standards, market incentives in the form of high price premiums are warranted to ensure corresponding supplies. The supplies of these products on the other hand need to be recognized for valuation among consumers, hence the development of eco-labelling to display environmental and sustainability information. Currently, there are numerous ecolabels competing in the same product market with different or similar levels of regulatory intensity; an example is the ecolabel for organic and Aquaculture Stewardship Council (ASC) in the aquaculture industry. It is therefore important to investigate competition between ecolabels as valued by consumers and identify ways by which value in the form of price premiums can be maintained for continual assurance for suppliers.

In this study, we employ a stated choice experiment to investigate the value for ecolabels in the presence of other attributes in the farmed portion size trout market in Germany. In effect, we explore how interventions such as provision of information for educating consumers on the ecological production methods based on the European organic aquaculture requirements can influence the organic value, the role of the type of information provided and how it varies with consumers' level of learned knowledge.

Organic aquaculture is ultimately committed to sustainability by making sustainable use of resources for feeding. A sustainable aquaculture growth and production is aiming for progressive reduction in capture based fisheries resource as feed; given that approximately 3724 thousand tonnes of wild fisheries was used as feed in aquaculture (Tusche *et al.*, 2011). Compared to the agriculture, organic ecolabels in the aquaculture industry is relatively new. Though the concept has existed for over decades, it was in 2010 that for example, the European Union implemented the organic aquaculture Regulation 710/2009 (European Union, 2009), and countries like the United States is now trying to play catch-up. Similarly, global ecolabels such as the ASC established in 2010, the aquaculture version MSC (Marine Stewardship Council established in 1999) for the

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wild capture fishery also exists with less stringent production requirements than the organic[28]. These ecolabels exist partly owing to the problems associated with fast growing aquaculture industry; including degradation of invaluable ecosystems, lack of concern for animal behavioral needs, non-sustainable origin of feed stuff given the interaction with the already over-exploited wild fish stocks and consumer concerns.

The growing interest in organic products in response to conventional practices regarding food safety and human concerns, animal welfare and environmental concerns (Harper & Makatoumi, 2002; Schifferstein & Ophuis, 1998) has prompted numerous studies that examine consumer demand and preference for organic food (Bravo *et al.*, 2013; Marian *et al.*, 2014; Meas *et al.*, 2015; Thompson, 1998; Zanoli & Naspetti, 2002). Studies such as Aschemann-Witzel and Zielke (2015) and Yiridoe *et al.* (2005) provide extensive reviews. In general, the literature reveals that wholesomeness, absence of chemicals, environmental friendliness and taste are major determinants for the demand for organic food (Schifferstein & Ophuis, 1998). Furthermore, the central outcome for research regarding the demand for animal welfare products by consumers is the use as an indicator for other more important product attributes such as safety/quality and health (Harper & Makatoumi, 2002).

On seafood (loosely farmed and wild), and specifically in the wild capture industry, the MSC ecolabel has been estimated to command a price premium in the range of 10-14% for various fish species (Asche *et al.*, 2015; Blomquist *et al.*, 2015; Roheim *et al.*, 2011; Sogn-Grundvåg *et al.*, 2013; Sogn-Grundvåg *et al.*, 2014). Stated preference literature on ecolabels demand is well documented in economic literature. Dolphin-safe ecolabel has been linked to consumer purchasing decisions (Teisl, Toe & Hicks, 2002). Other studies including Wessells, Johnston, and Donath (1999); Johnston *et al.* (2001); Johnston and Roheim (2006); Jaffry *et al.* (2004) have identified similar results for various ecolabels. In principle, wild fish has been known to be the most preferred over farmed fish (Roheim, Sudhakaran & Durham, 2012) and whether it is due to quality differences or if ecolabels could compensate for the difference in preference is a matter of future enquiry.

Zeroing in on aquaculture, Aarset *et al.* (2004) provide evidence of distrust in regulatory regimes, unawareness and skepticism among European consumers about the concept of organic farmed fish in a focus group survey. Olesen *et al.* (2010) show evidence of Norwegian consumers seeing organic and welfare (Freedom Food) labeled salmon to be identical, and willing to pay a price premium of approximately 2 euros per kg (15%) for either. A price premium of 20% from a hedonic function is identified for organic salmon in the Danish retail market using revealed data (Ankamah-Yeboah *et al.*, 2016) and 25% in the UK (Asche *et al.*, 2015). In Italy, Mauracher *et al.* (2013) find a positive willingness to pay for organic Mediterranean Sea bass, but identified a much higher price premium for country of origin than the organic attribute. The authors recommended the need for a suitable communication from public policy or commercial perspective to be taken for consumers to perceive the added value in the production method.

The literature on ecolabel demand in the aquaculture industry is limited. Our study fills in this gap, but also presents unique evidence of consumer preference for two newly competing ecolabels (organic and ASC) in the status quo market, identifies communication strategies that could increase the value for EU organic certified aquaculture products by considering the role of environmental and animal welfare concerns. The organic livestock (aquaculture) production as

[28] Organic is a concept related only to aquaculture and not the capture fisheries.

opposed to crops provides unique stand in relating to environmental and animal health attributes. We therefore hypothesize that, communication of elements of the production requirements to consumers as a suitable ecological campaign could create differential in the perceived value of the production method. The hypothesis is tested in a random utility framework using state of the art choice model; the generalized random parameter logit model that allows for exploring scale and preference heterogeneity. The newly improved model (Hensher *et al.*, 2015) provides advanced but easy ways of controlling for scale differences in data that arise from different information treatments of respondents.

The remainder of the study is organized as follows; section 2 presents on the methods for data collection and empirical analysis, section 3 discusses the results and section 4, the concluding remarks.

4.2 Methodology

4.2.1 Choice experiment design and data collection

Consumers' preferences for varying attribute mixes of portion size trout were elicited using survey questionnaire. The questionnaire was first designed and pretested in a focus group in Denmark and subsequently among German consumers. The necessary corrections were made and then pretested online among 65 German consumers. The final data were generated through an internet questionnaire survey implemented by Userneeds Denmark through an online panel from Research Now database in July 2016[29]. The recruitment of panel members for the panel survey is based on samples in the age range 18-65 years by gender, age, family structure, income and region.

The experiment involved subsampling respondents into control and information treatment samples on organic fish production. First respondents' objective knowledge on selected European organic aquaculture production principles were tested in the form of a quiz regarding antibiotic use; GMO, hormones and synthetic additives; feeding; and stocking density requirements. After each quiz, information on the right requirement is provided to the respondent in the treatment groups. In total there were three information treatment groups in addition to the control sample. Treatment group 1 were informed that the reason for each of the production requirements was due to environmental concerns, group 2 were attributed to animal health and welfare concerns and group 3 attributed to both concerns. The knowledge gained from the information treatment is equal to the number of wrong choices.

The choice sets presented to respondents were designed using the software Ngene (ChoiceMetrics, 2014) and the D-efficient Bayesian design applied with priors from multinomial logit model estimation of the pilot survey. This design approach is employed to limit generating cumbersome choice sets associated with full factorial designs and to maximize the amount of information about consumers' preferences from the choice experiments. Choice set attributes and attribute levels used in the survey are provided in table 4.1 below with six attributes, their description and attribute levels. Attribute selection were motivated from fish preference literature and focus group discussions and are composed of interplay between search and credence attributes.

[29] Userneeds and Research Now are professional marketing firms in Denmark and Germany respectively.

Table 4.1. Attributes and attribute levels

Attributes	Description	Levels
Product form	Indicates whether the trout is whole or has been fileted	• *Whole fish with head on* • Fileted with skin and bone • Fileted with skin but no bone • Fileted without skin and bone
Storage form	Indicates the processed and stored form	• *Frozen fish* • Smoked fish • Fresh (chilled conditions)
Place of purchase	Indicates the place where the fish is sold	• Specialized fish store • *Grocery store*
Production method	Indicates the production process used	• *Conventional* • Organic certification • Aquaculture Stewardship Council certification (ASC)
Country of origin	Indicates country of where the trout is farmed	• Germany • Denmark • *Turkey* • Other EU country
Price (€)	The price per 0.35kg of trout	2.99, 4.49, 5.99, 7.49, 8.99, 10.49

Italicized attribute levels are used as reference for utility estimation

A total of 36 choice sets with 3 blocks were designed and randomly assigned to the subsamples. Hence, each respondent was presented with 12 choice sets of three alternatives and an opt-out. A sample of the choice set presentation is shown in figure 4.

Figure 4. Sample choice card

Data from a total of 1,236 completed and usable questionnaire was extracted for the four subsamples. A questionnaire response rate of 12% was achieved. The respective sample sizes were 308, 310, 309 and 309 for groups 1, 2, 3 and 4 where group 1 indicates the control sample and 2 to 4, the information treatment samples. The summary description of the socioeconomic characteristics of the sample is presented in table 4.2. The regions were purposively selected to cover the northern (Hamburg/Schleswig-Holstein), eastern (Berlin/Brandenburg) and southern (Bayern) corners of Germany given that the entire population is relatively high.

Table 4.2. Socioeconomic characteristics of the sample

Characteristics	n	%
Gender		
Male	570	46.12
Female	666	53.88
Age (years)		
18-34	405	32.77
35-49	427	34.31
50-65	404	32.69
Region		
Bayern	426	34.47
Berlin/Brandenburg	396	32.04
Hamburg/Schleswig-Holstein	414	33.50
Household size		
1 person	253	20.47
2 persons	481	38.92
3 persons	259	20.95
4 persons	180	14.56
Above 5 persons	63	5.09
Occupation		
Part time	199	16.10
Full time	766	61.97
Other	271	21.93
Household monthly income		
< €1.000	127	10.28
€1,000 to < €1,500	128	10.36
€1,500 to < €2,000	145	11.73
€2,000 to < €2,500	150	12.14
€2,500 to < €3,000	164	13.27
€3,000 to < €3,500	130	10.52
€3,500 to < €4,000	114	9.22
€4,000 to < €4,500	86	6.96
> €4,500	192	15.53
Family status		
Single	305	24.68
Married/registered partner	600	48.54
Live together	220	17.80
Separated/widowed/divorced	111	8.98
Education Level		
Basic education	100	8.09
Secondary school	349	28.24
Higher secondary school	111	8.98
Post-secondary education	242	19.58
Tertiary education	421	34.06
Other	13	1.05
Total observations	1,236	100

4.2.2 Discrete choice modeling: generalized mixed multinomial logit

Developed by McFadden (1974), the random utility theory has become increasingly used for the analysis of choices in discrete choice experiments (DCEs). The approach has the ability to estimate marginal values for different attributes of a good. Assuming that person i faces a set of alternatives $Q = \{Q_1, Q_2, \dots, Q_N\}$ at time t and vectors of x attributes specific to respondents and alternatives. Each chosen alternative $Q_j \in Q$ has a corresponding net utility U_{ijt} for individual i that is assumed to be composed of two separable parts; the systematic (V_{ijt}) and random (ε_{ijt}) components expressed as (Train, 2009):

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} \qquad (1)$$

The idiosyncratic error term is assumed to be independent and identically distributed extreme value. The probability that individual i chooses alternative j from a particular set Qcan be written as:

$$P_{ij} = P\big(U_{ij} > U_{iq};\ \forall\, q(\neq j) \in Q\big) = P(\varepsilon_{iq} < \varepsilon_{ij} + V_{ij} - V_{iq};\ \forall\, q(\neq j) \in Q) \qquad (2)$$

Traditionally, the multinomial logit (MNL) model would be estimated. However, the past two decades have seen development of competing models that allow for taste and scale heterogeneity, and overcome the assumptions of the independent and irrelevant alternatives linked to the MNL specification. Moreover, the confounding scale parameter in the utility parameter has become less desirable. In this study, we follow the much more flexible generalized mixed multinomial logit (GMNL) specification in Fiebig *et al.*, (2010) and express the systematic component of the utility function in equation (1) with or without alternative specific constants as:

$$V_{ijt} = \beta_i x_{ijt} = [\sigma_i \beta + \gamma \eta_i + (1 - \gamma)\sigma_i \eta_i] x_{ijt} \qquad (3)$$

where β_i is the individual specific taste parameter confounded with a scale of the error term. It is assumed to follow a multivariate distribution with means and variance-covariance matrix Σ, $\beta_i \sim f(\beta, \Sigma)$. Decomposing β_i to follow the square bracket terms in equation (3) allows heterogeneity to be described by scale heterogeneity (i.e., scaled multinomial logit - SMNL), taste heterogeneity (i.e., mixed or random parameter logit - RPL) or some combination of the two (GMNL type models). From equation (3), Assuming $\sigma_i = \sigma = 1$ collapses the formulation to RPL where η_i is the individual specific deviations from the means and assumed to follow certain distribution. The parameter $\gamma \in [0, 1]$ determines how the variance of the residual taste heterogeneity varies with scale. GMNL-I and GMNL-II result from respectively restricting $\gamma = 0$ and $\gamma = 1$. The scale coefficient of the GMNL is individual specific, $\sigma_i \sim LN(1, \tau)$ or $\sigma_i = \exp(-\tau^2/2 + \tau \eta_i)$ where τ is a key parameter in the GMNL type models that reflects the level of scale heterogeneity.

An important feature for considering GMNL in the present study is the ability to simultaneously account for preference heterogeneity and scale differences arising from different data sets. Scale may vary across data sets due to differences in sampling or information provided to respondents (Hensher *et al.*, 1998) as designed in this study. Failing to account for these differences when combining data sets may lead to wrong conclusions. We follow Hensher *et al.*, (2015, page 861) on combining data sets in choice modeling and allow τ to be a function of a series of dummy variables that identify the presence of scale heterogeneity between the different data sets from the sample or information treatments. Thus, $\tau = \tau + \delta D_s$ where δ is data specific scale parameter and $D_s = 1$ for data set s and 0 otherwise, with $s = 1,2, \dots, S - 1$. As noted in Czajkowski *et al.* (2016), this approach has advantage over willingness to pay space data specific estimations as it avoids confounding preferences with marginal utility of income (cost), allows ease of testing for dispersion among random parameters and for equality of mean willingness to pay.

4.3 Results and discussion

In this section, we report on the estimation results from the generalized random parameter logit model outlined in section 2. The decision to the selected model was undertaken through a search process to determine the best fitting model. Models initially estimated included the multinomial, scaled multinomial, random parameter and GMNL type logit models. For random parameter assumptions, different distributional assumptions were also considered. The best fitting model based on the simulated log-likelihood values, McFadden pseudo r-square and information criteria was the GMNL model presented in table 4.3. The model was estimated using parameters estimates from random parameter logit model as the starting values and 1200 draws (stability of parameters confirmed at this point).

The model was estimated with normally distributed random parameters and allowing for correlated parameters in order to control for unobserved effects that are correlated among alternatives in a given choice situation. Attributes including the product form, storage form and place of purchase (search attributes) and the no purchase option were treated as fixed parameters, while the production method and country of origin were treated as random parameters following a normal distribution. The price variable was converted from per 0.35kg to per kg and also treated as a random parameter with non-stochastic distribution (i.e., variance equals zero). This implies that no a priori distribution is imposed, allowing testing for heterogeneity around the mean of the random parameter without having to worry about the distribution from which it was drawn (Hensher, 2005) as linked to willingness to pay calculations.

Table 4.3. Generalized mixed random parameter logit model

Variables	Coefficients	Std. errors	Coefficients	Std. errors
Random parameters (means)			*Std. dev. of random parameters*	
Price/kg	-0.169***	0.013	0.000	Fixed
ASC - Ecolabel	-0.090	0.068	1.029***	0.086
Organic (control – **GP1**)	0.212**	0.088	1.461***	0.107
Germany	1.558***	0.178	2.345***	0.155
Denmark	1.147***	0.142	1.623***	0.113
Other EU country	0.881***	0.123	1.522***	0.127
Nonrandom parameters				
Filet (skin & bone)	-0.073**	0.031		
Filet (skin & no bone)	0.475***	0.027		
Filet (no skin & no bone)	0.806***	0.035		
Fresh	0.376***	0.029		
Smoked	0.011	0.023		
Specialized store	-0.009	0.024		
Organic2 (GP2)	**0.086**	**0.061**		
Organic3 (GP3)	**0.193*** **	**0.057**		
Organic4 (GP4)	**0.126** **	**0.053**		
No purchase	-1.558***	0.048		
Covariances of random parameters				
Tau scale	1.287***	0.074		
	Heterogeneity in tau(i)			
Tau*GP2	**0.076**	**0.062**		
Tau*GP3	**-0.004**	**0.062**		
Tau*GP4	**0.017**	**0.061**		
Weighting parameter gamma in GMX model				
Gamma MXL	0.257***	0.029		
	Sample mean	*Sample std. dev.*		
Sigma(i)	0.958	1.664		
Log likelihood	-16067.280			
Restricted log likelihood	-20561.518			
Chi-Square (36)	8988.518***			
McFadden Pseudo R-Square	0.219			
AIC	32206.6			
AIC/N	2.171			
Panel groups	1,236			
Observations	14,832			

Used Halton sequences in simulations; Replications for simulated probs. is 1200; Use RP as starting values. GP1 – control group; Information treatment groups are GP2 – environmental information; GP3 – animal health and welfare information; GP4 – combined GP2 and GP3.

In table 4.3 we present the separation of heterogeneity in the error variance from the preference heterogeneity under the subheading *Covariances of the random parameters* so as to draw accurate conclusions from the preferences. As can be seen, the *Tau-scale* parameter (τ) which reflects the level of scale heterogeneity is statistically significant at the 1% level. This indicates the presence of significant unobserved scale heterogeneity in the sample – thus, significant differences exist between respondents on how deterministic or random their choices are to the analyst. Controlling for heterogeneity in the scale heterogeneity that may have occurred from differences in sample treatments reveals that the scale heterogeneity is not attributed to data specific differences. This is shown by the nonsignificant estimates from interaction of the scale parameter with the data specific dummies (Tau*GP#s).

The parameter estimates from the search attributes present some interesting facts. For product form (whole trout as reference): we observe that whole fish is in fact preferred to filet with skin and bone. The description of filet with skin and bone is just a whole fish cut into pieces, with the bone and skin intact. However, the marginal utility of fileted trout increases with value addition, filet – skin & no bone and filet – no skin & no bone relative to whole fish. These product forms appear to come with more convenience to customers especially with the ease and amount of time spent in preparation and consumption. Hence, it is not surprising that they are the most preferred.

In terms of the storage form (frozen trout as reference): there is no significant difference in utility between smoked and frozen products. Relatively, the marginal utility from fresh trout is highest. Fresh fish as described here is one that by definition has received no treatment other than chilling and has remained above -1 degree Celsius. The high preference for freshness is as expected at least for the European consumer as quality of seafood is mostly determined by degree of freshness (Olsen, 2004). Freshness to the consumer is also often associated with safety, reassurance, superior taste (Olsen, 2004; Wang *et al*., 2009). The current evidence supports the seafood literature that freshness will continue to have an important role in determining consumer preferences for fish. The place of sale, either in a grocery store or specialized fish stores makes no difference on the consumers' utility level. Alternative specific constant included in the model captures the utility associated with the "no purchase option". This is negative and significant and signifies respondents have disutility in opting out of purchase.

For the random parameter estimates, we observe that both the production method and country of origin reveal unobserved heterogeneous preferences among respondents as indicated by the significance of the attribute level standard deviations. First considering the country of origin with Turkey as the reference, it can be seen that the respondents have relatively very high preference for local German produced trout, followed by Denmark and then other European countries. Denmark and Turkey are top competing suppliers of trout in Europe with about 90% of Danish output landing in the German market. The corresponding willingness to pay (WTP) estimates computed as the ratio of the attribute parameter to the price is shown in table 4.4 for values from preference space estimation and also WTP space estimation[30].

The WTP values from the preference space are lower than the WTP space values. However, the patterns of valuation remain the same. Consumers are willing to pay highest for local German trout (€10.33), followed by Danish trout (€7.57) and then other European countries (€6.09). The

[30] A corresponding WTP space GMNL model was estimated but not presented so as to extract the true WTP values.

driving factor of the value for local might be linked to some of the emerging issues in literature regarding locally produced products. Local is linked to the environmental issues such as the carbon foot print in transporting a commodity from one place to another. In that case, the least transported is termed to be friendly to the environment. Denmark in the second place might also be linked to the relative stringent environmental requirements for aquaculture production (FAO, 2017) that could compensate for environmental claims of ecolabels.

Table 4.4. Willingness to pay values of random parameters

	Mean WTP in preference space (€)	Mean WTP in WTP space (€)
ASC - Ecolabel	-0.53	-0.41
Organic (Control – **GP1**)	1.25	2.14
Organic2 (**GP2**)[a]	1.76	2.36
Organic3 (**GP3**)[a]	2.40	2.94
Organic4 (**GP4**)[a]	2.00	2.53
Germany	9.22	10.33
Denmark	6.79	7.57
Other EU country	5.21	6.09

[a] Fixed parameters

Central to this study is the results from the production method and how bringing the consumer closer to knowledge about production practices of EU organic aquaculture production practices influences the marginal organic utility levels. The production method attribute levels include conventional production (the reference level), the ASC and organic certification. The significance of the standard deviations of the random parameters reveals that there is heterogeneous preference among respondents for this attribute levels. The mean parameter for the ASC certification is however insignificant, indicating that on average equal proportions of the sample have or have no preference for this certification and so does not influence consumers choices, hence there is about €0.4 valuation of this attribute level.

The positive and significant parameter estimate associated with organic in the control group reflects the market status quo for organic preference without any intervention. That is, there is preference for organic in trout choice among respondents relative to the conventional. This evidence shows that in the German trout market, there is no competition between the organic and ASC labeled portion size trout. ASC is just considered a conventional trout and the organic considered superior.

Given that commercialization of organic aquaculture is new relative agriculture such as dairy products, growth in the sector is warranted and continuous supply depends on the value for the product. Would public intervention in the form of organic information campaigns that bring the consumer closer to the producer increase consumers' preference and valuation? Does this depend on the information type and how does it vary with knowledge level? To provide answers to these questions, heterogeneity in the organic preferences is analyzed by interacting with the information treatment subsamples. What we observe is that treating responds with information on the organic production requirement and relating it to environmental concerns (*organic2-GP2*) does not seem to significantly shift respondents' organic marginal utilities (only a slight increase in value of €0.22) from the status quo.

However, relating it to animal health and welfare concerns (*organic2-GP3*) almost doubles the marginal utility level from the status quo, an increase in corresponding value of €0.80. When the information is related to combined environmental and animal health and welfare concerns (*organic2-GP3*), respondents retract on the marginal utility levels from the animal health and welfare only treatment, but significantly increase from the status quo. The finding shows that linking organic production requirements with animal health and welfare issues would achieve the highest welfare. This is because consumers' perception of animal welfare has been found to be linked to ethical and impact on human health from food related hazards and food safety risks (Harper & Makatoumi, 2002; Verbeke & Viaene, 2000) of various food scandals and consequential food scares that have engulfed Europe (Naspetti & Zanoli, 2009).

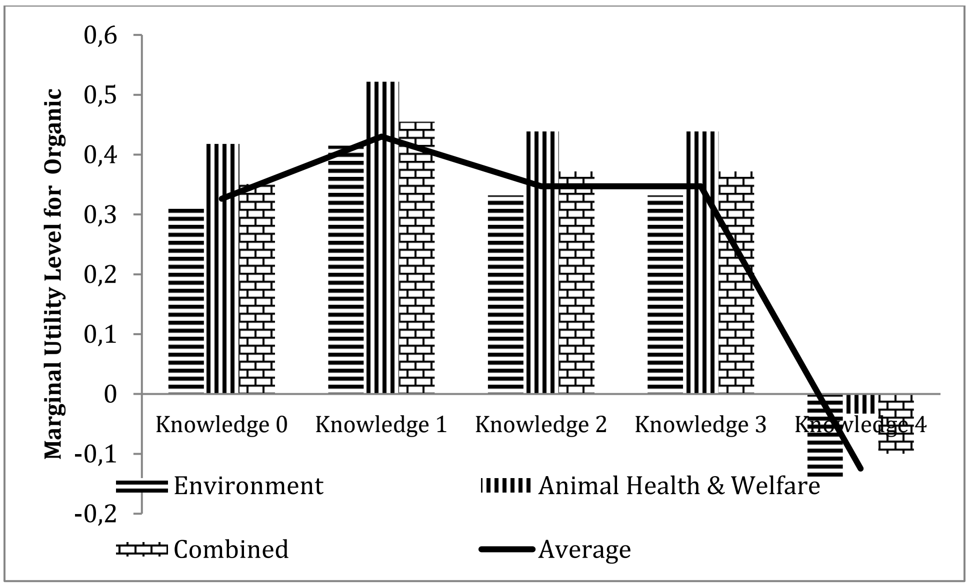

Figure 5. Marginal utility for organic across information treatments and knowledge gain levels

Figure 5 presents how the level knowledge gained varies with the marginal utility levels for organic across the three information treatments. Knowledge level gained is equal to the size of wrong responses. Four quiz questions of four multiple choices with only one correct choice result in five levels of knowledge ranging from zero to four as shown in the x-axis of figure 5. Hence, knowledge 0 is the respondent with full knowledge of the quiz (thus, all choices were correct). We observe that for each knowledge level, the marginal utility for organic in each information treatment is highest for the animal health and welfare, followed by the combined and least in the environmental treatment sample as shown in the model estimation results. Further, the preference structure reveals that for the respondent who gains 1 knowledge there is a little increase in the preference level but insignificant. As the knowledge level increases from 1 to 2 and 3, the preference structure equates to the respondent with the full a priori knowledge about the production practices. The last groups of respondents with knowledge 4 level (thus, those with no a priori knowledge) on average have disutility for organic trout in all treatments.

4.4 Conclusion

This study sought to determine consumer preferences for organic farmed trout in the presence of competing ecolabels and other important fish attributes that influences consumers purchasing decisions. Further, it explores avenues for increasing the value of organic aquaculture products by testing the effect of different types of information based on the EU organic aquaculture regulation. The information treatments involved relating feed; stocking density; antibiotics use; and GMO, hormones and synthetic additives to environmental, animal welfare concerns or combination of both. A state of the art generalized random parameter logit model based on the random utility theory was employed, given the flexibilities of modeling unobserved preference and scale heterogeneity and the ability to control for scale differences due to differences in sample treatments that could lead to biased conclusions.

The results indicate the presence of unobserved attribute taste and scale heterogeneity and lack of scale differences in the subsamples. It is shown that consumers prefer convenient fish products such as fillets. Thus, preference increases with increasing value addition in the form of fileting, when considering products with or without skin and bones. Fresh trout is also found to be a major positive determinant in purchasing decisions as it is often linked to quality and taste. On the other hand, country of origin features significantly and the level of the preference is greater than ecolabels; with local German trout being the most preferred, followed by Danish trout and then other European countries over trout from Turkey.

Considering the focal point of the study and hence the ecolabel attributes, we observe that the ASC ecolabel is equally recognized as a conventional product, however, the organic attribute relatively ranks high in purchasing decisions. This is an indication that the organic has value advantage among German trout consumers. Relating the organic production practices to environmental concerns in the event of public or commercial promotion campaigns does not further increase the perceived value consumers' associate with the organic attribute. Value is increased when related to animal welfare issues only or combination of both.

Information treatment based on animal welfare concerns only, however, is associated with the highest consumer welfare and valuation. This reveals that too much information claims for organic being linked to environmental and animal welfare tend to overwhelm consumers and so reduces the highest possible attainable welfare measure related to animal welfare information treatment. The levels of preference in the different treatments however, tend to be uniform across consumers prior knowledge, but for those with zero prior knowledge having the tendency to discount organic products on the average.

To promote green consumerism through interventions such as information campaigns to increase the overshadowing value of for example organic products, communication strategies would need to be carefully selected. For organic farmed trout for instance, bringing the consumer closer to productions principles based on animal welfare issues might be more satisfactory. This is because animal welfare issues are directly linked to human health impacts from food related hazards and food safety risks.

CHAPTER 5

DOES ORGANIC SUPPLY GROWTH LEADS TO REDUCED PRICE PREMIUMS? THE CASE OF SALMONIDS IN DENMARK[31]

5.1 Introduction

Increasing demand for organic products has led to a growing number of farmers considering converting from conventional to organic production. This also increases the demand for more knowledge on price development of organic products to avoid the risk of weakened prices when investing in organic farming. In the literature, the focus have mainly been on identifying the price premium of organic products and less on whether this price premium can be expected to be maintained. If high price premiums are received, more producers can convert to organic production and increasing organic supplies could, ceteris paribus, induce a downward pressure on prices. The purpose of this article is to show how market integration test of non-stationary price series of organic/conventional products can be applied to reveal important information on the riskiness of investments in organic farming and to apply the methodology on farmed salmonids (salmon and trout) in Denmark.

A Vector Auto Regressive Model in Error Correction Form is estimated for nonstationary price series. Cointegration between organic/conventional price series identifies long run market integration and the Law of One Price (LOP) show perfect market integration. Weak exogeneity tests reveal whether conventional prices lead organic prices, while impulse-response functions inform about the short-run adjustment process and time horizon following price shocks.

The issue of market integration between organic/conventional products is important when investing in organic farming, because risk of price reductions induced by growth in organic supply is normally only identified ex post, not ex ante. Hence, if organic price reductions are expected, this should be taken into account by the investor to insure an economic viable business when converting to organic production. Testing before the initial investment is made can identify the possible risk following from growth in organic supply. However, risks at the total market for conventional and organic products remains where prices are determined by total supply and demand.

Organic products face a constant price premium above conventional products when markets are integrated, since the prices of conventional/organic products follow each other during the adjustment period. The relevance of identifying this constant price premium depends on the market share of organic products. When the organic market share is small and markets are integrated, the method provides important information on stability of price premiums, with the implication that organic supply growth has limited effect on organic prices. However, when the organic market share is large and markets are integrated organic supply growth induces price reductions for organic products even though price premiums are stable. If markets are not integrated, a price reduction often follows growth in supply of organic products.

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Several studies identify price premiums of organic food products using a hedonic price model, including Maguire, Owans and Simon (2004) on baby-food in two cities in California and North Carolina, Corsi and Strøm (2013) on farm-gate prices on wine in Piedmond, Italy, and Ankamah-Yeboah, Nielsen and Nielsen (2016) on salmon in Danish retail sale. Connolly and Klaiber (2014) identified heterogeneous price premia for various organic certifications across states in the US. Other authors have identified price premiums on labelled/certified products praising specific social/environmental friendly attributes, such as, Fair Trade coffee in Sweden (Schollenberg, 2010) and on Marine Stewardship Council eco-labelled wild-caught seafood in the UK (Roheim, Asche & Santos, 2011). Choice experiments are used to identify the organic price premiums, for example in Van Loo (2011) for chicken breast in Arkansas. Ankamah-Yeboah et al (*work in progress*) identified significant marginal willingness to pay for organic trout over conventional and competing Aquaculture Stewardship Council certified products among German consumers. Meas *et al.* (2014) also identified a positive willingness to pay for organic blackberry jam and a strong substitution effects between local and organic production claims.

Market integration tests of non-stationary price series have been used to identify the market within which prices move together over time. The use is widespread between fish species, since the global seafood markets are diversified with a large number of species supplied. Contributions include Asche, Bremnes and Wessels (1999) studying market integration between domestic wild-caught salmon and farmed imported salmon in the US, Ankamah-Yeboah, Staahl and Nielsen (forthcoming) between warm-water shrimp and cold-water shrimp, respectively in five European countries, and Bronnmann, Ankamah-Yeboah and Nielsen (2016) between different wild-caught and farmed whitefish species in Germany.

Studies of market integration between organic and conventional products are sparse. Singerman, Lence and Kimble-Evans (2014) identify market integration between states in the US for conventional corn and soy bean, and loose market integration at the corresponding organic markets. Market integration across organic and conventional markets could, however, not be found. Würriehausen, Ihle and Lakner (2015) also test for market integration and finds that the extent to which the organic price depends on the conventional price differs over time.

Our article tests for market integration between organic and conventional products. To the best of our knowledge, it is the first that find stable price premium of organic products over time and to suggest that this could actually be used as a risk reducing tool when used as a pretest before investment. The article furthermore adds to the literature by using impulse-response functions in the analysis to show the dynamic adjustment processes in the short-run following price shocks.

The article is organized as follows. In section two, the Danish market for salmonids is described. Section three present the methodology, while section four goes through data. Results are presented and discussed in section five and the last section concludes the article.

5.2 The Danish market for salmonids

The beginning of the modern and intensive fish farming was first introduced by a German farmer in 1741 (Jacobi, 1765). He successfully fertilized trout eggs and raised the fish that hatched. Today, the control of the life cycle from the fertilization of the eggs to a full grown fish is recognized to be the main driver of growth in productivity and thereby production volume (Anderson, 2002; Asche, 2008; Asche *et al.*, 2013). The knowledge on salmonid production was reintroduced and spread throughout Europe in the 1840s, including Denmark (Hessel, 1993).

Despite the established importance of seafood as a nutritious source of protein and other health benefits (Brunsø *et al.,* 2008; Daviglus *et al*., 2002), there has been growing concerns about the sustainability of the aquaculture sector (Asche & Bjørndal, 2011; Asche *et al.,* 2015; Nielsen 2012; Nielsen *et al*., 2014). Thus, the use of information, such as eco-labelling forms an alternative way of regulating environmental externalities. Eco-labelling differentiates products by making the production method (organic/conventional) visible to consumers. Most often, the organic production process is more costly and producers undertaking these methods therefore expect higher prices than received when producing conventional. Trout and salmon producers in Europe have the opportunity to certify their product through different private and governmental organic labelling schemes. In Denmark, farmed fish are certified with the well-established and well-known organic label, a red Ø (Christensen *et al.,* 2014), which is issued, enforced and controlled by the Danish government.

The Danish market for rainbow trout (*Oncorhynchus mykiss*) produced in fresh water is mainly covered by domestic production. In 2014, the production reached 30,500 tons produced in 177 farms of which 9 farms where producing organic reaching a volume of 843 tons. The fish weigh less than 0.5 kilo each, have white meat and is not considered a substitute for salmon (Nielsen *et al.*, 2007). In Denmark, a handful of processing companies dominate the market buying up fish from farmers. The main product forms are fresh/frozen whole fish and smoked fillets. More than 90% of the Danish production is exported, primarily to Germany. The total supply at the European market is 290 thousand tons, where Denmark delivers 11% (FAO, 2016). Table 5.1 is showing the most important producer countries of organic trout and salmon in Europe, and mention the share of organic production to total volume. The share of organic produced trout in Denmark was 2.8% of the total production, which seems equivalent to the level in France and Germany.

Table 5.1. Organic and conventional produced trout and salmon, 2014

2014	Organic production tonnes	Total production tonnes	Share of organic production (%)
Trout (fresh water)			
Denmark	843	30,452	2.8
France	App. 700	34,000	2.1
Germany	App. 300	9,937	3.0
Total trout (tonnes)	**1,843**	**74,389**	**2.5**
Salmon (marine)			
Norway	App. 16,000	1,258,356	1.3
UK	3,588	179,022	2.0
Ireland	7,869	9,368	84.0
Total salmon (tonnes)	**27,457**	**1,446,746**	**1.9**

Sources: FAO 2016 and Statistics Denmark 2016,
https://www.destatis.de/DE/Publikationen/Thematisch/LandForstwirtschaft/Fischerei/Aquakulturbetriebe

The Danish production of conventional salmon is negligible reaching less than 500 tons. The Danish market for salmon is dominated by imports from Norway and UK who is the leading producers in Europe. The most important product sold is whole fresh salmon. Denmark is an intermediate market and most of the salmon is re-exported to other EU countries. The global production of Atlantic salmon (*Salmo salar*) reached 2.3 million ton in 2014. It is estimated that the European production of organic salmon reached 27,500 ton in 2014 originating from Norway, UK and Ireland. In Ireland, the total production of salmon has been converted from conventional to organic production in 2015 due to the more favourable prices on organic products.

Denmark has the highest share of organic food products sold in retail in the world covering 7.6 % of the total sale of food and beverages, in 2014. In table 5.2, the production of different organic food product and their shares of total production are shown. Furthermore, the share of organic food products in different food categories in Danish retail is shown.

Table 5.2. Organic food products share of total production in Denmark, 2014

Production in ton	**Fresh water trout**	**Pork meat**	**Milk**	**Eggs**	
Total	30,452	1,944,000	5.191,100	68,905	
Organic	843	9,020	479,700	12,256	
Organic share %	2.8	0.5	9.2	17.8	
Retail sale	**Fish and shellfish**	**Meat**	**Dairy products**	**Eggs**	**All food and beverages**
Organic share %	1.0	4.2	4.0	0.4	7.6

Sources: Statistics Denmark 2012 and 2016a

Compared to other products, milk and eggs, the primary production of organic fish only constitutes a small share of the total market. The production of organic milk and eggs are well established on the Danish market and they have been able to maintain a price premium for over 20 years even though the market share has increased. Looking at the retail sale, the organic sale of fish and shellfish only constitute 1%, where meat and dairy products have a market share of 4%. Thus, there is no indication that the production of organic fish has reached a volume that will significantly affect price premiums.

Denmark is the most expensive country in the European Union when it comes to purchasing food (Statistics Denmark, 2016b). In spite of this, a large segment of consumers are willing to purchase organic products with even higher prices and the increasing development in the purchase of organic products is expected to continue in the coming years, reaching 8.5% of the total sale of food and beverages in 2015.

5.3 Methodology

Commodity prices are seen by economists as valuable information medium for drawing relationships among commodity markets. Per earlier market definitions (Cournot, 1971; Stigler & Sherwin, 1985), market integration have been founded on the test of the Law of One Price (LOP) where the price relationship between two markets is simply expressed as the long run relation

$$p_t^1 = a + \beta p_t^2 + e_t \qquad (1)$$

where p_t is a price vector (in this case organic and conventional prices), e_t is the error term and a (measures quality differences/premium) and β are unknown parameters to be estimated. A test of the LOP is implemented by imposing the restriction $\beta = 1$. A rejection of the LOP implies partial market integration while failing to reject implies perfect market integration, implying that relative prices are constant (Asche, Bremnes & Wessells, 2001). In the case of partial market integration, organic prices could fluctuate above the conventional with a premium. Despite the simplicity of equation 1, estimation is not that straight forward as one has to consider the dynamic patterns to reflect delayed adjustments to costs and the nonstationary time series properties of the series. As shown by (Granger & Newbold, 1974), estimating equation 1 on nonstationary variables renders normal statistical inference invalid due to spurious regression.

In order to determine what kind of model to estimate, the study first examines the stationary properties of the price series. Here, the standard Augmented Dickey Fuller (ADF) unit root test of Dickey and Fuller (1979) is considered alongside with a post-estimation approach indicated in Hjalmarsson and Österholm (2010). The post-estimation is considered for checkup because the ADF type models are quite often sensitive to the lags specified. In the presence of unit root, cointegration becomes the natural analysis to consider. Cointegration of variables $p_t = \left(p_t^{organic}, p_t^{conventional}\right)$ implies defining equilibrium relation such that, there exists a vector β that renders the combination, $\beta' \, p_t$, a stationary process.

In this study, we consider the Johansen (1988) cointegration over the two stage estimation procedure of Engle and Granger (1987) given our interest in testing the proportionality between prices. The Engle and Granger approach do not provide well-defined limiting distributions for direct test on the β coefficient in equation 1. The Johansen (1988) cointegration is a maximum likelihood estimation of the vector autoregression model (assuming order 1)

$$\Delta p_t = \delta + \Gamma \Delta p_{t-1} + \Pi p_{t-1} + \epsilon_t \qquad (2)$$

Again, p_t is $n \times 1$ vector of endogenous price variables; Γ is $n \times n$ matrices of short run parameters; Π is $n \times n$ matrix of long-run parameters; δ captures deterministic terms and ϵ_t is a vector of errors assumed to be independent and identically distributed. If $\Pi = \alpha\beta'$ of rank (r), $0 < r < n$, then the system can be said to be cointegrated. The parameters α and β are matrices of dimension $n \times r$ with β representing cointegrating vectors while α gives the weight of the cointegration relationships. Johansen (1988) proposes two test statistics for testing the cointegration rank, namely the trace and maximum eigenvalue statistics. Cheung and Lai (1993) and Gonzalo (1994) indicate that, Johansen's trace and maximum eigenvalue test for cointegration are robust to non-normal errors. Non-normal errors are often empirical challenge and so the Johansen cointegration presents further advantage for its use.

In this study, we estimate a bivariate model for organic and conventional rainbow trout at the farm level and a trivariate system for organic salmon and conventional salmon and trout at the retail level. Writing out the system of equations, we can represent the vector error correction model (VECM) with one cointegrating equation for the bivariate system at the farm level as

$$\begin{pmatrix} \Delta p_t^1 \\ \Delta p_t^2 \end{pmatrix} = \begin{pmatrix} \delta_1 \\ \delta_2 \end{pmatrix} + \begin{pmatrix} \Gamma_{11} & \Gamma_{12} \\ \Gamma_{21} & \Gamma_{22} \end{pmatrix} \begin{pmatrix} \Delta p_{t-1}^1 \\ \Delta p_{t-1}^2 \end{pmatrix} + \begin{pmatrix} \alpha_1 \\ \alpha_2 \end{pmatrix} (p_{t-1}^1 - \beta p_{t-1}^2) + \begin{matrix} \epsilon_t^1 \\ \epsilon_t^2 \end{matrix} \qquad (3)$$

and the trivariate retail level system with two cointegrating equations as

$$\begin{pmatrix}\Delta p_t^1\\ \Delta p_t^2\\ \Delta p_t^3\end{pmatrix} = \begin{pmatrix}\delta_1\\ \delta_2\\ \delta_3\end{pmatrix} + \begin{pmatrix}\Gamma_{11} & \Gamma_{12}\\ \Gamma_{21} & \Gamma_{22}\\ \Gamma_{31} & \Gamma_{32}\end{pmatrix}\begin{pmatrix}\Delta p_{t-1}^1\\ \Delta p_{t-1}^2\\ \Delta p_{t-1}^3\end{pmatrix} + \begin{pmatrix}\alpha_{11} & \alpha_{12}\\ \alpha_{21} & \alpha_{22}\\ \alpha_{31} & \alpha_{32}\end{pmatrix}\begin{pmatrix}p_{t-1}^1 - \beta_{13}p_{t-1}^3\\ p_{t-1}^2 - \beta_{23}p_{t-1}^3\end{pmatrix} + \begin{matrix}\epsilon_t^1\\ \epsilon_t^2\\ \epsilon_t^3\end{matrix} \quad (4)$$

with the following restrictions imposed in equation 4 to enable identification: $\beta_{11} = \beta_{22} = 1$ and $\beta_{12} = \beta_{21} = 0$. Variables and parameters are defined as before. The existence of cointegration does not in itself show which markets equilibrium adjust or do not; neither does it entail which adjusts fast or slow. Such information is provided by the α parameters (known as the speed of adjustment parameter). Weak exogeneity of prices which is used to identify leading markets in the system is tested by $\alpha_{ij} = \alpha_{ik} = 0, \forall\, j \neq k$. The existence of a long run cointegration relationship implies that at least one of the $\alpha's$ is statistically different from zero. How to impose restrictions for the test of LOP is detailed later in the results section.

The post-estimation unit root raised earlier is implemented by imposing further restrictions on the cointegrating vectors. In this way, one is able to certainly conclude whether the evidence of cointegration is driven by a unit root process[32].

While the VECM is used to assess the long run equilibrium between the market prices, the short-run dynamics is assessed by considering the impulse response functions (IRF). The IRFs show how each of the variables respond to an exogenous shock to the system. Thus, it reveals the evolution of market prices along a specified time horizon following an exogenous shock to the system. In the case of a cointegrated system, computation of IRFs from a Moving Average Representation (MA) of the VECM presents much more precise estimates (Lutkepohl, 2005).

5.4 Data

To investigate the linkages between ecological and conventional fish markets, we use data for two fish products; trout and salmon. We use two sets of data, a farm level trout prices that spans from May 2010 to September 2015 and is obtained from a parent company with three production units accounting for approximately 48 percent of total organic trout production in Denmark. The second set of data is obtained from GfK consumer panel and represents retail market prices. The panel contains records of Danish households' quantities and expenditure of commodities consumed. The price for trout, organic and conventional salmon used in this study is the weighted average expressed in DKK/Kg. These retail level prices are weekly observations and spans from 2013 week 40 to 2015 week 52.

Figure 6 presents price development over time for the retail and farm level prices respectively. As can be seen in figure 6a, the price of conventional trout is always lower than salmon prices. The organic salmon price is the most valued. The average percent difference in price between organic and conventional salmon is more than 50 percent. Ankamah-Yeboah *et al.* (2016) show using data for 2013 and 2014, and controlling for other salmon attributes that the premium for organic salmon range from 20 to 36 percent. While a stable price is observed for the conventional salmon and trout prices, the organic salmon prices tend to be more volatile.

[32] See results section for the kind of restrictions imposed on the cointegrating vectors.

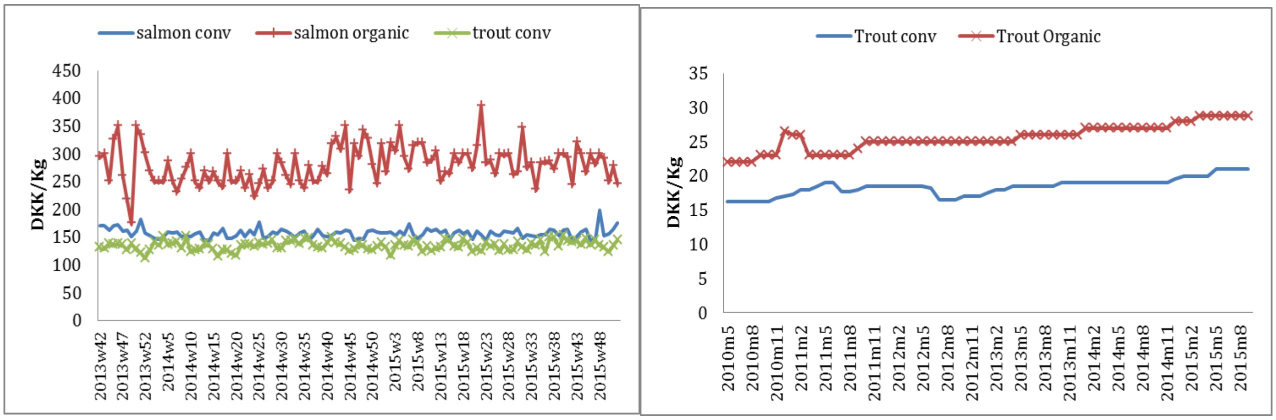

Figure 6. a) Weekly retail salmon and trout prices b) Monthly farm level trout prices

The farm level trout in figure 6b shows that the organic and conventional trout prices show similar patterns. The difference in prices which indicates the premium is estimated to be around 33 percent. The stability of prices over several months might be a reflection of fixed contract pricing and revisions. For the subsequent analyses, all variables are expressed in logarithms. Table 5.3 below shows the summary of prices used in the analysis. Generally trout prices are lower relative to salmon and farm levels are also the lowest as expected. The organic prices are higher than the conventional salmonids price.

Table 5.3. Summary statistics of prices in DKK

	Farm level		Retail level		
	Conv. trout	Organic trout	Conv. salmon	Organic salmon	Conv. trout
Mean	18.40	25.58	157.59	280.21	134.30
Median	18.50	25.00	157.44	279.75	134.34
Maximum	21.00	28.75	198.52	385.27	151.88
Minimum	16.25	22.00	142.58	175.00	112.02
Standard deviation	1.28	1.91	8.47	33.69	8.24

5.5 Results

As indicated earlier, analysis of price relationships within market integration concept depends on whether the price series have unit root process. In table 5.4 the unit root tests are presented. For the ADF test, we specify models with and without constant and trend terms. Using combinations of information criteria, the null hypothesis of unit root is tested in level and first difference. Failing to reject the null hypothesis in level and rejecting in first difference indicates that the series has unit root. The ADF statistics shown in table 5.4 indicates that organic and conventional salmonids in both nodes of the value chain have unit root for all the three specifications. For retail conventional trout and salmon, unit root is revealed only at the ADF specification without constant and trend. The constant and trend specifications indicate a stationary processes.

Since it is evident that all variables have unit root with the specification without constant and trend, we proceed with the cointegration test.

Table 5.4. Unit root test

Market	Farm level: Organic trout	Farm level: Conventional trout	Retail level: Organic salmon	Retail level: Conventional trout	Retail level: Conventional salmon
Level ADF					
None	1.516^{aic}	1.215^{sic}	-0.089	-0.029^{maic}	-0.060^{maic}
Constant	-1.073^{aic}	-1.695^{sic}	-1.552	$-3.540^{***maic}$	$-9.911^{***maic}$
Constant and trend	-1.959^{aic}	-2.935^{aic}	-2.001	-3.775^{**maic}	$-9.851^{***maic}$
First Δ - ADF					
None	-6.524***	-8.040***	-15.948***	-15.770***	-16.518***
Constant	-6.683***	-8.185***	-15.879***	-15.702***	-16.444***
Constant and trend	-6.628***	-9.844^{***aic}	-15.807***	-15.631***	-16.410***

Lags automatically selected using Schwarz's and (modified) Akaike's information criteria (aic, sic and maic). *** and ** indicate significance at 1% and 5% significance level respectively

The results presented in table 5.5 are the cointegration test using the Johansen maximum likelihood approach. The cointegration test involves a simultaneous determination of the evidence of cointegration at the rank of n-1 and the estimation of a well-defined error correction model. Specifications considered include 1) no trend 2) restricted constant and 3) unrestricted constant, with seasonal dummies and the number of lags that makes the residuals white noise. For all models estimated, the portmanteau test for serial correlation (indicated by Q-stat) and the vector residual heteroscedasticity test shown at the bottom of table 5.5 indicate that the models are well specified. The farm level model however, fails on normality test of residuals. The consequence is absorbed by the robustness of the Johansen's trace and maximum eigenvalue test for cointegration to non-normal errors (Cheung & Lai, 1993; Gonzalo, 1994).

First considering the farm level salmonids market, the null hypothesis of no cointegration which is a test of $r = 0$ is significantly rejected at the 5 percent level. A rank of $r = 1$ is however not rejected. This evidence is also consistent in both the trace (λ_{trace}) and maximum eigenvalue (λ_{max}) statistics. The VAR specification is modelled with a restricted constant using two lags. This show evidence that that farm level organic and conventional trout have a long run relationship (i.e., cointegrated). With a rank of one, we are able to effectively conclude that the two markets are integrated and function in the same market. Though it is possible that farm level organic and conventional trout prices may vary in the short run, stability of price premium is maintained in the long run across the different production methods.

The cointegrating vector is estimated to be positive and close to one ($\beta = 1.097$), indicating they have a very close relationship between them. A likelihood ratio test of the "Law of One Price"; $\beta' = (1 \quad -1)$ produces LR statistic of 0.16 that fails to be rejected at any significance level. This implies that the LOP holds and that the prices are proportional to each other. A likelihood ratio test on the speed of adjustment parameter α indicates insignificant α_1 and a statistically insignificant α_2. This shows that the farm level conventional trout which corresponds to α_1 is weakly exogenous and as such acts as the market leader in determining market prices. Alternatively, the organic trout prices acts as the market follower. A simple conclusion is that the organic trout price is essentially determined on the large market for conventional trout in the long run.

Table 5.5. Cointegration, proportionality and weak exogeneity tests

Farm level		Retail level	
	Conv. trout/ organic trout		Conv. salmon/ organic salmon/ conv. trout
Model(lags)	2M (2)	Model(lags)	1M (2)
λ_{trace}- Statistic		λ_{trace}- Statistic	
$r = 0$	22.261**	$r = 0$	77.657***
$r = 1$	4.044	$r = 1$	25.107***
$r = 2$	-	$r = 2$	0.201
λ_{max}- Statistic		λ_{max}- Statistic	
$r = 0$	18.555**	$r = 0$	52.551***
$r = 1$	4.044	$r = 1$	24.905***
$r = 2$	-	$r = 2$	0.201
β	1.097	$[\beta_{13}]$ and $[\beta_{23}]$	-1.115 and -0.970
LR-Stat of $(\beta = 1)$	0.160	LR-Stat of $[\beta_{13} = 1]$ and $[\beta_{23} = 1]$	19.786***
Weak exogeneity		*Weak exogeneity*	
α_1	-0.020	$[\alpha_{11}, \alpha_{12}]$ and	[-0.692] [0.428]
		LR test $[\alpha_{11} = \alpha_{12} = 0]$	23.645***
α_2	0.200***	$[\alpha_{21}, \alpha_{22}]$ and	[0.030] [-0.587]
		LR test $[\alpha_{21} = \alpha_{22} = 0]$	23.267***
		$[\alpha_{31}, \alpha_{32}]$ and	[0.090] [0.526]
		LR test $[\alpha_{31} = \alpha_{32} = 0]$	26.358***
Misspecification tests			
Q-Stat(Lags=3)	3.624(0.805)	Q-Stat(Lags=3)	14.060(0.277)
P (VEC res. hetero.)	0.056	P (VEC res. hetero.)	0.088

*** and ** indicate significance at 1% and 5% significance level respectively

Further considering the retail level salmonids, a rank of $r = 0$ and $r = 1$ are rejected at the 1 percent significance level while $r = 2$ fails to be rejected. This conclusion is affirmed in both the trace and maximum eigenvalue statistic. Again we effectively conclude evidence of market integration given the rank of two (i.e., two cointegrating equations) in the trivariate system. The cointegrating vectors for the two cointegrating equations are estimated to be close to unity, however, a test of the LOP; thus $\beta' = \begin{pmatrix} 1 & 0 & -1 \\ 0 & 1 & -1 \end{pmatrix}$ shown in table 5.5 as $[\beta_{13} = 1]$ and $[\beta_{23} = 1]$ is rejected at the 1% significance level using LR test. Hence a partially integrated market is found between commodities at the retail level. This implies that in the event of a shock, organic prices can be sold as conventional prices, but not below.

Weak exogeneity of prices and the determination of feedback from the respective retail markets are tested by the joint significance of $\alpha_{ij} = \alpha_{ik} = 0, \forall\, j \neq k$, under the restrictions of the estimated cointegrating vectors. As shown in table 5.5, the LR statistic is rejected at the 1 percent significance level for all the three variables indicating that there are feed-back effects or adjustment back to equilibrium following deviant price behaviors between the salmonids market.

In order to affirm the findings of cointegration, it is necessary to ensure that price series are nonstationary. Price series are thus tested for stationarity using the post-estimation approach by imposing the following restrictions on the bivariate case with rank 1: $(i)\ \beta' = (1\ 0)$ and $(ii)\beta' = (0\ 1)$ for a bivariate system with rank of one. The respective restrictions produce likelihood ration statistic of 4.66 and 6.92 with 5% and 1% levels of significance. For a trivariate system with rank of 2, the following restrictions $\beta' = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix}$, $\beta' = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$ and $\beta' = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$ are imposed. The respective likelihood ratio statistics are 24.65, 48.12 and 46.51, all significant at the 1% level. These restrictions are a test of the null hypothesis of a stationary process. Hence the conclusion is that the cointegration relationships are driven by unit root processes.

The IRFs are presented in figures 7 and 8 for cross market shocks. The IRFs show how a shock to one particular variable is reverberated in the system over time. The IRFs are based on the Cholesky decomposition of the contemporaneous covariance matrix. Thus, the variables appearing first in the VAR model have contemporaneous impacts while the later have lag impacts. Hence, we order as: organic and conventional trout for the farm level; and conventional salmon, organic salmon and conventional trout for the retail level model. The bootstrap method with 90 percent confidence interval for the responses was used with a VAR residual sampling of 999 replications. Validity of the IRF depends on stability of the model. For a VEC specification with r cointegrating relations, $n - r$ roots should be equal to unity for stability condition to hold (Juselius, 2006). The IRF was estimated by ensuring that in each model one real root lies on the unit circle of the characteristic polynomial.

As shown in figure 7, a shock in the farm level organic trout leads to a permanent increase in the conventional trout (see panel A). This increase in the conventional trout prices however, takes effect following the fifth month. A shock to the conventional trout prices on the other hand has no effect on the organic trout prices in the short run, as shown in panel B.

The IRFs for the retail level prices shown in figure 8, indicate that a shock to organic salmon prices resonates the conventional retail trout prices for the first two weeks but a permanent and stable increase from the third week (see panel A). The conventional salmon price as well starts increasing from the third week and reaches a stable and permanent increase from the sixth week (see panel B). A shock to the conventional retail trout only increases organic salmon prices in the third week, but falls back to the previous level in the next period (see panel C); and permanently increases the conventional salmon prices from the second week and maintains stability from the seventh week (see panel D). As shown in panels E and F respectively, a shock to the conventional salmon prices causes no effect on the organic salmon prices, but a permanent increase in the conventional trout prices.

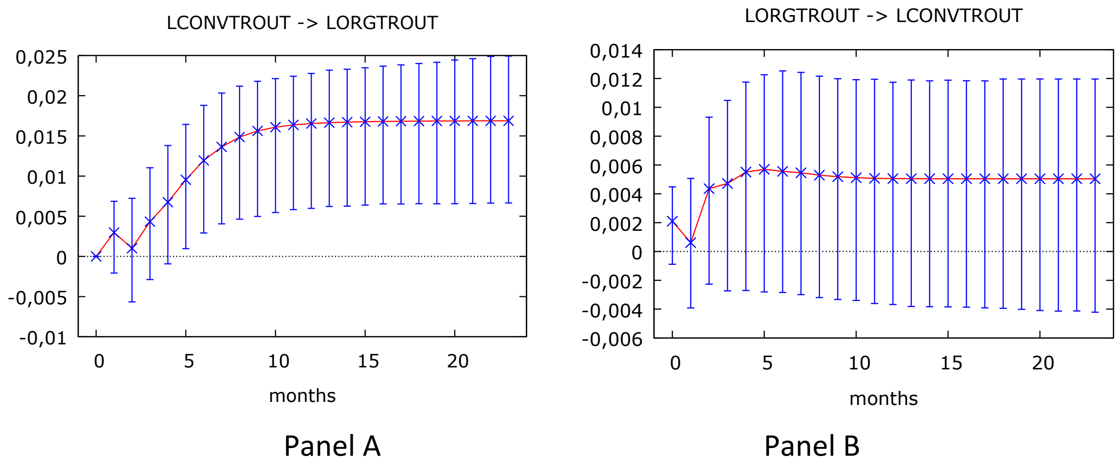

Figure 7. Farm level – impulse responses of one standard error shock

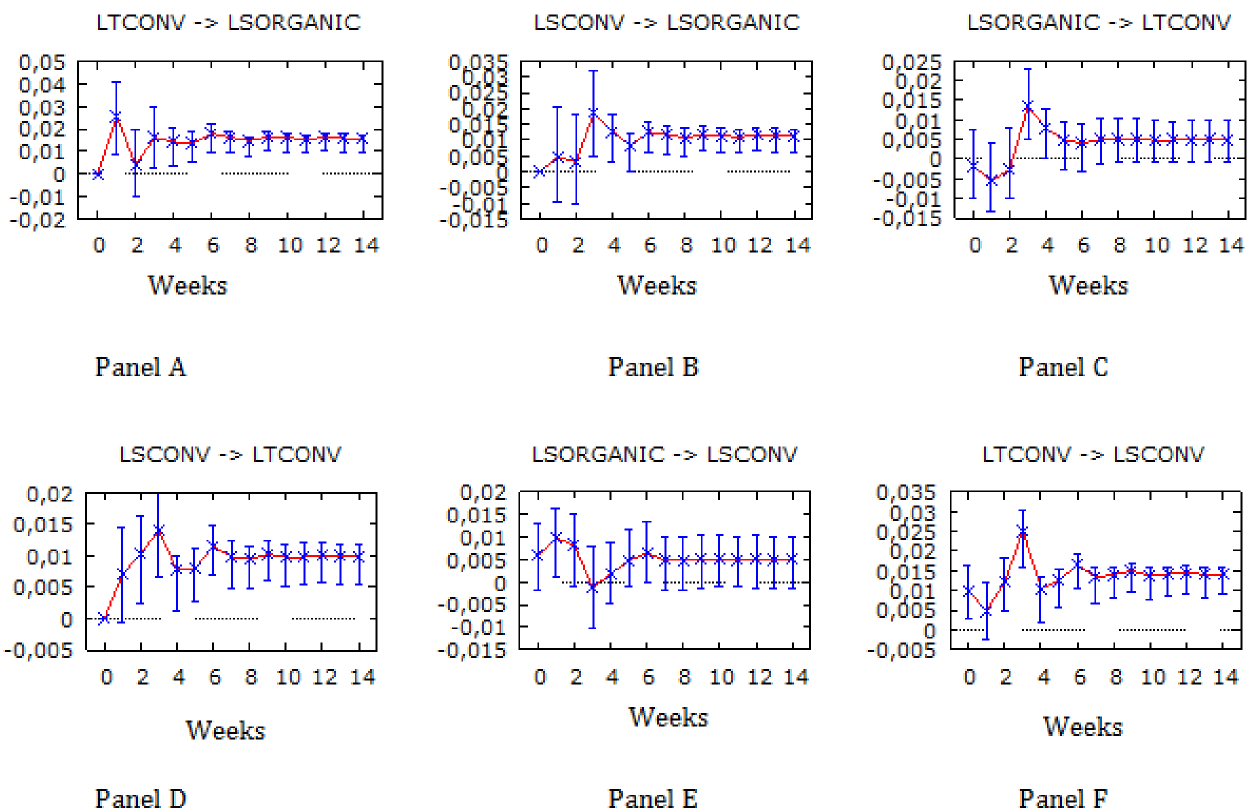

Figure 8. Retail level – impulse responses of one standard error shock

In summary, the study identifies price relations between organic and conventional salmonids in the long and short run. Results in the long run indicate that for the farm level trout markets, there exist a stable price premia between the conventional and organic trout markets, given that the LOP or constant relative prices is estimated in the presence of cointegration. Further, the organic trout prices are found to be determined by the conventional trout prices at the farm level. The adjustment time horizon reveals that in the short run, a shock to the organic trout prices will cause a permanent increase in the conventional trout prices from the fifth month, while maintaining the constant relative prices (constant premium), but not vice versa.

At the retail level, the long run analysis indicates that while organic and conventional markets are integrated, the test of constant relative prices between the organic and conventional salmonids does not hold. Price premia will vary, but randomly and with each market contributing in the determination of the price of the other in the market. In the short run however, a shock to the organic salmon prices cause a permanent increase in both the conventional salmon and conventional trout retail prices with the response starting in the third week. A corresponding shock to the conventional salmonids eventually leads to no response from the organic salmon market.

5.6 Conclusion

Market integration tests of non-stationary price series between organic/conventional products have been suggested as a pre-test to reduce investment risks for organic farming. The tests have also been applied to Danish salmonid markets. Upstream, market integration is identified between organic and conventional trout. The LOP holds and markets are perfectly integrated. Conventional trout is found to be market leader and impulse-response analysis identify significant short run effects from organic to conventional trout prices after 5 months, but with insignificant results *vice versa*.

Downstream, markets for organic salmon, conventional trout and conventional salmon is identified as integrated, while LOP and market leaders was not found. Impulse-response analysis show significant short run effects from organic to conventional salmonid prices already after 3 weeks, but with tests in the opposite direction being insignificant. This result is surprising. While the reasons remain a matter of speculation, it might be that buyers of the expensive organic products react faster to shocks than buyers of conventional goods, but that need to be confirmed in further enquiry. Organic and conventional prices also adjust faster downstream than upstream. While price premiums exist downstream, market integration is not perfect, but nevertheless exists and forms the basis for a price premium that can be transmitted upstream.

On this basis, it is concluded that investment in organic trout farming can be made in Denmark without risking of a reduced price premium. Ceteris paribus, growth in organic salmonids will not reduce price premiums given the small share of organic trout upstream and organic salmonids downstream.

The method is broadly applicable to identify stable price premiums and, thereby, to reduce investment risks when the organic market share is small and organic supply grow. Only the risk associated with organic supply growth is identified and the risk associated with supply and demand developments at the total market still remain.

The results are obtained for a small dataset and the reliability can be increased with more data. However, availability of few data is the rule rather than the exception at emerging markets including organic salmonids in Denmark and the indications of a stable price premium is important knowledge when an investment decision is made.

CHAPTER 6

CONSUMER PREFERENCES FOR FARMED ORGANIC SALMON AND ECO-LABELLED WILD SALMON IN DENMARK[33]

6.1 Introduction

While rapidly gaining increased popularity, at least when measured by the number of labeled products offered, ecolabels remain controversial as it is far from obvious that they lead to real changes in consumer behavior and thereby more sustainable production practices. A main reason for the controversy is that there are few studies that have access to data that allows actual consumer behavior to be measured. Using survey data to investigate consumer preferences or market data to estimate premiums associated with ecolabels, one can obtain indirect evidence that an ecolabel is a useful signal, but it is not conclusive evidence. This challenge is well illustrated with seafood, where there exist a number of studies providing indirect evidence that an ecolabel will be effective. However, there exist to our knowledge only two studies that investigate actual market impacts due to ecolabels for seafood. Teisl *et al.* (2002) indicate that the dolphin safe label on canned tuna increased demand for labeled products. Villas-Boas and Hallstein (2013) investigate the impact of traffic-light labeling in a California retail chain.[34] The main result here is that consumers reduce their purchase of seafood with a yellow label, while the green and red labels have limited impact. In this paper we will add to this literature using household scanner data from Denmark to investigate consumer purchases of salmon. The scanner data also contain demographic information, allowing us to investigate to what extent the influence of ecolabels vary for groups of consumers – a feature that turns out to be important.

Since ecolabels for seafood was first introduced at the turn of the century, a large number of studies using survey data indicated a strong preference for the ecolabel and a substantial positive willingness-to-pay (WTP) for products carrying the ecolabel (Brécard *et al.*, 2009; Fonner & Sylvia, 2016; Jaffry *et al.*, 2004; Johnston *et al.*, 2001; Johnston & Roheim, 2006; Salladarré *et al.*, 2010; Uchida *et al.*, 2014a; 2014b; Wessells *et al.*, 1999). Gudmundsson and Roheim (2000) show that a necessary condition for an ecolabel to change producer behavior toward more sustainable practices is that it is profitable for them. Accordingly, there must be a price premium associated with supplying product with an ecolabel. In recent years, this has motivated a number of studies using market data to show that there is a positive premium associated with many ecolabeled products. These are mostly hedonic price studies (Ankamah-Yeboah *et al.*, 2016; Asche *et al.*, 2015; Blomquist, Bardolino & Waldo, 2015; Bronnmann & Asche, 2016; Roheim, Asche & Insignaris, 2011; Sogn-Grundvag, Larsen & Young, 2014), but there are also other approaches (Stemle, Uchida & Roheim, 2015; Wakamatsu, 2014). These studies provide evidence that in a large number of cases, there is a positive premium associated with an ecolabel. However, the actual market impact

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[34] In addition, Stemle, Uchida and Roheim (2016) provides mixed evidence with respect to price effects using Ex. Vessel data in the US and Japan, and Blomquist, Bardolino and Waldo (2016) find that the existence of a price premium depend on the supply chain being served.

of ecolabels is contested, as is the existence of the price premium associated with the label (OECD, 2006; Washington, 2008). In a study not focusing on seafood, Grunert, Hielke and Wills (2014) provide support for the critics in reporting evidence that general concern about sustainability does not influence actual purchasing behavior to any extent.

A potential challenge with the price premium literature is that it does not account for the potential consumer response to the higher price. The theory of the consumer indicates that *ceteris paribus*, a higher price will lead to a lower quantity being purchased. However, this can be offset if the consumers have a sufficiently strong preference for sustainable produced seafood that they are willing to pay the higher price. Whether this is the case is of course an empirical question, although the results from the consumer preference literature indicate that this may willl be the case. The consumer preference studies also recognize that different groups of consumers may have different preferences with respect to the ecolabel, and try to capture this by estimating the taste preferences to follow certain distribution or clusters that are linked to demographic variables. This is a challenge for the price premium literature that have been using store scanner data without taking account of consumer characteristics and heterogeneity in preferences among consumers.

In this paper we will investigate the impact of ecolabels (specifically organic and Marine Stewardship Council) on salmon demand in Denmark using household scanner data. These data capture consumer behavior on actual household purchases. In addition, substantial information is available on demographic characteristics of the consumers. Consumer heterogeneity will be accounted for by the two most common approaches in the literature: A mixed multinomial logit model (MMNL) where consumer heterogeneity is accounted for by random parameters, and a latent class model (LCM) where heterogeneity is accounted for by consumer segments. The LCM is used to augment the MMNL in this study in that, linking heterogeneity to households' socio-demographic profile is interesting than merely knowing the distribution of their preferences. Denmark is an interesting country to conduct such a study, as it has a long tradition for buying organic food products. Organic products have a market share of 8% in Denmark, which is ranked highest in the world (Willer & Lernoud, 2016).

6.2 Data description

Consumer household scanner data are provided by the 'Gesellschaft für Konsumforschung' (GFK) for the year 2014 and include about 2800 households. Households scan their food purchases on a daily basis. Using 'European Article Number' (EAN) codes, each purchased salmon product can clearly be identified. The panelists further add information about the point and date of purchase as well as whether or not the product was on sale. The data set contains 1,477 salmon consuming households with 6,432 purchase transactions. Among the households, we select only those households that purchased packages of salmon at least on five weeks within the observation period. In accordance with the literature (Allender & Richards 2012), we furthermore choose those households that only purchase one salmon product at a time. If households buy more than one product at one purchase event, we cannot distinguish between households that are variety seekers and households that consist of several members with diverging preferences. Furthermore, a prerequisite of the mixed logit model is that the choices are mutually exclusive.

There are 257 distinct product alternatives (EAN codes) in the data. To simplify, products with less than 0.5% choice share were identified with a common identifier, hence, collapsing the total alternatives to 44 products. The data set identify 6 homogenous categories of distribution channels, Coop, Dansk Supermarked, Reitan, SuperGros, Internet/Mail Order and Other Food, where the first four are the main retail chains. Since we also need to specify the available alternatives that the household did not choose, the household choice set is designed to include all product alternatives that were available in the distribution channels visited. This reflects the changing product lines that gets introduced or removed from the retail shelf. The alternative nonchosen price faced by the household is calculated as the average unit price that is observed in the distribution channel visited during the specified period. As a result, prices vary over time and between households according to the distribution chain visited. In some situations, there are no alternatives available within a given week for the chain visited; these purchases are therefore excluded from the analysis. Hence, the choice set in our analysis is made up of 474 households with an average of 9 choice sets/purchase situations, summing up to 4,047 purchase situations. With varying number of alternatives and purchase situations, we analyze a total of 41,904 observations.

Most salmon consumed in Denmark is farmed and imported. The only ecolabel available for these products are organic labeling.[35] There is also some wild salmon in the data set, which all carry the label of the Marine Stewardship Council (MSC). The MSC-label is the most common ecolabel for seafood, but it only labels wild seafood. While the literature in the 1990s indicated that there were a positive preference for farmed seafood (Gu & Anderson, 1995; Holland & Wessells, 1998), there is now increasing evidence of a preference for wild seafood (Roheim *et al.*, 2012; Salladarré *et al.*, 2010; Uchida *et al.*, 2014a). As our data do not contain observations with unlabeled wild salmon, hence we are not able to test any hypothesis with respect to wild versus farmed, and we will not be able to estimate if there is preference associated with MSC for salmon in Denmark over the wild.

The data is summarized in table 6.1. Organic certified salmon products makes up a bit more than 4% of the observations, as do MSC labeled wild salmon. The alternatives no ecolabel, fileted, smoked, fresh, smaller package sizes of less than 300 grams hold the highest shares in their respective categories. Private label on the other hand hold the least share[36]. The demographic variables include income, education, age, the degree of urbanization of the community, household size, children and gender of shopper. Age of the shopper is skewed with those over 60 years representing more than 60% of the sample.[37]

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[35] The Aquaculture Stewardship Council (ASC) was established first in 2012, and there are no products with that label in our data set. This is also similar to the setting observed by Asche *et al.* (2015).

[36] Private labels are subsequently designated as economy packed products since they come with low priced products.

[37] This is not surprising as consumption of seafood generally is higher among older people (Jahns *et al.*, 2014).

Table 6.1. Data summary of variables used in estimations

Variable	Description	Mean 1	Mean 2
ATTRIBUTES			
Price	Price per kg of salmon purchased in DKK	177.693 (65.57)	169.457 (68.30)
Certification:			
Organic	=1 if organic certified, 0 otherwise (no label)	0.041	0.044
MSC	=1 if MSC certified, 0 otherwise (no label)	0.044	0.045
Product type:			
Filetf	=1 if fileted fish, 0 otherwise (whole fish, other)	0.762	0.799
Processed form:			
Smokedp	=1 if smoked fish, 0 otherwise	0.511	0.538
Marinp	=1 if marinated fish, 0 otherwise	0.149	0.154
Storage form:			
Freshs	=1 if stored fresh/chilled, 0 otherwise (frozen, other)	0.887	0.883
Package sizes:			
Pack_299	*=1 if pack <300g, 0 otherwise*	0.797	0.810
Pack_599	=1 if pack=300-599g, 0 otherwise	0.142	0.136
Pack_899	=1 if pack=600-899g, 0 otherwise	0.045	0.042
Pack_900	=1 if pack >899, 0 otherwise	0.016	0.012
Brand:			
PrivLabel	=1 if private/store label, 0 if brand label	0.293	0.307
SOCIAL CLASSES:			
Inc1 (1st Quartile)	*=1 if in lowest 25%, 0 otherwise*	0.308	0.325
Inc2 (2nd Quartile)	=1 if in low medium 25%, 0 otherwise	0.214	0.210
Inc3 (3rd Quartile)	=1 if in high medium 25%, 0 otherwise	0.291	0.281
Inc4 (4th Quartile)	=1 if in highest 25%, 0 otherwise	0.187	0.184
Educ1	=1 if have vocational high education, 0 otherwise	0.473	0.491
Educ2	=1 if have short further education, 0 otherwise	0.134	0.138
Educ3	=1 if have medium further education, 0 otherwise	0.291	0.284
Educ4	=1 if have long further education, 0 otherwise	0.101	0.088
Educ5	*=1 if have no or up to senior high education, 0 otherwise*		
Age1	*=1 if less than 30 years, 0 otherwise*	0.008	0.009
Age2	=1 if 30-44 years, 0 otherwise	0.093	0.089
Age3	=1 if 45-59 years, 0 otherwise	0.257	0.253
Age4	=1 if more than 59 years, 0 otherwise	0.641	0.648
Urban1	=1 if lives in the urban capital region, 0 otherwise	0.300	0.297
Urban2	=1 if lives in urban area mainland, 0 otherwise	0.436	0.447
Urban3	*=1 if lives in rural area, 0 otherwise*	0.264	0.256
Hhsize1	=1 if single member household, 0 otherwise	0.316	0.320
Hhsize2	=1 if two member household, 0 otherwise	0.505	0.505
Hhsize3p	*=1 if three or more member household, 0 otherwise*	0.179	0.175
FamnoChild	=1 if family has no child (0 - 14yrs) present, 0 otherwise	0.823	0.831
Femshopper	=1 if shopper is a female, 0 otherwise	0.798	0.803

Mean 1 and mean 2 indicate statics from the choices with (N=41,904) and without the non-chosen (N=4,047) alternatives respectively. For all the dummy variables, the means represent the respective shares. Standard deviation is in parentheses.

6.3 Model specification

Discrete choice modelling is based on the random utility theory (McFadden, 1974) and Lancaster (1966) approach to individual utility maximization problem. Lancaster's theory postulates that, consumers derive utility from the attributes by which the product is described. According to the random utility theory, utility is a latent construct in the consumer's mind that cannot be directly observed. Consider a consumer (decision-maker) who faces J product alternatives in each of T choice situations (time periods), typically assuming that choice situations can vary among consumers and choice set can also vary over consumers and choice situations. The latent utility (U) that consumer n obtains from brand j in choice situation t can be decomposed into two components: a systematic utility (V) and a random component (ε), represented as

$$U_{njt} = V_{njt} + \varepsilon_{njt} = \beta_n' x_{njt} + \varepsilon_{njt} \qquad 1$$

where the random component ε, arises both because of the randomness in the consumers' preferences and that, not all the preferred attributes of the consumer are modelled in the systematic part. If the consumer chooses the alternative which brings the greatest utility, then the probability of the choice of the alternative j over i,

$$P_{nj} = prob(V_{nj} + \varepsilon_{nj} > V_{ni} + \varepsilon_{ni}) = prob(\varepsilon_{ni} - \varepsilon_{nj} < V_{nj} - V_{ni}) \qquad 2$$

is the cumulative distribution function of the random variable $\varepsilon_{ni} - \varepsilon_{nj} = \varepsilon_{nji}^*$. Different discrete choice models are obtained from different assumptions about this probability distribution. By assuming that i) each of the ε_{nj} is independently and identically distributed according to the extreme value distribution otherwise known as Gumble distribution (Greene, 2012) and ii) allowing the systematic utility to be composed of individual consumer's taste preference β_n(taste heterogeneity) as shown in equation 1, one models a mixed multinomial logit (MMNL) also known as the random parameter logit (RPL). The parameter β_n is assumed to follow certain distribution with mean b and standard deviation σ_b, where a significant σ_b indicates that consumers have different preferences for the respective attribute[38].

An assumption of homogenous taste preference ($\beta_n = \beta$) transforms the random parameter logit into the standard multinomial logit (MNL) model. In addition to estimating taste heterogeneity, the mixed logit model has advantage over the MNL by overcoming the independence from irrelevant alternatives (IIA) property (Train, 2009). The probability of consumer n choosing alternative i in period t can be computed as a general logit formula (Revelt & Train, 1998)

$$P_{nit}(\beta_n) = \frac{\exp(\beta_n' x_{nit})}{\sum_{j=1}^{J} exp(\beta_n' x_{njt})} \qquad 3$$

An alternative model to identifying preferences among consumers is the latent class model (LCM) and can be empirically traced back to the market segmentation and product choice literature by Swait (1994). The LCM has become popular in discerning and unravelling heterogeneity among product choices. Unlike the RPL model which specifies the random parameters to follow a certain distribution, the LCM assumes that a discrete number of classes, S,

[38] Note that some parameters can be assumed fixed in the estimation of the random parameter logit model.

are sufficient to account for preference heterogeneity across segments but not known by the analyst. The choice probability that an individual n of segment s chooses alternative i from set J at time t is expressed as

$$P_{in|s} = \frac{\exp(\beta_s' x_{nit})}{\sum_{j=1}^{J} exp(\beta_s' x_{njt})} \qquad s = 1, \dots, S \qquad 4$$

where equation 4 is a standard MNL in segment s. The classification model can be constructed with some household-specific attributes to explain the heterogeneity across segments. In this case, the estimation of the LCM can be a simultaneous determination of class-specific utility parameters for S segments and class membership probabilities, H_{ns} for individual n being in segment s. The class probabilities are specified by the multinomial logit form (Green & Hensher, 2003)

$$Prob[class = s] = H_{ns} = \frac{\exp(\theta_s' z_i)}{\sum_{s=1}^{S} exp(\theta_s' z_i)}, \quad \theta_S = 0 \qquad 5$$

where z_i is a set of household or consumer specific covariates, such as the social classes and perceptions. One class is normalized to zero to allow for model identification. The determination of the optimal finite number of classes is commonly done by relying on the statistical information criteria (Ruto *et al.*, 2008). However, as indicated in Scarpa and Thiene (2011), following this criterion often leads to models with a large number of classes and poor estimates of utility. Swait (1994) suggests researcher's judgement, interpretability and the overall parsimony of the model to be factors that come into play when selecting the appropriate number of segments. In determining households' preferences for salmon demand in this study, we employ the general types of multinomial logit models described in this section using the product attributes and household specific covariates summarized in table 6.1. The latent class is used alongside the mixed logit model in that; linking taste heterogeneity to sociodemographic is clearly preferable to simply knowing that heterogeneity follows some assumed distribution in the sample population. It has the ability of grouping individuals into relatively homogeneous segments and enriching the traditional economic choice model by including individual related factors in explaining the choice behavior of segment members.

6.4 Estimation results and discussion

Table 6.2 presents the estimated results of the MNL and RLP specifications. All models are specified without alternative specific constants given the design of the data. Thus, the choice design is a non-labelled choice set with 44 alternatives designed on EAN codes. In addition to not making sense in terms of interpretability, excluding them reduces the burden of constraining the model with excessive parameters. The coefficient of price is significant and negative for all specifications. In the MNL specification the credence attributes organic and MSC do not appear to influence households' preferences for salmon. Smoked and marinated salmon, fileted, private labels and package sizes in the range of 600g-899g are the only features influencing the preferences in a statistically significant manner. These estimates presented in the MNL are used as priors for the estimation of the heterogeneous choice models. In the RPL specification, price was assumed fixed while all other attributes are treated as random and assuming a normal distribution[39]. The log-likelihood and the Akaike Information Criterion (AIC) related to the RPL shows a significant improvement relatively to the MNL specification. This is an indication that the RPL better predicts the preferences of households with respect to salmon. The standard deviations of the parameters are all significant, indicating that there is significant heterogeneity across households.

Table 6.2. Multinomial logit and random parameter estimation results

	MNL model		RP model				
Variables	Coefficient	Std. error	Coefficient	Std. error	RP std. dev.	Std. error of RP std. dev.	Dist.
PRICE	-.002***	(2.7e-4)	-0.002***	(3.4e-4)	-	-	
ORGANIC	0.064	(0.106)	-4.890***	(0.882)	-5.734***	(0.732)	80%
MSC	-0.120	(0.105)	-0.491**	(0.198)	-1.399***	(0.271)	64%
SMOKED	.255***	(0.055)	0.384***	(0.113)	1.824***	(0.112)	58%
MARINP	.214***	(0.067)	-0.104	(0.139)	2.073***	(0.154)	48%
FRESHS	-.320***	(0.075)	-0.053	(0.155)	2.066***	(0.167)	49%
FILETF	.229***	(0.058)	0.682***	(0.13)	1.887***	(0.131)	64%
PACK_599	-.006	(0.058)	-0.267**	(0.107)	1.296***	(0.136)	42%
PACK_899	.193**	(0.098)	-1.538***	(0.348)	-3.282***	(0.348)	68%
PACK_900	-0.204	(0.165)	-0.677**	(0.335)	1.263**	(0.547)	30%
PRIVLA	.090**	(0.044)	-0.145*	(0.084)	1.237***	(0.094)	45%
Log-likelihood	-8547.74		-7211.16				
AIC	17117.5		14464.32				
# Choice obs.	4,047		4,047				

***, ** and * indicate significance at 1%, 5% and 10% levels, #e-# indicates #x10^-#^.

Surprisingly given the results in the literature, the credence attributes organic and MSC have negative parameters. Note, however, that though on average, there is a disutility for these attributes, interpretation in RPL models is enhanced relative to the MNL, given the distribution. In the last column of table 6.2, we compute the distribution of preferences for each parameter as $100 * \Phi(b_k/\sigma_{b,k})$, where Φ is the cumulative standard normal distribution and b_k and $\sigma_{b,k}$ are the mean and standard deviation of the kth RP coefficient. Hence, whereas households on the average prefer salmon that are not eco-labeled, 20% and 36% of the households respectively have a positive preference for organic and/or MSC labeled salmon as expressed by the sign of the parameter. We do not know how many of these households have a statistically significant preference, but it is clear that many households do not care. The latent class model estimated below will shed light on this issue. However, these findings support the notion of Grunert, Hielke and Wills (2014) that most households are not aware of the issues, it is therefore difficult to create a consumer preference. Anderson (2011) uses this current data but for eggs and finds that the

[39] The RPL was estimated with 500 halton draws, as this is the minimum number that appears to stabilize parameter estimates.

share of the households with positive willingness to pay were 35% for organic and barn eggs, and 31% for free-range eggs with market shares between 10% and 26%.

Regarding the search attributes, smoked salmon is preferred by majority (58%) relative to other processed salmon products. In general, the RPL reveals that some segments of the population prefer certain characteristics of salmon to the other. The question of which segments of households prefer what characteristic arises. In answering this, we employ the market segmentation approach and estimate a latent class model capable of unravelling the sources of heterogeneity among agents. The estimated results are presented in table 6.3.

When determining the optimal number of latent classes, the researcher's intuition on interpretability of parameters and well estimated parameters factoring in higher standard errors and collinearity issues arising from increasing number of classes are used as a gauge. In this case, we settle on a five segment latent class model where segment 3 is used as the reference for the class membership model for model identification purposes. In the class probability model, age group 1 and 2 are bundled because they form only a smaller share (see table 6.1) of the sample and because of collinearity problems in the estimation.

All classes have a negative and significant coefficient of price. Otherwise, we observe substantial variations in preferences between the classes. The probability of a household belonging to the segments are respectively 19% (segment 1), 11% (2), 20% (3), 18% (4) and 32% (5). What characterizes the households within each segment?[40] In segment 1, households have strong preference for MSC/wild, while being neutral on the organic eco-label. Hence, they are labeled as "*Eco-wild*" conscious consumers. In addition, they tend to have preference for fileted private label salmon with package size between 300-599 grams. They are, however, sensitive to freshly stored products compared to frozen. This is not surprising since all the wild pacific salmon imported into the Danish domestic market come in frozen forms and if available fresh, it is refreshed. These consumers are more likely to live in rural areas with a household size of two and a shopper of age below 45 years relative to segment 3, but in this and the other segments the geographic effects are weak.

Segment 2 is identified to be neutral with respect to eco-labeled salmon and have preference for (or sensitive to) each of the categories of the search attributes. Thus, they are sensitive to value added products such as smoked and marinated salmon and have preference for fresh and fileted salmon. As a result, this segment of households is labeled as "*Eco-neuter*" consumers. They are less likely to opt for private labeled products and have preference for package sizes in the range of 300-599 grams. They are more likely to be female shoppers with two or more persons in the households and also more likely to be less than 45 years old relative to segment 3.

The consumers in the third segment are concerned with fewer attributes; they are neutral to eco-labels and only prefer marinated salmon but are sensitive to filets and private labeled products. This segment is labeled as "*Random*" choosers and we use this segment as the reference class for the class probability model.

Households in segment 4 are not influenced by eco-labels in their demand for salmon. However, they relatively prefer marinated salmon and whole salmon. A revealing and interesting characteristic within this segment is that they have preference for the very largest package sizes

[40] The labeling of segments is first based on significance of core ecological variables of interest and then a shift to other variables in the absence of preference for any ecolabel.

Table 6.3. Latent class estimation results

LCM	Segment 1 Eco-wild	Segment 2 Eco-neuter	Segment 3 Random	Segment 4 Low-end	Segment 5 Eco-farmed
Choice model					
PRICE	-.002***	-.002***	-.002***	-.002***	-.002***
ORGANIC	-27.011	-4.645	-3.432	-9.099	3.852***
MSC	3.816**	-2.153	-0.410	-2.527	.749*
SMOKED	9.899***	-1.091***	-12.744	-0.328	6.826***
MARINP	0.865	-1.710***	.414**	6.901***	-6.331
FRESHS	-10.482***	2.322***	-0.234	9.517	-5.141**
FILETF	5.051***	5.237***	-.416**	-4.496**	-1.145***
PACK_599	.792**	1.250***	-.287*	-1.570	-1.243***
PACK_899	2.426	7.261***	-13.099	2.516**	-5.338*
PACK_900	2.507	-1.526	-9.638	6.390***	1.171
PRIVLABEL	6.992***	-8.266***	-.358**	5.827***	-1.529***
Class membership model					
Constant	1.614	-1.554***	0.000	-2.237***	1.811***
FAMNOCHILD	-0.998	0.347	0.000	2.006***	-0.379
FEMSHOPPER	-0.541	0.175**	0.000	-0.030	-0.332**
EDUC1	0.687	1.135*	0.000	0.831	0.504**
EDUC2	0.149	0.937	0.000	0.613	0.436*
EDUC3	0.373	0.408	0.000	0.527	0.326
EDUC4	0.312	0.141	0.000	0.310	0.557**
INC2	0.117	0.503	0.000	-0.011	0.311*
INC3	0.039	0.246	0.000	-0.469	-0.073
INC4	0.287	0.579	0.000	0.026	0.372
HHSIZ2	0.317**	0.766***	0.000	0.792***	-0.196
HHSIZ3PLUS	-0.425	0.627**	0.000	0.681**	-0.536
URBAN1	-1.599***	-0.542*	0.000	-0.774**	-0.136
URBAN2	-0.616***	-0.062	0.000	-0.413*	-0.043
AGE3	-0.922	-0.543**	0.000	-2.645**	-1.258***
AGE4	-0.433***	-0.335***	0.000	-0.726*	-1.302***
Class probability	0.187	0.113	0.205	0.179	0.316
Log-likelihood	-7665.8				
McF. Pseudo R2	0.499				
AIC	15561				
# Choice obs.	4,047				

***, ** and * indicate significance at 1%, 5% and 10% levels

of at least 899 grams. They further prefer private labels. These households are therefore labeled as "Low-end" consumers since they are sensitive to prices and exploit the supply of quantity discounts in addition to the economy packed products. Relative to segment 3, these salmon consumers are more likely to have families without children in the range of 0-14 years. However, they are more likely to fall in the larger household sizes and are less likely to live in the urban area. The age of these households' shoppers is likely to be less than 45 years.

Segment 5 is the largest class with a probability of 31.6%. It is composed of households who have limited preference for organic salmon and a weak preference for MSC eco-labeled salmon. These households are labeled as "*Eco-farmed*" conscious consumers. With respect to the search attributes, these consumers have preference for smoked, frozen and whole salmon. They opt for smaller package sizes of less than 300 grams and prefer value products to economy products. Considering the class probability model, consumers in this segment are more likely to be male shoppers who have higher levels of education and fall under the age of 45 years.

6.5 Conclusion

During the last decade, a number of papers have provided strong evidence that ecolabels for seafood work. Survey and experimental data indicate a consumer WTP for ecolabels, and number of hedonic price studies find a premium. However, this evidence only provides strong indications as the first set of studies do not use market data and the second set measures a price effect, but not the quantity effect. With a downward sloping demand schedule, the observed price premium does not need to originate from an outward shift of the schedule; it can be just a movement along the schedule. To separate these outcomes, quantity effects need to be accounted for. The evidence from the two studies doing this is mixed. Teisl *et al.* (2003) provide evidence that the dolphin safe tuna label led to a positive shift in demand. Villa-Boas and Hallstein (2013) provide a much more mixed picture with unexpected results in that the effect of traffic light cards was limited from red and green labeled seafood, but a string negative effect for seafood with a yellow label.

In this study we use scanner data to investigate consumer preferences for salmon in Denmark. A mixed logit indicates substantial consumer heterogeneity with respect to MSC-labeled wild salmon and organic labeled farmed salmon, with a negative preference on average. A latent class model nuances the picture. We find 5 segments, where 3 segments have no preference for ecolabeled salmon. The two remaining segments both have a preference for ecolabeled salmon, but are otherwise different. The smaller segment has a strong preference for MSC-labeled wild salmon, while the largest segment has preference for organic salmon and a weak preference for MSC-labeled wild salmon.

The results nuance the picture of seafood ecolabels in the literature. One the one hand, the skeptics get some support in that a large number of consumer do not care about the ecolabel. Whether that is because they genuinely do not care or whether they just are not informed cannot be determined using market data. However, Grunert, Hielke and Wills (2014) and Uchida *et al.* (2014) indicate that it may be a bit of both. The results indicate that there is almost a combined 50% chance of a consumer belonging to one of the segments that have a preference for ecolabeled fish. These two groups are, as noted above highly different though in having one with a strong preference for MSC-labeled wild salmon and the other with a preference for organic farmed salmon. Hence, communication to consumers with a preference for ecolabeled salmon is complicated by the different preferences in the two groups.

CHAPTER 7

CONCLUSION

Organic aquaculture production has accomplished an impressive growth and demand in Europe. Countries like Germany, France and Switzerland particularly have a well-established consumption market for organic aquaculture products. In 2010, the European Union implemented a harmonized system of organic aquaculture production principles for all member states. The regulation requires that fish production should exclusively be based on organic fish fry from 2016. Given that antibiotic use is only allowed within very strict limits, robustness of the fry to diseases is very crucial, particularly for countries like Denmark where serious trout fry diseases are a major concern. In spite of this, Denmark is making headway in organic aquaculture production, currently being the leading supplier of organic rainbow trout where Germany is the number one market, consuming about 90% Danish trout production.

The focus of this work package was to provide knowledge about the market conditions, consumer attitudes, preferences and the competitive effect of increased production that could result in strengthening the development of the organic trout productions in Denmark. Given that the market for organic trout is not well-established, the analysis is extended to other organic aquaculture products, particularly salmon, in order to map out a future for organic trout production. Lessons from major markets like Germany are also drawn upon given that the Danish market is relatively small. The analyses are conducted on two foundations; a descriptive statistics and review of the value chain, farm economic performance and a literature review for identification of price premiums for eco-labeled products; a science based analyses based on Danish and German markets.

A number of interesting issues emerge and the following conclusions are reached:

- There is unprecedented growth in the organic aquaculture industry, new product lines are emerging, stakeholders in the value chain have increased; processors have increased their supply portfolio to include organic fish products, distribution outlets are also expanding and include supermarket chains, catering services, restaurants and online shop operators. Hence, the value chain follows that of the conventional aquaculture products.
- Producers of organic aquaculture are economically performing well, particularly for the case of portion sized rainbow trout in Denmark. The organic farms are at least equal to conventional trout and organic agricultural farms in terms of generating income per unit value of assets (8% per unit value of assets) and are more robust, having a solvency rate of 28%.
- On the demand side, a review shows organic aquaculture products (mainly salmon) command price premia (24%-38%) which is higher than ecolabels in the capture fisheries (10%-13%) based on actual market data. These premia is within the range of organic agricultural food products. Generally, consumers are more sensitive to price changes of organic products.
- A price premium of 20% was identified for organic salmon in the Danish retail market. This is a premium over both conventional farmed and wild (eco-labeled) salmon. The

identification of a premium signifies that; consumers recognize and value the product; and that there is also trust in the Danish organic ecolabel (Ø), which is widely known among consumers. For product development, the value (decreasing order) of fresh, marinated and smoked products attract premium over frozen products, brand labels are valued higher than private labels.

- In a survey in Germany, consumers show high preference for organic produced portion size trout, while seeing the ASC ecolabel to be equivalent to the conventional. However, the greatest value is placed on local German farmed trout, followed by Denmark relative to trout produced in Turkey. Further evidence shows that in the event of campaigns to increase the perceive value of organic trout, which eventually determines the market price, stronger emphasis should be placed on attributing organic principles, such as, GMO, hormones and synthetic additives; antibiotics use; feed and stocking densities to animal health and welfare concerns than on environmental issues. The second best is the combination of both. That is because animal health and welfare has been shown to be linked to food safety and food hazard risks by consumers. For product development and value adding, filets have are valued higher than whole trout products; the more the processing (skin and bones removed), the higher the preference. Fresh products are, however, preferred over smoked and frozen trout. The point of sale (supermarkets or specialized shops make no difference)
- At the farm level, price premium for organic produced rainbow trout in Denmark (about 33%) appear to be constant over time. Hence, increased production of organic rainbow trout would not result in falling price premiums to the farmer. Organic trout prices are, however, determined by prices of the conventional products. This indicates that farmers could be assured of safeguarding their investments in organic trout farms. At the retail level, the evidence shows that relative organic salmon prices are non-constant, meaning that premium tend to fluctuate above the conventional prices. This is due to the fact that salmon prices are globally volatile in nature.
- Consumer demand for salmon in Denmark reveals that the market is segmented. There is about 50% chance of choosing eco-labeled salmon (organic farmed label + MSC label wild fish combined). Though on average, there is a lower chance of buying organic salmon due to the high market prices, preference is heterogeneous and so there is a segment of the population (about 20-30%) with high preference for organic farmed salmon. The relative smaller share might be due to the smaller share of organic products in the total aquaculture market.

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APPENDIX 1

Average cost of organic trout per farm and percent cost distribution of trout farms

		Organic trout average cost trend			Percentage dist. of avg. cost per farm in 2012			
		2010	2011	2012	Organic	Traditional	Model 1	Model 3
51	Sell and Dist.	1.8	4.0	15.2	1.2	1.2	1.1	0.2
52	Fish	72.0	336.2	189.5	14.9	18.5	15.3	16.7
53	Feed	374.0	438.8	485.0	38.1	36.0	42.6	46.1
54	Electricity	…	…	…	…	6.2	9.6	9.5
55	Other variable c	87.4	129.8	124.3	9.8	3.5	2.7	2.6
56	Op. and mn. equip	54.0	50.2	76.5	6.0	7.6	5.9	5.1
57	Op. property	62.4	56.6	50.2	3.9	2.9	2.4	2.4
58	Admin	21.6	15.8	28.3	2.2	3.3	2.3	2.2
59	Personnel	163.2	227.8	254.7	20.0	15.6	11.4	8.5
60	Depr.	26.8	40.8	48.0	3.8	5.3	6.7	6.7
50	Total cost	863.2	1300.0	1271.7	100	100	100	100

Source: Statistics Denmark

APPENDIX 2

Study characteristics of seafood ecolabelled/sustainability premium

Study	Product	Country	Year	Premium	Value chain level	Data source	Type of sustainable practice
Seafood: Revealed:							
Aarset *et al*. (2000)	Fresh salmon	Norway	1996-1997	24.0	Producer/ processing	Giga-producer	Organic
"	Smoked salmon	"	"	38.0	"	"	"
Roheim *et al*. (2011)	Frozen processed Alaska pollock	UK	2007-2008	13.0	Retail	IRI Infoscan	MSC
Blomquist *et al.* (2014)	Baltic cod	Sweden	2011-2012	10.0	Retail	Personal store observation	MSC+KRAV
"	"	"	"	0.3	Landings	Landing ticket+log books	Non-MSC
Asche and Guillen (2012)	Hake	Spain	1998-2004	15.0	Wholesale	Mercabarna wholesale market	Long-line/trawl
"	"	"	"	50.0	"	"	Long-line/gillnet
Sogn-Grunvåg *et al.* (2013)	Chilled cod	UK	2010-2012	18.0	Retail	In-store observation	line-caught
"	Chilled haddock	"	"	10.0	"	"	line-caught
"	Chilled haddock	"	"	10.0	"	"	MSC
Sogn-Grunvåg *et al.* (2014)	Cod and haddock	UK	2010-2012	25.0	Retail	In-store observation	line-caught
"	"	"	"	13.0	"	"	MSC
"	"	"	"	10.0	"	"	Certified/private noncertified
Asche et al. (2012)	Wild salmon	UK	2012-2013	13.0	Retail	In-store observation	MSC
"	Farmed salmon	"	"	25.0	"	"	Organic
Seafood: Stated:							
Olesen *et al*. (2010)	Salmon	Norway	2010	15.0	Retail	Choice experiment	Animal welfare
"	"	"	"	17.0	"	"	Organic
Rudd et al. (2011)	Salmon	Canada	2011	35-50	Retail	Choice experiment	Reduced PCBs
Uchida et al. (2014a)	Salmon	Japan	2014	26.0	Retail	Choice experiment	Ecolabel
"	"	"	"	44.0	"	"	EcolabelxLocal
Uchida et al. (2014b)	Salmon	Japan	2014	20.0	Retail	Auction	MSC

" indicates – the same value as the previous cell, * non-ecolabel but relevant for its environmental/ecological implication.
A/B indicates the premium of A relative to B (thus, B received a discounted).
Source: Author's compilation