School of Business and Economics

Analysis of import demand and consumption of salmon in France

Discovering the reasons behind the increasing salmon prices

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Yulia Pyanchenkova

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Abstract

This thesis is an analysis of import demand and consumption of salmon in France. The objective is to discover the reasons behind the dramatically increasing salmon prices during the recent years. The dynamic first difference version of the Linearized Almost Ideal Demand System (LA/AIDS) is primarily applied and two separate demand systems are constructed and estimated. The first demand system analyses the French import demand for salmon, trout, cod and Alaska pollack in order to see how salmon operates in the same market with chosen representatives of other fish/seafood species. The second demand system focuses on salmon from different supply sources, namely Norway, the United Kingdom, Chile and the Rest of the World, in order to see how salmon from different countries of origin compete with each other in the same market. In order to account for the structural break in both demand systems, the whole observation period is divided into two samples: monthly observations from 1 to 156 cover the period from January 1999 to December 2011, while monthly observations from 157 to 216 cover the period from January 2012 to December 2016. In addition, the ordered logit model of salmon consumption choice is estimated in order to examine how different factors influence the frequency of salmon consumption for the French consumers. The applied model is based on the evoked sets concept and it is assumed that salmon choice can be explained by socioeconomic and demographic profile of a consumer, experience, perceptions and preferences regarding salmon consumption.

The main results show that, firstly, salmon acts as a much stronger substitute for whitefish species than vice versa, and, as a result, salmon faces less competition from other fish/seafood products, which, makes salmon prices increase significantly. Secondly, it is revealed that Norwegian salmon has become a much stronger substitute for Scottish salmon than vice versa, especially during the last five years. This indicates that it is harder for French consumers to replace the demand for Norwegian salmon, which forces the demand for Norwegian salmon to grow and pushes prices up. Next main result is that Norwegian salmon has started to act as an extremely strong substitute for Chilean salmon after the structural break, which reflects the consequences of the Chilean salmon decease crisis. Furthermore, salmon from all major supply sources follows the common trend and is becoming less expenditure elastic over time. This result is coherent with another finding that French consumers mostly consider salmon to be more suitable for weekday home occasions, which means that salmon is becoming a central part of the regular diet, which clearly contributes to the growth of salmon demand that, in turn, may cause the increase of salmon prices.

Keywords: *salmon prices, French salmon demand, LA/AIDS model, elasticities, salmon consumption*

Abbreviations

ADF	Augmented Dickey-Fuller test
AIDS	Almost Ideal Demand System
AME	Average Marginal Effect
BCR	Benefit-Cost Ratio
BG	Breusch–Godfrey test
CN	Combined Nomenclature
DW	Durbin-Watson test
ERPT	Exchange Rate Pass-Through
EU	European Union
EUMOFA	European Market Observatory for Fisheries and Aquaculture Products
ISA	Infectious Salmon Anemia
LA/AIDS	Linear Approximate Almost Ideal Demand System
LM test	Lagrange Multiplier test
LR	Likelihood Ratio
MLE	Maximum Likelihood Estimation
MTB	Maximum Total Biomass
NSC	Norwegian Seafood Council
OLS	Ordinary Least Squares
ROW	Rest of the World
SCI	Seafood Consumer Insight
SSR	Sum of Squared Residuals
SUR	Seemingly Unrelated Regression
UK	United Kingdom
US	United States

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

1.1 Introduction

Salmon is one of the most vital and economically important fish species in the world. The global salmon supply comprises both wild and farmed salmon, and today salmon is consumed in more than 100 countries worldwide (Asche & Bjørndal, 2011). The development of salmon aquaculture industry is a continuing success story, since the farmed salmon supply has increased tremendously from 12,000 tonnes in 1980 to over 2.4 million tonnes in 2011. (Asche, Roll, Sandvold, Sørvig, & Zhang, 2013; Larsen & Asche, 2011).

Productivity growth and demand growth are the two main factors that have caused such growth of farmed salmon production. Initially, productivity growth has been the main engine for this development. Through the improved technologies and production practices, productivity growth reduced the production costs and increased profitability. As a result, salmon prices declined substantially in order to induce greater salmon consumption (Asche, 2008; Asche & Bjørndal, 2010, 2011).

The real price of salmon was rapidly declining until the late 1990s because productivity growth was faster than demand growth. However, since the late 1990s, productivity growth has slowed down and the price of salmon stabilized, indicating that demand growth has caught up with productivity growth (Asche, Dahl, Gordon, Trollvik, & Aandahl, 2011; Asche, Guttormsen, & Nielsen, 2013). The price of salmon was relatively constant for some years, but since 2005 salmon price has followed an upward trend and has increased especially dramatically, even at increasing volumes supplied (Brækkan, 2014; Brækkan & Thyholdt, 2014). Increasing salmon price at higher volumes indicates that demand growth is outpacing productivity growth. In other words, the supply of salmon is not able to keep up with a strong growth in demand, which causes salmon prices to increase substantially.

This thesis is originally motivated by the statistics for export of salmon from Norway, which is the world's leading producer of salmon. Norwegian salmon exports achieved a record-high volume in combination with record-high export prices in 2015 (NSC, 2016a). Moreover, the export price for salmon has been at a historic high throughout 2016 and 40% higher than in 2015 (NSC, 2016b, 2017a).

Reports for the European Union (EU) salmon market, which is the largest single salmon market since the mid 1990s, have also provided numerous evidences for significantly increasing salmon prices. Imports of salmon from countries outside of the EU (extra-EU trade), with Norway as a major supplier, grew substantially from 2009 to 2014 both in volumes and values with a parallel 36% rise in average prices that moved from 3.90 Euro/kg to 5.30 Euro/kg (EUMOFA, 2014, 2015). However, in 2015 salmon import prices decreased by 1.5% compared with 2014. The reason is the 15% depreciation of the Norwegian currency against the Euro from 2013 to 2015. Another reason of this slight price decrease in 2015 is that significant volumes of Norwegian salmon, which were intended for the Russian market, were reallocated to the EU market after the introduction of the Russian import ban on seafood imposed in August 2014. (EUMOFA, 2015, 2016b). The extension of the Russian import ban to December 2017 could have also led to growth of the Norwegian exports to the EU countries in 2016. However, volumes of the salmon imports to the EU, hit by a high price increase, actually declined by 4% in 2016 compared with 2015 but, at the same time, values of the salmon imports grew remarkably by 25% and were registered at the highest amount ever. The increase of the average price of salmon imported in the EU in 2016 compared with 2015 is 27% which is from 5.22 Euro/kg to 6.62 Euro/kg (EUMOFA, 2017).

The same trends apply to the exchanges between EU Member States (intra-EU trade). Intra-EU exchanges of salmon increased significantly between 2005 and 2015 with an average annual growth rate of 12% (EUMOFA, 2016b). The development of the average salmon prices within the intra-EU exchanges is described as follows. For the first seven months of 2013 the average salmon price has grown by over 20% with respect to 2012, reaching 6.14 Euro/kg (EUMOFA, 2014). In 2014, the average salmon price reached 6.34 Euro/kg, which was almost the same level as in 2013 and the highest price registered since 2006 (EUMOFA, 2015). In 2015, although the volumes of salmon exchanged were significantly higher than in 2014, the resulting price of 6.18 EUR/kg represented only a 3% decrease as the result of the Russian import ban and the Norwegian currency depreciation (EUMOFA, 2016b). In 2016, intra-EU exchanges of salmon presented a remarkable 20% value growth compared with 2015. This was a result of a 24% price increase, with salmon moving from an average price of 6.18 Euro/kg in 2015 to a price of 7.67 Euro/kg in 2016 (EUMOFA, 2017).

1.2 Research objective and structure

The objective of this thesis is to discover the reasons behind the increasing salmon prices during the last five years. In other words, the aim is to explain why salmon prices have been increasing so dramatically during the recent years and to identify which factors contributed the most. To my knowledge, this specific issue has not been fully enough discussed in the recent published studies. Focusing primarily on the period from 2012 to 2016, I expect to fill this gap in literature and contribute to increased knowledge about salmon prices and world demand for salmon.

To address the research question, the demand for salmon will be examined in the French market at the import level. The French market is selected as a representative for the empirical study since the EU is the most important and the largest single salmon market in the world and, within the EU, France is the largest and the most sophisticated salmon market with a very diversified supply of product forms (Asche & Bjørndal, 2011; Asche et al., 2011; Xie & Myrland, 2011).

The Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980) will be primarily applied for the purpose of this thesis. Two separate demand systems will be constructed and estimated. The first demand system will focus on different fish/seafood species and analyse the French import demand for salmon, trout, cod and Alaska pollack. The goal of the first model is to see how salmon operates in the same market with chosen representatives of other species. The second demand system will focus on salmon from different supply sources and analyse the French import demand for salmon from Norway, the United Kingdom, Chile and the Rest of the World. The goal of the second model is to see how salmon from different countries of origin compete with each other in the same market. Both demand systems cover the period from January 1999 to December 2016 and, therefore, the presence of the possible structural break in the data will be assessed and tested.

Furthermore, a supplementary model of salmon consumption choice will be estimated. The goal of this model is to examine how different factors influence the decision for the consumption of salmon. The conceptual model is based on the evoked sets concept which was introduced by Kinnucan, Nelson, and Hiariey (1993) and modified by Nauman, Gempesaw, Bacon, and Manalo (1995). In this thesis, it is assumed that the end decision for the consumption of salmon, i.e. salmon choice, is explained by socioeconomic and demographic profile of a consumer, experience, perceptions and preferences regarding salmon consumption. The ordered logit technique will be applied to estimate the French consumers' choice to consume salmon.

It is expected that the model of salmon consumption choice will provide supplementary findings that may be coherent with the findings from the main import demand analysis and will help to explain the increasing salmon prices.

This thesis is organized as follows. The current introductory chapter includes the research question and objectives of this thesis. Chapter 2 continues to present the literature review that will construct the theoretical and empirical basis for the future discussions. Chapter 3 proceeds with a presentation of the models that will be applied, namely the AIDS model and the ordered logit model for consumer choice. This chapter will also cover the elasticity concept and possible econometric difficulties related to the time series data. Chapter 4 provides a detailed description of data and data collection process. Chapter 5 describes all estimation procedures paying special attention to the econometric issues that may arise. Thereafter, Chapters 6 provides statistical and economical interpretation of the empirical results. Summarising discussion and concluding remarks and are given in the final Chapter 7.

Chapter 2: Literature and background review

2.1 Historical review on salmon prices

Farmed salmon is one of the most successful fish/seafood species with production growing faster than total aquaculture production, which indicates an even faster innovation rate and productivity growth than for aquaculture in general (Asche, Dahl, Valderrama, & Zhang, 2014; Asche, Roll, et al., 2013). It was already mentioned in the previous chapter that significant increases in productivity and demand are the two key factors that have caused the tremendous growth in farmed salmon production. Initially, the main driver of growth in salmon aquaculture is productivity growth that has reduced real production cost to less than a third of the level in the early 1980s (Asche, Misund, & Oglend, 2016). Productivity growth is an innovation-driven process that reduced the production costs and increased profitability through the improved technologies and production practices. As a result, salmon prices declined substantially in order to attract new customers and induce greater salmon consumption (Asche, 2008; Asche & Bjørndal, 2010, 2011).

The real price of salmon was rapidly declining until the late 1990s-early 2000s because productivity growth was faster than demand growth. Earlier studies of Asche (1997) and Asche, Bremnes, and Wessells (1999) confirmed that productivity growth of farmed salmon production was the main cause of decreasing salmon prices and stated that prices for farmed salmon were likely to continue to decline unless there were significant demand shifts. Moreover, it was expected that productivity growth in salmon aquaculture to continue to reduce the price of wild Pacific salmon through the substitution relationship with farmed Atlantic salmon (Asche, Bjørndal, & Salvanes, 1998).

However, since the early 2000s, productivity growth has slowed down and the price of salmon has become relatively stable for some years, indicating that demand growth has caught up with productivity growth (Asche et al., 2011; Asche, Guttormsen, et al., 2013).

Later, since 2005 salmon price has followed an upward trend and has increased dramatically, even at increasing quantities supplied (Brækkan, 2014; Brækkan & Thyholdt, 2014). Increasing salmon price at higher volumes indicates that demand growth is outpacing productivity growth. Vassdal and Holst (2011) showed that change in total factor productivity for production of Atlantic salmon in Norway increased from 2001 to 2005, but thereafter declined. Authors concluded that salmon aquaculture industry has reached a level of technological sophistication from where it is hard to make substantial progress. Similarly, Asche, Guttormsen, et al. (2013) demonstrated that the annual growth of the Norwegian salmon production has slowed down from annual growth rates of 15-20% in 1992-1995 to 1-2% over the period 1996-2008. Such results clearly illustrate that salmon aquaculture industry has developed into a mature industry. Authors also explained that lower growth rates of production mean limited possibilities to increase productivity growth thorough technical development and more efficient production. Hence, salmon aquaculture industry is becoming more dependent on external factors such as demand and regulations, which industry has less control over. Brækkan (2014) added that when productivity is slowing down, any significant supply expansion in future depends on a relaxation of government regulations.

Whereas, Asche et al. (2011) used an index approach to investigate the demand growth for salmon in the EU and France for the period from 1996 to 2009. Their results indicate that demand for salmon has increased at an average rate of 7.6% per year in the EU and 4.7% in France. Brækkan and Thyholdt (2014) extended the analysis of Asche et al. (2011) and examined demand growth in all major salmon-importing regions for the period from 2002 to 2011 and reported that emerging markets, such as Russia and Brazil, have experienced the largest demand growth at an average annual rate of about 20%, while more established markets, such as Japan and the United States, have experienced the lowest demand growth at an average annual rate of about 3%. It was also reported that total global demand for salmon shifted upwards by approximately 94% from 2002 to 2011, whereas production volume increased by approximately 50%. This difference reflects an obvious imbalance between demand and supply growth, meaning that supply of salmon is not able to keep up with a strong growth in demand, which causes salmon prices to increase substantially. Salmon is perishable and mostly marketed fresh, so all production in one period has to be consumed in the same period. Hence, it is difficult to adjust supply in the short time since salmon production cycle is three-year long (EUMOFA, 2016c).

Another important issue is volatility of salmon prices that has increased substantially along with the increasing prices. Volatility is different from occasional shocks and seasonal fluctuations and is defined as variations in prices around its expected value (Oglend, 2013). Volatility is fundamentally related to unexpected movements in supply and/or demand, and the positive relationship between price and volatility can be explained by demand fluctuations that, in lack of supply, must be adjusted by price movements (Oglend, 2013). Brækkan and

Thyholdt (2014) concluded, among other things, that demand growth for salmon is characterized by large variations between regions and over time within regions, and such variations may partly explain the high volatility of salmon prices. Oglend (2013) suggested that, first of all, the volatility trend is largely accounted for by higher prices of food relevant to salmon, which includes both demand side substitutes for salmon and input factors, such as cereals, oils and fish meal. Secondly, higher volatility of salmon prices is also linked to strong demand for Norwegian salmon as the result of the Chilean salmon disease crisis which has started in late 2007. Thirdly, increasing use of bilateral contracts over spot trading and introduction of the futures market for salmon by Fish Pool ASA in May 2006 could also increase the volatility of salmon prices. The fourth factor that could have contributed to high salmon price volatility is change in government regulations, namely introduction of a maximum total allowable biomass (MTB) restriction in 2005.

2.2 Global salmon market

2.2.1 Norway

Worldwide, aquaculture accounts for two thirds of total salmon production. Atlantic salmon is the main farmed species and accounts for 93% of total aquaculture production (European Commission, 2012). Salmon aquaculture industry originated in Norway in the 1970s, and since then, Norway has always been the world's leading producer of salmon. Good natural environment for salmon aquaculture, good cooperation between aquaculture industry and government, generic advertising and high level of innovativeness are the major reasons for success of Norwegian salmon. Most salmon from Norway is exported, and the EU is the primary export market with France in lead. Norway mostly exports salmon as fresh/chilled whole, which made up 75% of total export value in 2008 (Asche & Bjørndal, 2011). Russia has been the most important destination outside of the EU until the introduction of the Russian import ban on seafood that was imposed in August 2014. As a result, significant volumes of Norwegian salmon, which were intended for the Russian market, were reallocated to the EU market, that, in turn, cause a slight decrease of salmon price in 2015 (EUMOFA, 2016b, 2016c).

The demand for Norwegian salmon continues to grow, which partly may be a result of a generic advertising of Norwegian seafood conducted by the Norwegian Seafood Council (NSC). NSC is owned by the Norwegian The Ministry of Trade, Industry and Fisheries and works together with the Norwegian fisheries and aquaculture industry to develop markets for Norwegian seafood. The activities of the NSC are financed by the Norwegian seafood industry through fees levied on all exports of Norwegian seafood. The traditional way of estimating the effect of the advertising expenditures is as shifters of demand (Xie, 2015). For instance, Xie (2008) estimated the effect of the promotion program conducted by the NSC in EU Atlantic salmon market for the period from 1998 to 2007. The results indicate that Norwegian salmon advertising shifted its own demand curve to the right and salmon demand curve of the Rest of the World (ROW) to the left. The research underlined the importance of the generic advertising influence on marginal benefit-cost ratio (BCR) and producer surplus measurement.

Likewise, Xie, Kinnucan, and Myrland (2009) estimated the direct and spillover effects of the NSC promotion efforts for the period from 1998 to 2005. Authors concluded that there is a positive spillover effect of the generic advertising on the demand for fresh salmon not only from Norway, but also from the United Kingdom (UK) and Chile, which are also important salmon producers. Another result is that the NSC promotion increased the demand for fresh salmon at the expense of frozen.

Ulstein, Wifstad, Mæhle, Fjose, and Jakobsen (2014) evaluated the activities of the NSC for the period from 2005 to 2013 and stated that generic advertising was both important and correct instrument in the 1990s. However, a huge development of seafood industry and markets during the last two decades reduced the need for generic marketing and several leading Norwegian seafood companies would now prefer to promote their own products rather than to finance a common marketing.

In contrast to Ulstein et al. (2014) who used mostly document study, surveys and interviews as research methods, Kaiser (2014) applied a pure econometric modeling approach in order to evaluate the net impact of the NSC export promotion activities on Norwegian salmon import demand of the EU consumers (9 countries) for the period from 2004 to 2014. The most important result is that the estimated NSC export promotion elasticity is 0.036 and statistically significant, which means that NSC salmon export advertising to the EU has a positive and statistically significant effect on the demand for Norwegian salmon. The second result suggests that in the absence of Norwegian salmon export promotion to the EU over the period from 2004 to 2014, salmon exports would have been 15.1% lower than they actually were. The third finding of Kaiser (2014) indicates that NSC salmon export promotion has been very profitable for the Norwegian salmon industry, and each krone invested in advertising in the EU returned between NOK 4.95 and 9.53 on average. Finally, Kaiser (2014) examined whether the promotion elasticity and BCR vary over time and estimated the model separately for the two time periods 2004-2009 and 2009-2014. As a result, the export promotion elasticity for the earlier time period is 0.026, while for the latter time period it is double that of the earlier time period and equals 0.05. The BCRs for the two periods reveal that the profitability of the NSC export promotion program increased by about 37% to 40% since 2009.

2.2.2 Chile

Chile has been the second largest salmon producer since the mid 1990s, although the salmon disease crisis briefly made Scotland the second largest producer of Atlantic salmon in 2010 (Asche, Roll, et al., 2013). Infectious salmon anemia (ISA) was discovered in Chile in late 2007. Thereafter, during the period from 2008 to 2010, the Chilean salmon aquaculture industry was experiencing the worst disease outbreak ever observed in salmon aquaculture. This caused a dramatic decline in the production of Atlantic salmon in 2009 and 2010 (Asche & Bjørndal, 2011; Asche, Hansen, Tveteras, & Tveterås, 2009). The reduction of supply of Chilean salmon explains the increased demand for salmon from other sources and the increased salmon prices.

The US is the main export market for fresh salmon from Chile, taking about 90% of exports. Whereas, frozen salmon is primarily sent to the EU and the US, taking 38% and 24%, respectively, of exports in 2008 (Asche & Bjørndal, 2011).

2.2.3 The United Kingdom (UK)

All production of farmed salmon in the UK takes place in Scotland. Scotland is the only major producer of farmed salmon with a large domestic market, while exports take approximately 50% of output. Scottish salmon is mostly exported fresh/chilled and the EU is the primary export market, with France in lead (Asche & Bjørndal, 2011).

It is also proved to be difficult for Scottish salmon to compete with Norwegian salmon on the basis of the price. Scottish producers position their products with an emphasis on high quality, rather than high quantities with lower prices. Compared with Norwegian producers, Scottish producers are limited in output, which makes it difficult to compete on price (Asche & Bjørndal, 2011).

2.2.4 The European Union (EU) and France

The EU is the largest single salmon market in the world and is very dependent on imports. The EU imports 80% of its salmon supply from third countries and 80% of that are from Norway. The major EU importers are Sweden and Denmark which only act as "trade hubs" for Norwegian exports and actually re-export salmon within the EU (EUMOFA, 2014; European Commission, 2012). The main EU markets for salmon are France, Germany and Poland. It is important that Germany and Poland also contribute to the intra-EU trade by processing, mainly smoking, Norwegian raw material. In the recent years, imports from China to the EU have been increasing, but this is very often salmon from Norway that has been filleted and frozen in China and then re-exported to the EU (European Commission, 2012).

France is the largest European market for salmon and imports salmon primarily from European producers. Norway is the main supplier of salmon with approximately 60% of the imported quantities. UK is the second largest supplier with approximately 20% of the imported quantities. Chile is the third largest supplier and mainly supplies frozen salmon fillets (Asche & Bjørndal, 2011). The French salmon market provides consumers the stable supply all year round and a wide selection of high-quality products. French consumers are typically concerned about product diversity, origin, quality and production process. It is also interesting that French consumers perceive salmon from Scotland as superior to Norwegian salmon, which makes sense since Scottish salmon has higher price and is positioned as salmon of the best quality.

2.3 Role of the exchange rates

Traditionally, exporters benefit from weak domestic currency value. The impact of exchange rates on salmon prices has not been so widely discussed in the literature yet. Larsen and Kinnucan (2009) and Xie, Kinnucan, and Myrland (2008) used the term exchange rate pass-through (ERPT), which is defined as a measure of responsiveness of international prices to changes in exchange rates. Under complete ERPT a change in the farm price measured in a domestic currency will be fully transmitted to the retail price measured in a foreign currency. Xie et al. (2008) found out that prices of major exporting countries are at least as sensitive to changes in relative domestic currency values as to changes in export volume. Authors also concluded that ERPT is complete for the Chilean peso and the British pound, but incomplete for the Norwegian kroner and the US dollar. This means that producers in Chile and the UK are more affected by short-term movements in relative currency value than producers in Norway and ROW. Meanwhile, Larsen and Kinnucan (2009) investigated how Norwegian export prices and exchange rates affect French wholesale prices and confirmed the incomplete ERPT for the Norwegian kroner, which means that exchange rate had no effect on French wholesale prices.

2.4 Demand interactions and elasticities

Traditional demand analysis typically focuses on price sensitivity of demand, degree of substitution between potentially competing species and on income/expenditure effects using the elasticity concept.

Asche, Bjørndal, and Gordon (2005) provided a review of several demand studies related to fish/seafood. They state an own-price elasticity of -1 as a focal point and reported that own-price elasticities for whitefish species are generally either about -1 or more elastic. The own-price elasticity for salmon is initially highly elastic, however since the early 1990s, researchers have been reporting a common trend for less elastic demand for salmon (Asche, 1996; Asche et al., 1998; Bjørndal, Salvanes, & Andreassen, 1992; Devoretz & Salvanes, 1993). Recent research of Xie et al. (2009) proved that world demand for salmon is becoming even less price elastic. This is clearly not surprising given the tremendous increase in the total supply of both wild and farmed salmon since the early 1980s. Hence, Asche et al. (2005) assumed that current own-price elasticity for salmon is quite close to -1. Asche et al. (2005) focused mainly on the own-price effects, but noticed that the more elastic the demand for the good, the greater substitution possibilities there will be, and consequently, the greater the competition.

When it comes to the expenditure elasticities, it was concluded by Asche (1996) and proved by Xie (2008) that fresh salmon is more expenditure elastic than frozen salmon in the EU market. However, Xie (2008) also noticed that fresh salmon has a trend to become not luxury good, i.e. less expenditure elastic, due to large supply of farmed salmon in the EU market. Whereas, smoked salmon is considered to be a luxury good, since it is much more expensive than fresh and frozen salmon (Xie & Myrland, 2011).

Asche et al. (2005) also discussed market integration studies and concluded that there is a highly integrated global market for salmon, both wild and farmed, and trout, such that all product forms of salmon are competing in the same market. For the whitefish species, it was mentioned, firstly, that cod is a part of the larger whitefish market that includes haddock, saithe, hake and pollock, and secondly, that all product forms of cod compete.

Asche, Gordon, and Hannesson (2003) showed the importance of empirically defining a market and conducted several tests for market integration. One of the findings of their study reveals that salmon species does not belong to the whitefish market in France. There are several more studies that provide the evidences that the salmon market is separated from markets for other fish/seafood species (Asche, 2001; Asche et al., 1999; Asche, Gordon, & Hannesson, 2002; Gordon, Salvanes, & Atkins, 1993; Jaffry, Pascoe, Taylor, & Zabala, 2000). Nevertheless, there are recent researches that investigate the demand interactions between salmon and other species. For example, the results in the paper of Fofana and Clayton (2003) suggest that salmon has a long-run market relationship with the whitefish species of cod, monkfish, saithe, whiting and plaice. They inspected the seafood demand within the UK and showed that the whitefish species mentioned above act as the most potential substitutes for salmon.

2.5 Consumer choice of fish/seafood

Consumer perceptions and preferences are rather difficult to measure. Therefore, the traditional demand analysis often assumes that perceptions and preferences are constant and never change. However, there have been researchers who address consumer experience, perceptions, preferences and choices directly, rather than focus only on price and income effects. Such studies provide a better understanding of fish/seafood demand structure.

It was noticed by Gempesaw, Bacon, Wessells, and Manalo (1995) that the evoked set concept is widely used to understand the consumer behaviour regarding the fish/seafood consumption. The evoked set, as defined by Howard and Sheth (1969), consists of product or brand alternatives a consumer would consider when faced with a purchase decision.

The concept of evoked sets was introduced by Kinnucan et al. (1993) as a tool for determining the factors that form consumer preferences for fish/seafood products. Their study was based on a variation of the “lens” model of Brunswik (1952) that formed a conceptual framework consisting of four equations describing the individual models for experience, perceptions, preferences and choice:

$$Experience = f(socioeconomic/demographic\ factors);$$
$$Perceptions = f(socioeconomic/demographic\ factors, experience);$$
$$Preferences = f(socioeconomic/demographic\ factors, experience, perceptions);$$
$$Choice = f(socioeconomic/demographic\ factors, experience, perceptions, preferences).$$

This conceptual framework has a recursive structure and starts with the assumption that consumer experience depends on socioeconomic and demographic factors. Then consumer behaviour proceeds such that experience with the product category determines perceptions, which determine preferences for a particular product within the category, which, in turn, determine the final consumption choice.

Kinnucan et al. (1993) define experience as purchase frequencies of fish/seafood *in general* for either at-home or restaurant consumption. Perceptions are defined as consumer beliefs about general product attributes, for example, quality, taste, odour, health and nutritional value, cost, convenience, ease of preparation and safety. Preferences form the basis for the evoked set of a consumer and are usually determined by posing two questions:

1. What are your three favourite types of fish and seafood?
2. When you think of a good fish to eat, which species do you think of?

Choice is defined as the ultimate decision for the consumption of a specific product and is expressed as purchase frequencies of a *particular* fish/seafood item for either at-home or restaurant consumption.

The concept of evoked sets was later modified by Nauman et al. (1995) by presenting an alternative measurement of consumer preferences as the ratio of the number of individuals in a household who have consumed a particular fish/seafood product and the total household size. It is assumed that if more than 50 percent of the household members consume a particular fish/seafood product, their preference for that product would be high which, in turn, may affect their final decision of choice to purchase that product.

Myrland, Trondsen, Johnston, and Lund (2000) used a similar preferences construction by measuring the ratio of total fish/seafood dinner dishes to the total number of dinner dishes consumed by the respondent. In their study, they examined how strongly the consumption of fish/seafood is influenced by the variation in lifestyle factors and consumer’s experience with available products in the market.

Chapter 3: Methods

3.1 The AIDS model

The Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980) is a commonly used approach to estimating the demand for a certain commodity and has been especially widely applied in the seafood demand studies. The AIDS model is selected since it is compatible with general demand theory and weak separability assumption which is used to separate a group of commodities from the rest of the consumer's bundle (Asche et al., 2005). Moreover, the AIDS model is proved to be a better choice in salmon demand analysis than Rotterdam model, which is also commonly used in demand analysis (Xie et al., 2008; Xie & Myrland, 2011). Asche et al. (2005) have also considered the AIDS model to be more intuitive and easier to use than the Rotterdam model.

The AIDS model is specified as a set of demand equations where the market (expenditure) share for each good is a dependent variable, whereas the price of a particular good and the prices of other goods in the commodity group are explanatory variables. The true (original) static AIDS model is defined as follows:

$$R_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} lnp_j + \beta_i ln\left(\frac{y}{P}\right) \qquad for\ i = 1, 2, \dots, n$$

where

- $R_i = \frac{p_i q_i}{y}$ is the market (expenditure) share of the i^{th} good
- p_i is the price of the i^{th} good
- q_i is the demanded quantity of the i^{th} good
- $y = \sum_{i=1}^{n} p_i q_i$ is the nominal total expenditure for n goods included in the system
- P is a non-linear price index defined by

  $lnP = \alpha_0 + \sum_{i=1}^{n} \alpha_i lnp_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} lnp_i lnp_j$ (the translog price index)
- $\frac{y}{P}$ is the real total expenditure
- $ln\left(\frac{y}{P}\right) = lny - lnP$
- α_i is the intercept
- γ_{ij} are the price parameters
- β_i is the expenditure parameter

The true AIDS model has a non-linear form since the translog price index is used. In order to make the system linear the translog price index is approximated by the linear Stone price index that is defined as follows:

$$lnP^* = \sum_{i=1}^{n} R_i lnp_i$$

By using the Stone price index, the linear approximate form (LA) of the AIDS model is obtained. The LA/AIDS model is written as follows:

$$R_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} lnp_j + \beta_i ln\left(\frac{y}{P^*}\right) \qquad for\ i = 1, 2, \dots, n$$

In order to comply with economic theory, the price parameters are required to satisfy the following theoretical restrictions of homogeneity and symmetry:

- $\sum_{j=1}^{n} \gamma_{ij} = 0\ for\ i = 1, 2, \dots, n$ (Homogeneity)
- $\gamma_{ij} = \gamma_{ji}\ for\ all\ i \neq j$ (Symmetry)

The following adding up conditions apply to the price and expenditure parameters and intercept:

- $\sum_{i=1}^{n} \gamma_{ij} = 0\ for\ j = 1, 2, \dots, n$
- $\sum_{i=1}^{n} \beta_i = 0$
- $\sum_{i=1}^{n} \alpha_i = 1$

The adding up conditions, which are imposed automatically, bring the problem of a singular variance-covariance matrix of the residuals (Buse, 1994). The solution is to omit one equation from the demand system prior to the estimation process. The demand system is invariant to which equation is to be omitted. In order to recover the coefficients of the dropped equation the adding up restrictions may be applied. Another way to recover the coefficients of the dropped equation is to rerun the model with another equation dropped.

3.1.1 Seasonality

Seasonality effects may be captured by adding indicator (i.e. dummy) variables into the model. One of the indicator variables must be dropped to avoid the dummy variable trap. The LA/AIDS model augmented by a set of monthly dummy variables D_k $(k = 2, \dots, 12)$ is written as follows:

$$R_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} lnp_j + \sum_{k=2}^{12} \delta_{ik} D_k + \beta_i ln\left(\frac{y}{P^*}\right) \qquad for\ i = 1,2,\dots,n$$

where δ_{ik} are the parameters associated with the monthly dummy variables and where the dummy variable D_1 for January is dropped.

3.1.2 Econometric issues

Time series data is often characterised by existence of dependencies in the data over time (Asche et al., 2005). The first econometric challenge concerning a time series data is non-stationarity. A non-stationary time series is one whose properties depend on the time at which the series is observed (Hyndman & Athanasopoulos, 2013). Using non-stationary time series variables can bring the spurious regression. Differencing the series is a way to make a time series stationary. In order to find out whether the time series variable is non-stationary and how many times it should be differenced, one can use unit root tests, e.g. the Augmented Dickey-Fuller (ADF) test.

Another problem one would expect when working with time series data is serial correlation (i.e. autocorrelation) (Xie & Myrland, 2010). One refers to serial correlation when successive residuals are correlated. Serial correlation can occur in the time series data since event in the current time period frequently influences the event in the next period. Thus, one can expect correlation among the residuals. The most common ways to test for serial correlation are the Durbin-Watson (DW) test and the Breusch–Godfrey (BG) test. The last one is often referred to as Lagrange Multiplier (LM) test for serial correlation. If the serial correlation is detected, one may estimate a dynamic version of the AIDS model in order to solve the problem. The dynamics specification presents the inclusion of the lag-dependent variable, i.e. a regression of R_i on its own lag.

Therefore, the dynamic first difference version of the LA/AIDS model with lag-dependent variable solves both the problem of non-stationarity and serial correlation. Such empirical model is written as follows:

$$dR_{i,t} = \varphi_i dR_{i,t-1} + \sum_{j=1}^{n} \gamma_{ij} dlnp_{j,t} + \beta_i dln\left(\frac{y_t}{P_t^*}\right) + \lambda_i e_{i,t-1} + \upsilon_{i,t}$$

$$for\ i = 1, 2, \dots, n\ and\ t = 1, 2, \dots, T$$

where subscript t is the index time, d is the first-difference operator, $dlnP_t^* = \sum_{i=1}^{n} R_{i,t} dlnp_{i,t}$ is the logarithmic differential of the Stone price index, $e_{i,t-1}$ is the estimated residual from the static model, φ_i is the parameter of the lag-dependent variable, λ_i is the parameter associated with the residual from the static model and $\upsilon_{i,t}$ is the disturbance term.

3.1.3 Structural break

Many time series contain clear structural breaks (changes). The estimates obtained from a model, which does not account for a structural break if one actually occurs, would be meaningless and implications based on such estimates would be incorrect (Kocenda & Černý, 2014). Hence, it is important to find out whether a structural break has occurred somewhere in the sample. The sup-Wald test can be applied in order to detect the presence of the structural break.

There are two approaches to allowing for the structural break in the model. The first approach is to incorporate a dummy variable in the model, such as:

$$br_t = \begin{cases} 0 \; before\ the\ structural\ break \\ 1 \; after\ the\ structural\ break \end{cases}$$

Hence, one can make use of the dummy variable and interaction variables and then estimate the unrestricted "dummy variable model".

The second approach is to divide the whole observation period into two samples: before and after the structural break, and then estimate and compare the two separate sub-models (Becker, 2015, April 7).

These two approaches are related. Firstly, the SSR (sum of squared residuals) of the "dummy variable model" is equal to the sum of the SSR of the two sub-models in the second approach. Secondly, the coefficients are related. If $br_t = 0$, the coefficients of the "dummy variable model" will be exactly the same as the coefficients of the sub-model for the "before the structural break" period. Similarly, for $br_t = 1$, the coefficients of the "dummy variable model" will equal the coefficients of the sub-model for the "after the structural break" period.

3.1.4 Elasticities

Price and expenditure elasticities are computed in order to evaluate the response of demand/consumer preferences to changes in prices and expenditure. Elasticities are calculated using the estimated parameters from the AIDS model and the average market (expenditure) shares over the study period (Wan, Sun, & Grebner, 2010).

The Marshallian elasticities capture the total effect of the price change, i.e. both substitution and income effect. The Marshallian elasticities are also called uncompensated elasticities since they take into account the variation in real income resulting from the variation in prices. The Marshallian elasticities and expenditure elasticities are directly obtained from the LA/AIDS model:

- $E_{ii} = -1 + \frac{\gamma_{ii}}{R_i} - \beta_i$ (Marshallian own-price elasticity)
- $E_{ij} = \frac{\gamma_{ij} - \beta_i R_j}{R_i}$ (Marshallian cross-price elasticity)
- $A_i = 1 + \frac{\beta_i}{R_i}$ (expenditure elasticity)

The own-price elasticity E_{ii} measures the responsiveness of the demanded quantity of a good i to a change in its own price, where:

- $E_{ii} = -1$ denotes a unit elastic good
- $E_{ii} = 0$ denotes a perfectly inelastic good
- $-1 < E_{ii} < 0$ denotes relatively price inelastic good
- $E_{ii} < -1$ denotes price elastic good

The cross-price elasticity E_{ij} measures the responsiveness of the demanded quantity of a good i to a change in the price of a good j, where:

- Goods are substitutes if $E_{ij} > 0$
- Goods are complements if $E_{ij} < 0$
- Goods are independent if $E_{ij} = 0$

In the case of the expenditure elasticity A_i, which measures the responsiveness of the demanded quantity of a good i to a change in the expenditure:

- $A_i > 1$ denotes a luxury good
- $A_i > 0$ denotes a normal good
- $0 < A_i < 1$ denotes a necessity good
- $A_i < 0$ denotes an inferior good

The Hicksian elasticities capture only the substitution effect of the price change. The Hicksian elasticities are also called compensated elasticities since they imply that the income of the consumer varies in order for him/her to stay on the same indifference curve. The Slutsky equation ties together the Marshallian and Hicksian elasticities and is written as follows:

$$E_{ij}^{*} = E_{ij} + A_i R_j$$

The Hicksian elasticities are then written as follows:

- $E_{ii}^{*} = -1 + \frac{\gamma_{ii}}{R_i} + R_i$ (Hicksian own-price elasticity)
- $E_{ij}^{*} = \frac{\gamma_{ij}}{R_i} + R_j$ (Hicksian cross-price elasticity)

Hicks-Allen (1934) definition of substitutes, complements and independent goods is used when interpreting the Hicksian cross-price elasticities:

- If $E_{ij}^{*} > 0$ then good j is a substitute for good i
- If $E_{ij}^{*} < 0$ then good j is a complement to good i
- If $E_{ij}^{*} = 0$ then good j is independent of good i

Weber (2002) showed in his paper that for discrete price changes, Hicksian cross-price elasticities for two goods need not be equal if the household consumes three or more goods. Moreover, in such case, the signs of the Hicksian cross-price elasticities for two goods can differ depending on which price changes. Therefore, the Hicks-Allen (1934) distinction between complements and substitutes will in some cases depend on which of the two prices is assumed to change.

3.2 The Ordered Logit Model for Consumer Choice

3.2.1 Conceptual model of choice

The selected conceptual framework for consumer choice is based on the evoked sets concept which is commonly used to understand the consumer behaviour regarding the fish/seafood consumption. The evoked set concept was introduced by Kinnucan et al. (1993) and modified by Nauman et al. (1995) and was described in Section 2.5. The following supplementary model of consumer choice is chosen for this thesis:

$$Choice = f(socioeconomic/demographic\ factors, experience, perceptions, preferences)$$

Therefore, the ultimate decision of choice to consume a specific product is determined by socioeconomic and demographic profile of a consumer, experience, perceptions and preferences regarding that specific product. Choice is the dependent variable and is expressed as frequency of consumption of a particular fish/seafood item for either at-home or restaurant consumption.

3.2.2 The Ordered Logit Model

The probit and logit techniques are often used to estimate the model based on the evoked sets concept (Gempesaw et al., 1995; Kinnucan et al., 1993; Nauman et al., 1995). For a binary (i.e. indicator) dependent choice variable, the probit/logit model for binary choice is usually applied. If the choice variable contains more than two consumption categories, the extended multinomial probit/logit model is usually applied. However, it is important to pay attention to whether the order of consumption categories is meaningful. If the choice variable is constructed as ranked ordinal consumption categories, it is necessary to apply the ordered probit/logit model (Myrland et al., 2000). It is not appropriate to apply the usual linear regression model, since such regression would treat the values of the dependent choice variable as they have some numerical meaning whereas they only reflect the ranking of the outcomes (Hill, Griffiths, & Lim, 2012).

The probit model is based on the random errors being standard normal, whereas the logit model is based on the assumption that the errors follow a logistic distribution. Both the ordered probit and ordered logit model are commonly used by the researchers and usually deliver quite similar results (Hill et al., 2012).

Following Myrland et al. (2000), the ordered logit model is used in this thesis and has the following general structure. To begin with, let y_i^* be the latent, i.e. unobserved, continuous dependent variable for the i^{th} observation such that one can construct a so-called index model:

$$y_i^* = \beta' x_i + \varepsilon_i \qquad for\ i = 1, 2, \ldots, n$$

where x_i is a $(n \times k)$ matrix of observed values of the independent explanatory variables, β' is a k-dimensional vector of unknown parameters to be estimated and ε_i is an unobservable $(n \times 1)$ vector of uncorrelated and identically distributed random variables.

Further, let one observe the ranked ordinal values of the dependent variable, y_i, which has $j + 1$ categories. The ordered probability model is then can be written as follows:

$$y_i = \beta' x_i + u_i \qquad for\ i = 1, 2, \dots, n$$

where u_i is the error term and

$$y = 0\ if\ y^* \leq \mu_0$$
$$y = 1\ if\ \mu_0 < y^* \leq \mu_1$$
$$y = 2\ if\ \mu_1 < y^* \leq \mu_2$$
$$\dots$$
$$y = j\ if\ \mu_{j-1} < y^*$$

The thresholds, which are denoted as μ, provide information about the distribution of the ordered dependent variable.

Then, the probability of observing $y_i = j$ can be written as follows:

$$P(y_i = j \mid x_i) = \Lambda(\mu_j - \beta' x_i) - \Lambda(\mu_{j-1} - \beta' x_i)$$

where, for the ordered logit,

$\Lambda(l) = \frac{e^l}{1+e^l} = \frac{1}{1+e^{-l}}$ is the logistic cumulative distribution function, and

$\Lambda(\mu_0 - \beta' x_i) = 0$ and $\Lambda(\mu_j - \beta' x_i) = 1$,

since $\mu_0 = -\infty$ and $\mu_j = \infty$ and $\mu_1 < \mu_2 < \cdots < \mu_j$.

Similarly, one can obtain the expressions for the probabilities of the other values of y_i.

3.2.3 Maximum Likelihood Estimation (MLE)

In order to estimate the unknown slope parameters β' and the set of intercepts μ, it is necessary to apply the Maximum Likelihood Estimation (MLE). The MLE procedure provides the estimates that maximize the probability, i.e. likelihood, of observing the sample.

The likelihood function gives the probability of observing the sample data and is written as follows:

$$L = \prod_{i=1}^{n} \prod_{j=1}^{m} \left[\Lambda\left(\mu_j - \beta' x_i\right) - \Lambda\left(\mu_{j-1} - \beta' x_i\right)\right]^{d_{ij}}$$

where $m = j + 1$ and

$d_{ij} = 1$ if $y_i = j$ and $d_{ij} = 0$ otherwise.

In practice, the MLE procedure, instead of maximizing the likelihood function, maximizes its logarithm. The log-likelihood function is then written as follows:

$$L^* = ln\,L = \sum_{i=1}^{n}\sum_{j=1}^{m} d_{ij}\, ln\left[\Lambda\left(\mu_j - \beta' x_i\right) - \Lambda\left(\mu_{j-1} - \beta' x_i\right)\right]$$

3.2.4 Average Marginal Effect (AME)

Myrland et al. (2000) and Gempesaw et al. (1995) noticed that the estimated coefficients of the probit/logit model do not have a straightforward interpretation. Hence, it is necessary to focus on the change in marginal probabilities calculated at the sample means.

For the i^{th} observation, the marginal effect of an increase in the explanatory variable on the probability of observing $y_i = j$ is written as follows:

$$\frac{\partial P(y_i = j)}{\partial x_i} = \left[\Lambda\left(\mu_{j-1} - \beta' x_i\right) - \Lambda\left(\mu_j - \beta' x_i\right)\right] * \beta'$$

Similarly, one can obtain the marginal effect on the probabilities of the other outcomes of y_i.

Further, it is convenient to compute the average marginal effect (AME) which is expressed as the average of the marginal effects evaluated at each sample observation. In this way it is possible to summarize the response of all individuals in the sample to a change in the value of an explanatory variable (Hill et al., 2012).

3.2.5 Pseudo-R^2

In the probit/logit model it is technically impossible to compute R^2, which is the goodness-of-fit indicator, in the same way as in the usual linear regression. However, researchers have searched for a corresponding measure for models with binary and multinomial outcomes. Many different R^2 statistics have been proposed in the past four decades, and entropy-based R^2 statistics, so-called pseudo-R^2, have got special attention in the social sciences (Hu, Shao, & Palta, 2006). Pseudo-R^2 statistics are based on the comparison of the log-likelihood for the fitted model against the log-likelihood of a restricted null model with no predictors.

Pseudo-R^2 statistic of Cragg and Uhler (1970) is chosen to be applied in this thesis and is defined as follows:

$$\text{Pseudo-}R^2 = [1 - \exp\{2(L_\omega - L_\Omega)/T\}]/[1 - \exp\{2(L_\omega - L_{\max})/T\}]$$

where L_ω is the maximum of the log-likelihood function using only a constant, L_Ω is the maximum using all variables and $L_{\max}$ is the maximum possible.

Chapter 4: Data

4.1 French import data

French import data was obtained from Eurostat (2017) and contains 216 monthly observations that cover the period from January 1999 to December 2016. Two separate datasets were constructed according to the model specification. The first dataset contains data on value and quantity of different product forms of salmon, trout, cod and Alaska pollack. Imports both from EU Member States (intra-EU trade) and from countries outside of the EU (extra-EU trade) are observed.

The second dataset contains data on value and quantity of different product forms of salmon, both wild and farmed, from different supply sources, namely Norway, Sweden, Denmark, United Kingdom (UK), Chile and the Rest of the World (ROW). It is important to keep in mind that salmon originating from Norway is mostly sold to neighbouring Sweden and Denmark, but they re-export it to other EU countries (EUMOFA, 2016b). Therefore, it is reasonable to aggregate the salmon imports from Norway with imports from Sweden and Denmark into single supply category – salmon originating from Norway.

Datasets are originally specified according to product forms and the associated 8-digit Combined Nomenclature (CN-8) code for each product. Data collection was a rather time-consuming process because of the updates in CN codes in 2007 and 2012. Those updates included, for instance, changes in the CN number for a product or changes in way of aggregation in the same CN code for some products. Hence, it was necessary to be careful when working with CN codes in order to collect correct observations for the correct product.

Therefore, both original datasets contain data on various product forms. In total, salmon is mostly imported to France as fresh/chilled whole (61.01%) and 14.55% is imported as frozen fillets. Only 8.51% of total import of salmon is traded as smoked. Trout is mainly imported as fresh/chilled whole (36.74%), live (19.05%) and smoked (14.88%). Main product forms of total import of cod are frozen fillets (31.75%), fresh/chilled fillets (21.91%) and fresh/chilled whole (21.61%). The share of dried cod in total cod imports is only 9.71%. Whereas, Alaska pollack is mostly imported to France as frozen fillets (78.5%).

If one examines the salmon supply sources, 74.23% of salmon from Norway is imported as fresh/chilled whole and 15.24% are fresh/chilled fillets, i.e. 89.47% of Norwegian salmon import are fresh products. Imported salmon from the UK is mostly fresh/chilled whole (82.98%), while salmon from Chile is almost entirely imported as frozen fillets (96.62%). Salmon from ROW is imported as fresh/chilled whole (33.18%), frozen fillets (25.19%) and smoked (23.15%).

However, the quantities for different products are expressed in product weights and it is not possible to compare them directly. EUMOFA (2016a) provided the conversion factors in order to convert the quantity from product weight into the live weight equivalents. Live weight is the weight of the whole fish taken from the sea and is a common unit of measurement for different products. Once data on products was collected, product weights were multiplied by the relative conversion factor, taking into account the CN-8 code and the relative year of observation.

Hence, there is no distinction between product categories. The first modified dataset contains observations on the value (Unit: Euro) and quantity in live weight equivalents (Unit: kg) of the following species: salmon, trout, cod and Alaska pollack. The second modified dataset contains observations on the value (Unit: Euro) and quantity in live weight equivalents (Unit: kg) of salmon from the following supply sources: Norway, UK, Chile and ROW. Prices (Unit: Euro/kg) in both datasets were obtained by dividing value by quantity.

Figure 1 shows the French monthly import price dynamics for salmon, trout, cod and Alaska pollack for the period from January 1999 to December 2016. Prices for the whitefish species, namely cod and Alaska pollack, have a similar pattern which is flat and stable during the whole period. Prices for salmon and trout followed a quite common trend until about 2006, however the price of trout has become very volatile afterwards. Whereas the price of salmon has been increasing since 2006 and has been experiencing a particularly substantial upward trend since about 2012. It is also possible to observe that the salmon price volatility has also increased along with the increasing price.

Figure 2 focuses only on the total annual French import of salmon for the whole study period and shows import value, quantity and average import price of salmon. Over the whole period, the yearly imported quantity has increased from 150 thousand tonnes to 222 thousand tonnes. Whereas, due to variation in price, the yearly import value has increased from 454 million

Euros to 1,236 million Euros. The salmon import price has increased a lot from 2.99 Euro/kg to 5.56 Euro/kg over the whole period. Figure 2 shows that salmon price experienced peaks in 2000 and 2006 and has been increasing since 2006. Moreover, one can clearly see that salmon price has been increasing especially significantly since 2012.

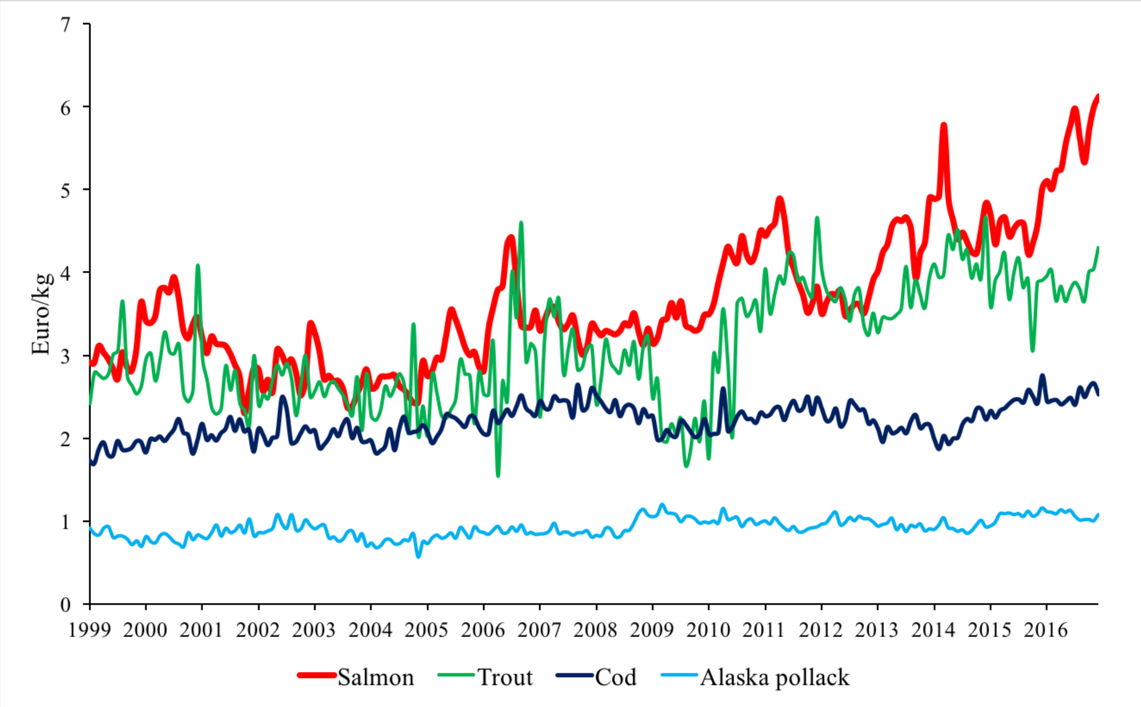

Figure 1 – Import prices of salmon, trout, cod and Alaska pollack (1999-2016).

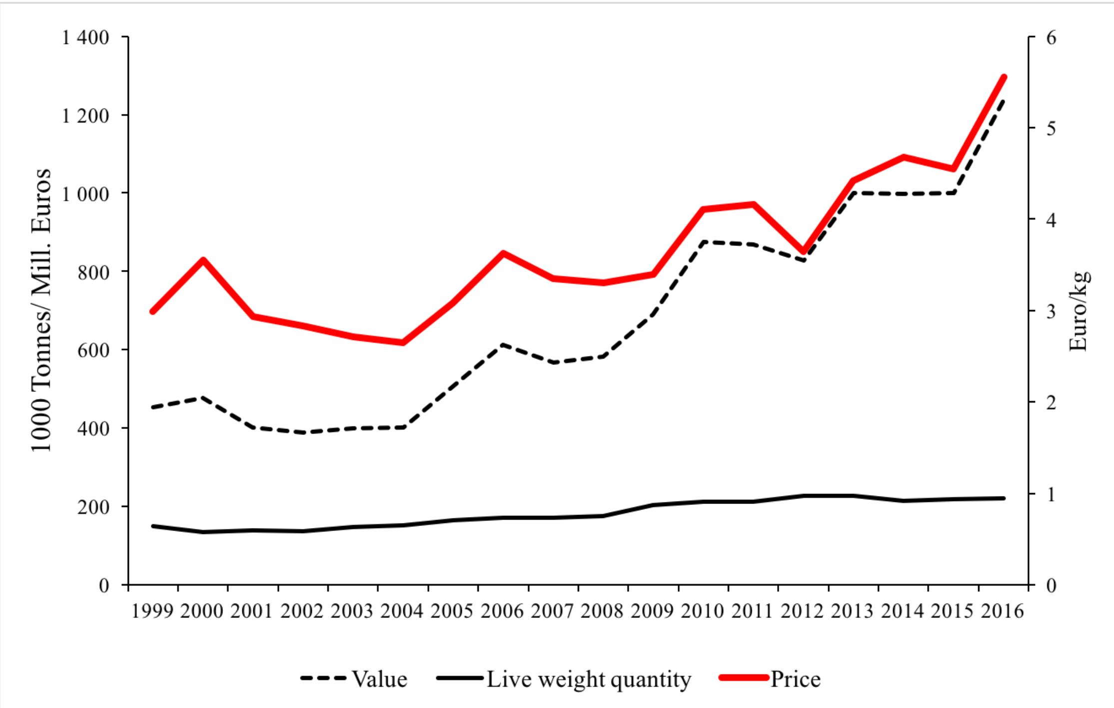

Figure 2 – Salmon import value, quantity in live weight equivalents and price (1999-2016).

Since the objective of this thesis is to discover the reasons behind the increasing salmon prices during the last five years, it is reasonable to assume that a structural break may have occurred around 2012. Hence, the whole observation period can be divided into two sub-periods: before and after the structural break, i.e. 1999-2011 and 2012-2016.

Table 1 lists the average prices, average monthly quantities and average market shares for import of salmon, trout, cod and Alaska pollack to France both for the period from January 1999 to December 2011 and from January 2012 to December 2016. Salmon has the largest market share that has increased from 59% in the first period to 64% in the second period. Salmon is also the most expensive species with the average price that has increased substantially from 3.28 Euro/kg in the first period to 4.57 Euro/kg in the second period. Cod is the second main species in the group and has a market share that has decreased from 28% to 25%. The average prices of the whitefish species, cod and Alaska pollack, has remained quite stable for both periods. The price of cod has increased from 2.15 Euro/kg to 2.29 Euro/kg and the price of Alaska pollack, which is the cheapest species in the group, has increased from 0.88 Euro/kg to 1.00 Euro/kg. Trout has the lowest market share of 1% that has remained unchanged for both periods.

Table 1 – Average price, monthly quantity and market share.
French import of salmon, trout, cod and Alaska pollack.

January 1999 - December 2011			
	Average price (Euro/kg)	**Average monthly quantity (kg)**	**Average market share**
Salmon	3.28	13 932 715	0.59
Trout	2.83	308 090	0.01
Cod	2.15	9 747 952	0.28
Alaska Pollack	0.88	10 513 338	0.12
January 2012 - December 2016			
	Average price (Euro/kg)	**Average monthly quantity (kg)**	**Average market share**
Salmon	4.57	18 488 012	0.64
Trout	3.83	355 632	0.01
Cod	2.29	14 246 777	0.25
Alaska Pollack	1.00	13 136 241	0.10

Figure 3 shows the French monthly import price dynamics for salmon from the different supply sources, namely Norway, UK, Chile and ROW for the whole study period from January 1999 to December 2016. It is obvious that prices for every salmon supply source have the same pattern, which confirms the existence of the global salmon market. One can also observe that all salmon prices have been increasing since about 2006. Salmon prices for Norway, UK and ROW have been experiencing a particularly significant growth since about 2012. Whereas, for comparison, price for salmon from Chile has been increasing not that substantially since 2012.

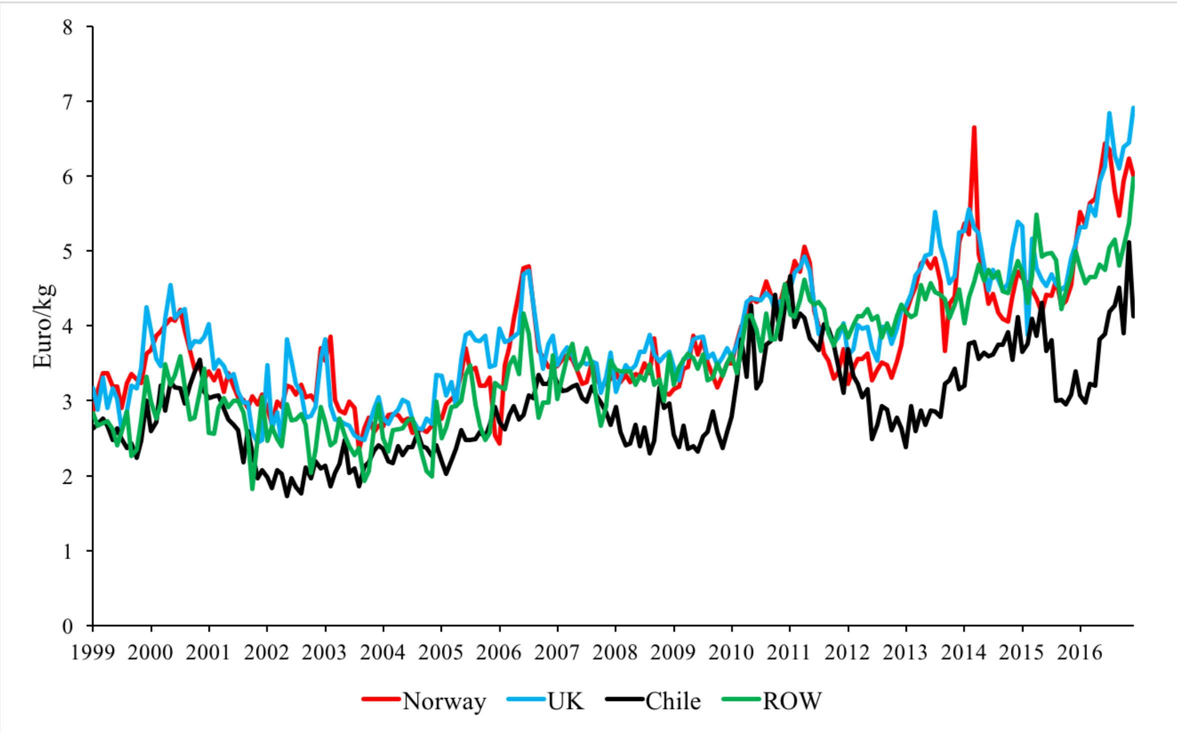

Figure 3 – Import prices of salmon from Norway, UK, Chile and ROW (1999-2016).

Table 2 lists the average prices, average monthly quantities and average market shares for import of salmon from Norway, UK, Chile and ROW both for the period from January 1999 to December 2011 and from January 2012 to December 2016. Import of salmon originating from Norway, which comprises direct imports from Norway, Sweden and Denmark, takes a considerably larger market share than salmon from other sources. Moreover, the Norwegian salmon has taken over a bit of the market shares from other sources, by moving from 47% in the first period to 54% in the second period. One can also notice that there is only the

Norwegian salmon which has experienced a significant growth of the average monthly imported quantity from 6.35 thousand tonnes to 9.98 thousand tonnes.

The salmon from the UK, which origins from Scottish producers, has moved from having a 19% of the market in the first period to 16% in the second period. Salmon from Chile has a relatively small market share that has decreased from 5% to 4%. Import of salmon from ROW takes a market share that has also decreased from 29% to 26%. The main supply sources for ROW are direct imports from the US, Ireland, Canada, imports of frozen fillets from China and imports of smoked salmon from Poland and Germany.

Salmon from Chile has the lowest average price that has increased from 2.76 Euro/kg in the first period to 3.39 Euro/kg in the second period. The prices for salmon from other sources have increased more substantially, for instance, the average price for salmon from ROW has increased from 3.12 Euro/kg to 4.54 Euro/kg.

Table 2 – Average price, monthly quantity and market share.
French import of salmon from Norway, UK, Chile and ROW.

January 1999 - December 2011			
	Average price (Euro/kg)	**Average monthly quantity (kg)**	**Average market share**
Norway	3.42	6 352 311	0.47
United Kingdom (UK)	3.51	2 430 280	0.19
Chile	2.76	864 565	0.05
Rest of the World (ROW)	3.12	4 285 559	0.29
January 2012 - December 2016			
	Average price (Euro/kg)	**Average monthly quantity (kg)**	**Average market share**
Norway	4.62	9 984 695	0.54
United Kingdom (UK)	4.89	2 797 060	0.16
Chile	3.39	945 605	0.04
Rest of the World (ROW)	4.54	4 760 652	0.26

4.2 Consumer insight data

The data used to estimate the model of salmon consumption choice was provided by the Norwegian Seafood Council (NSC, 2017b). The source of the data is the Seafood Consumer Insight (SCI) surveys which are organized by the NSC and performed by Kantar TNS and their global partners. The SCI surveys provide complex insights in preferences, attitudes and how consumers choose fish/seafood in different occasions. The SCI surveys were first conducted in 2012 and since then have been performed annually in the most important markets for Norwegian fish/seafood export.

For this thesis, the data for French fish/seafood consumer market is provided and contains 1012 observations for 2015, 1010 observations for 2016 and 1000 observations for 2017. Hence, the total sample consists of 3022 observations.

Focusing on the salmon consumption, the survey questionnaire was carefully studied and relevant questions, as well as corresponding raw data, were selected. The selected questions are related to the socioeconomic and demographic profile of a consumer, experience, perceptions, preferences and choice decisions regarding salmon consumption. The selected questions and corresponding responses descriptions can be found in Appendix A.

The raw data was decoded and required variables were constructed according to the specification of the conceptual model of consumer choice which was described in Section 2.5 and Section 3.2.1. Definitions and properties of the variables, as well as corresponding sample mean values, are reported in Table 3.

Socioeconomic and demographic factors consist of gender, age, total household size, number of children in the household, marital status, area of residence, total gross annual household income and level of education.

The construction of the variables for perceptions, preferences and consumption choice is similar to the approach followed by Kinnucan et al. (1993). However, the alternative construction for consumer experience is chosen. In this thesis, one can think of experience as the measure of how well a consumer is familiar with salmon products. Therefore, the experience variables are introduced as the preferred country of origin (only one alternative can be chosen) and usually chosen product forms when purchasing salmon (multiple alternatives can be chosen). When buying salmon 41.7% of respondents choose Norway and

26.0% choose Scotland (UK) as strictly preferred country of origin. As for salmon product forms, 71.9% of respondents regularly buy fresh salmon, 32.8% regularly buy frozen salmon and 54.8% often buy smoked salmon.

Perceptions of respondents regarding salmon were asked, stating that up to five alternatives can be chosen. Perceptions are consumer beliefs about salmon products characteristics and are expressed as ease and quickness of preparation, taste, health benefits, inspiration from preparation, safety of consumption, production in an environmentally friendly way, consuming as a lean alternative, family satisfaction and good value for money. It is interesting to observe that 67.0% of respondents choose salmon because it tastes good, 49.7% choose salmon because, among other things, it brings health benefits and 47.0% choose salmon because of ease of preparation. Quickness of preparation is an important reason for choosing salmon for 31.6% of respondents. One can also see that production and catch of salmon in an environmentally friendly way, as well as safety of consumption, are not that essential for French consumers, since only 12.6% of respondents care about safety and only 9.6% find environmental friendliness important.

Preferences variables are determined by asking what type of fish/seafood a respondent normally prefers for a fish/seafood dinner: 1) on a weekday (Monday-Friday) at home, 2) on weekend at home, 3) at a restaurant or café. It was possible to state only one preferred species and salmon is the most popular alternative in all three cases. However, it is important to notice that a substantial part of the respondents did not answer this question: 41% in the first case, 47% in the second case and 15% in the third case, which affects the sample means for these variables.

Choice is the dependent variable and is expressed as frequency of salmon consumption for both at-home and restaurant consumption. Choice variable was determined by posing a question: "How often do you eat salmon?". The responses were coded in the following five ranked ordinal consumption categories:

(0) Never

(1) 1-8 times a year

(2) Once a month,

(3) 2-3 times a month

(4) Once a week or more

One can notice that, on average, the French consumers eat salmon about 1-2 times a month.

Table 3 – Definition and properties of variables and sample means.

Variable name	Description	Property	Range	Mean
Male	1 if male; 0 if female	Dummy	0-1	0.489
Age18_34	1 if age is between 18 and 34; 0 otherwise	**Base**	0-1	0.322
Age35_49	1 if age is between 35 and 49; 0 otherwise	Dummy	0-1	0.351
Age50_65	1 if age is between 50 and 65; 0 otherwise	Dummy	0-1	0.327
HdSize	Number of people in total in the household	Continuous	1-15	2.845
NrChild	Number of children (under 18) in the household	Continuous	0-10	0.901
Married	1 if respondent is married/registered partner or co-habitant; 0 otherwise	Dummy	0-1	0.650
Rural	1 if respondent lives in a rural area; 0 otherwise	**Base**	0-1	0.320
Town	1 if respondent lives in a town or residential area; 0 otherwise	Dummy	0-1	0.469
City	1 if respondent lives in a city; 0 otherwise	Dummy	0-1	0.211
Income1	1 if total gross annual household income is lower than 17,500 Euro; 0 otherwise	**Base**	0-1	0.317
Income2	1 if total gross annual household income is between 17,500 Euro and 60,000 Euro; 0 otherwise	Dummy	0-1	0.615
Income3	1 if total gross annual household income is higher than 60,000 Euro; 0 otherwise	Dummy	0-1	0.068
EdLow	1 if respondent has a primary or a lower secondary school education; 0 otherwise	**Base**	0-1	0.229
EdMed	1 if respondent has an upper secondary school or a secondary vocational education or a two-year post-secondary school education; 0 otherwise	Dummy	0-1	0.500
EdHigh	1 if respondent has an undergraduate or a postgraduate degree; 0 otherwise	Dummy	0-1	0.271
Norway	1 if respondent prefers salmon from Norway; 0 otherwise	Dummy	0-1	0.417
Scotland	1 if respondent prefers salmon from Scotland; 0 otherwise	Dummy	0-1	0.260
France	1 if respondent prefers salmon from France; 0 otherwise	Dummy	0-1	0.079
Fresh	1 if respondent usually buys fresh salmon; 0 otherwise	Dummy	0-1	0.719
Frozen	1 if respondent usually buys frozen salmon; 0 otherwise	Dummy	0-1	0.328
Smoked	1 if respondent usually buys smoked salmon; 0 otherwise	Dummy	0-1	0.548
Lean	1 if consuming salmon as a lean alternative is an important reason for choosing salmon; 0 otherwise	Dummy	0-1	0.163
Easy	1 if ease of preparation is an important reason for choosing salmon; 0 otherwise	Dummy	0-1	0.470
Healthy	1 if health benefit is an important reason for choosing salmon; 0 otherwise	Dummy	0-1	0.497

Inspire	1 if inspiration from preparation is an important reason for choosing salmon; 0 otherwise	Dummy	0-1	0.117
Eco	1 if production in an environmentally friendly way is an important reason for choosing salmon; 0 otherwise	Dummy	0-1	0.096
Quick	1 if quickness of preparation is an important reason for choosing salmon; 0 otherwise	Dummy	0-1	0.316
Safe	1 if safety of consumption is an important reason for choosing salmon; 0 otherwise	Dummy	0-1	0.126
Taste	1 if good taste is an important reason for choosing salmon; 0 otherwise	Dummy	0-1	0.670
Family	1 if the fact that family likes salmon is an important reason for choosing salmon; 0 otherwise	Dummy	0-1	0.297
Money	1 if a good value for money is an important reason for choosing salmon; 0 otherwise	Dummy	0-1	0.240
WeekDay	1 if respondent prefers salmon for a weekday (Monday-Friday) fish/seafood dinner at home; 0 otherwise	Dummy	0-1	0.164
WeekEnd	1 if respondent prefers salmon for a weekend fish/seafood dinner at home; 0 otherwise	Dummy	0-1	0.141
Out	1 if respondent prefers salmon for a fish/seafood dinner at a restaurant, café or similar; 0 otherwise	Dummy	0-1	0.179
FreqSalmon	Respondent's choice of salmon consumption: "How often do you eat salmon?" 0 if never 1 if 1-8 times a year 2 if once a month 3 if 2-3 times a month 4 if once a week or more	Ordinal	0-4	2.231

Chapter 5: Estimation procedures

5.1 Estimating the LA/AIDS models

The general set up for the LA/AIDS model was presented in Section 3.1, and two separate datasets, which are used in the further estimations, were described in Section 4.1.

Two separate demand systems, i.e. two separate LA/AIDS models, are constructed and estimated. The first demand system (Model 1) focuses on different seafood species and analyses the French import demand for salmon, trout, cod and Alaska pollack. The second demand system (Model 2) focuses on salmon from different countries of origin and analyses the French import demand for salmon from Norway, the UK, Chile and ROW.

Now it is convenient to state species as $i = 1, 2, 3, 4$ for salmon, trout, cod and Alaska pollack, respectively, in Model 1. Similarly, state salmon supply sources as $i = 1, 2, 3, 4$ for Norway, UK, Chile and ROW, respectively, in Model 2.

The econometric software RStudio is used for the estimations. Both models are estimated using seemingly unrelated regression (SUR) method. The main advantage of the SUR method is a simultaneous estimation of regression coefficients in all demand equations (Zellner, 1962). One equation must be dropped to avoid singularity in the variance-covariance matrix of the residuals. The equation for trout ($i = 2$) is omitted from the first demand system, and the equation for Chile ($i = 3$) is omitted from the second demand system. In order to recover the coefficients of the dropped equation one may apply the adding up restrictions or simply re-run the model with another equation dropped.

Before running the models, it is necessary to perform tests for non-stationarity and serial correlation, as well as test the joint significance of the monthly dummy variables and the theoretical restrictions. It is also important to carry out the test for the presence of the structural break in the data.

5.1.1 Non-stationarity

The Augmented Dickey-Fuller (ADF) test is applied to find out whether the price variables are non-stationary and how many times they should be differenced to become stationary. The null hypothesis is that prices follow a unit root process, that is non-stationarity:

$$H_0: non - stationarity$$
$$H_1: stationarity$$

If the p-value is lower or equal 0.05 significance level, then the null hypothesis is rejected. From Table 4 and 5, for the first and second demand system, respectively, it is shown that all price variables are non-stationary in the level form.

Table 4 – The ADF test for stationarity with level price variables. Model 1.

	Test statistic	***p*-value**	
$\boldsymbol{p_1}$ **(salmon)**	-2.5646	0.3391	Non-stationarity
$\boldsymbol{p_2}$ **(trout)**	-2.5631	0.3398	Non-stationarity
$\boldsymbol{p_3}$ **(cod)**	-3.0711	0.1267	Non-stationarity
$\boldsymbol{p_4}$ **(Alaska pollack)**	-2.8922	0.2017	Non-stationarity

Table 5 – The ADF test for stationarity with level price variables. Model 2.

	Test statistic	***p*-value**	
$\boldsymbol{p_1}$ **(Norway)**	-3.2545	0.08003	Non-stationarity
$\boldsymbol{p_2}$ **(UK)**	-1.7942	0.6623	Non-stationarity
$\boldsymbol{p_3}$ **(Chile)**	-2.6915	0.2859	Non-stationarity
$\boldsymbol{p_4}$ **(ROW)**	-2.757	0.2584	Non-stationarity

In order to solve the non-stationarity problem, it is necessary to take the first difference of the price variables, such that they become integrated of order one, i.e. I(1). The ADF test is now applied on the first difference price variables in both models. From Table 6 and 7, for the first and second demand system, respectively, it is shown that the null hypothesis is rejected for all first difference price variables. That means that all price variables are stationary in the first difference form.

Table 6 – The ADF test for stationarity with first difference price variables. Model 1.

	Test statistic	***p*-value**	
dp_1 **(salmon)**	-7.9255	0.000	Stationarity
dp_2 **(trout)**	-8.5215	0.000	Stationarity
dp_3 **(cod)**	-7.2929	0.000	Stationarity
dp_4 **(Alaska pollack)**	-6.9546	0.000	Stationarity

Table 7 – The ADF test for stationarity with first difference price variables. Model 2.

	Test statistic	***p*-value**	
dp_1 **(Norway)**	-8.2106	0.000	Stationarity
dp_2 **(UK)**	-7.2275	0.000	Stationarity
dp_3 **(Chile)**	-5.7424	0.000	Stationarity
dp_4 **(ROW)**	-8.4263	0.000	Stationarity

5.1.2 Serial correlation

The Breusch–Godfrey (BG) test, which is also known as Lagrange Multiplier (LM) test, is applied to test for serial correlation (i.e. autocorrelation). The null hypothesis is that there is no serial correlation among the residuals:

$$H_0: no\ serial\ correlation$$
$$H_1: serial\ correlation$$

A dynamic version of the LA/AIDS model usually solves the serial correlation problem. Therefore, both demand systems are firstly estimated as static models, and then as dynamic models. Table 8 reports the results from the BG test for Model 1. In the static LA/AIDS model, none of the four equations passed the test of no serial correlation. Whereas for the dynamic LA/AIDS model, three of the four equations passed the test and only the equation for trout still has a serial correlation problem.

Table 9 reports the results from the BG test for Model 2. In the static LA/AIDS model, none of the four equations passed the test of no serial correlation. Whereas for the dynamic

LA/AIDS model, only the equation for ROW passed the test and the other three equations still have a serial correlation problem.

Table 8 – The BG test for serial correlation on the static and dynamic LA/AIDS. Model 1.

Static LA/AIDS			
Equation	**Test statistic**	***p*-value**	
$\boldsymbol{R_1}$ **(salmon)**	46.887	0.000	Serial correlation
$\boldsymbol{R_2}$ **(trout)**	10.529	0.000	Serial correlation
$\boldsymbol{R_3}$ **(cod)**	18.396	0.000	Serial correlation
$\boldsymbol{R_4}$ **(Alaska pollack)**	65.905	0.000	Serial correlation
Dynamic LA/AIDS			
Equation	**Test statistic**	***p*-value**	
$\boldsymbol{dR_1}$ **(salmon)**	0.598	0.440	No serial correlation
$\boldsymbol{dR_2}$ **(trout)**	6.853	0.010	Serial correlation
$\boldsymbol{dR_3}$ **(cod)**	1.283	0.260	No serial correlation
$\boldsymbol{dR_4}$ **(Alaska pollack)**	0.478	0.490	No serial correlation

Table 9 – The BG test for serial correlation on the static and dynamic LA/AIDS. Model 2.

Static LA/AIDS			
Equation	**Test statistic**	***p*-value**	
$\boldsymbol{R_1}$ **(Norway)**	81.259	0.000	Serial correlation
$\boldsymbol{R_2}$ **(UK)**	113.524	0.000	Serial correlation
$\boldsymbol{R_3}$ **(Chile)**	90.245	0.000	Serial correlation
$\boldsymbol{R_4}$ **(ROW)**	92.193	0.000	Serial correlation
Dynamic LA/AIDS			
Equation	**Test statistic**	***p*-value**	
$\boldsymbol{dR_1}$ **(Norway)**	4.776	0.030	Serial correlation
$\boldsymbol{dR_2}$ **(UK)**	11.102	0.000	Serial correlation
$\boldsymbol{dR_3}$ **(Chile)**	5.974	0.010	Serial correlation
$\boldsymbol{dR_4}$ **(ROW)**	0.001	0.980	No serial correlation

All in all, the dynamic model may not solve the serial correlation problem completely, but still has a better fit than the static model. Hence, a dynamic version of the LA/AIDS model with the lag-dependent variable should be estimated for the both demand systems.

5.1.3 Seasonality

Seasonality has always proven to be important in seafood demand analysis (Xie & Myrland, 2011). The effects of seasonality are accounted for by including monthly dummy variables. The dummy variable for January ($k = 1$) is omitted to avoid the dummy variable trap. Before running the models, it is necessary to test the joint significance of the monthly dummy variables. The Likelihood Ratio (LR) test is applied and the following hypotheses are set up:

$$H_0: \delta_{ik} \; are \; jointly \; equal \; to \; zero$$
$$H_1: \delta_{ik} \; are \; not \; jointly \; equal \; to \; zero$$
$$for \; i = 1, 3, 4 \; and \; k = 2, \dots, 12 \qquad (for \; Model \; 1)$$
$$for \; i = 1, 2, 4 \; and \; k = 2, \dots, 12 \qquad (for \; Model \; 2)$$

If the likelihood ratio (LR) ≥ critical Chi-square value χ^2 or if the *p*-value ≤ 0.05, then the null hypothesis is rejected. From Table 10 and 11, for the first and second demand system, respectively, it is shown that null hypotheses are rejected and monthly dummies are statistically significant and can be included into both models.

Table 10 – The LR test of the significance of the monthly dummy variables. Model 1.

Degrees of freedom	**LR**	**Critical value χ^2 at 5% significance level**	***p*-value**
33	99.704	47.400	1.274e-08 ***

Note: *** significant at 1%; ** significant at 5%; * significant at 10%

Table 11 – The LR test of the significance of the monthly dummy variables. Model 2.

Degrees of freedom	**LR**	**Critical value χ^2 at 5% significance level**	***p*-value**
33	75.168	47.400	3.925e-05 ***

Note: *** significant at 1%; ** significant at 5%; * significant at 10%

5.1.4 Homogeneity and symmetry

The next step is to perform the Likelihood Ratio (LR) test on whether the theoretical restrictions are compatible with data. There are three hypotheses to be examined: homogeneity, symmetry and both combined. The following null hypotheses are set up for Model 1:

$$H_0: \gamma_{11} + \gamma_{12} + \gamma_{13} + \gamma_{14} = 0 \; and \; \gamma_{31} + \gamma_{32} + \gamma_{33} + \gamma_{34} = 0$$
$$and \; \gamma_{41} + \gamma_{42} + \gamma_{43} + \gamma_{44} = 0 \text{ (Homogeneity)}$$

$$H_0: \gamma_{13} - \gamma_{31} = 0 \; and \; \gamma_{14} - \gamma_{41} = 0 \; and \; \gamma_{34} - \gamma_{43} = 0 \text{ (Symmetry)}$$

The following null hypotheses are set up for Model 2:

$$H_0: \gamma_{11} + \gamma_{12} + \gamma_{13} + \gamma_{14} = 0 \; and \; \gamma_{21} + \gamma_{22} + \gamma_{23} + \gamma_{24} = 0$$
$$and \; \gamma_{41} + \gamma_{42} + \gamma_{43} + \gamma_{44} = 0 \text{ (Homogeneity)}$$

$$H_0: \gamma_{12} - \gamma_{21} = 0 \; and \; \gamma_{14} - \gamma_{41} = 0 \; and \; \gamma_{24} - \gamma_{42} = 0 \text{ (Symmetry)}$$

Table 12 reports the results from the LR test of the theoretical restrictions for Model 1 and shows that in all cases a LR is larger than the critical value. That means that all three null hypotheses are rejected and one should not include any of the theoretical restrictions in the model. However, it is preferable for the model to be consistent with the demand theory (Xie et al., 2009). Therefore, both homogeneity and symmetry are chosen to be imposed when estimating the first demand system.

Table 12 – The LR test of the theoretical restrictions. Model 1.

Restriction	**Degrees of freedom**	**LR**	**Critical value χ^2 at 5% significance level**	***p*-value**	**Test result**
Homogeneity	3	16.076	7.815	0.001094 ***	Reject
Symmetry	3	154.63	7.815	2.2e-16 ***	Reject
Homogeneity and symmetry	6	65.956	12.592	2.752e-12 ***	Reject

Note: *** significant at 1%; ** significant at 5%; * significant at 10%

Table 13 reports the results from the LR test of the theoretical restrictions for Model 2 and shows that in all cases a LR is smaller than the critical value. That means that null hypotheses cannot be rejected and both homogeneity and symmetry are true.

All in all, both homogeneity and symmetry are chosen to be imposed when estimating the both demand systems.

Table 13 – The LR test of the theoretical restrictions. Model 2.

Restriction	Degrees of freedom	LR	Critical value χ^2 at 5% significance level	*p*-value	Test result
Homogeneity	3	2.7623	7.815	0.4298	Fail to reject
Symmetry	3	3.7229	7.815	0.293	Fail to reject
Homogeneity and symmetry	6	6.8653	12.592	0.3335	Fail to reject

Note: *** significant at 1%; ** significant at 5%; * significant at 10%

5.1.5 Structural break

It was clearly seen from Figures 1, 2 and 3 that salmon prices have been increasing since 2006 and have been experiencing a particularly significant growth since about 2012. Therefore, it is reasonable to test whether the structural break has occurred around 2012.

The sup-Wald test is used in order to detect the presence of the structural break. Unfortunately, it is impossible to test for structural breaks using the SUR method, so the alternative is to run an ordinary least squares (OLS) regression. The null hypothesis is that there is no structural break:

$$H_0: no\ structural\ break$$
$$H_1: structural\ break$$

The sup-Wald test was applied on the OLS regression for three equations: the salmon equation from Model 1, equation for salmon from Norway and equation for salmon from the UK from Model 2. The test results are presented in Table 14 and show that the null hypothesis is rejected for all three equations, which means that a structural break does exist. The possible break dates list from the end of 2010 to the beginning of 2014, which is on average around 2012 for all three equations.

Table 14 – The sup-Wald test for the presence of the structural break.

Number of observations		216	
Full sample		January 1999 - December 2016	
Equation	**Test statistic**	***p*-value**	**Possible break dates**
Total Salmon	194.61	0.000	October 2010 September 2013
Salmon from Norway	115.27	0.000	August 2011 December 2012 March 2014
Salmon from the UK	258.38	0.000	December 2010 March 2014

As a result, running the models for the whole study period, i.e. 1999-2016 may bring ambiguous and incorrect results. Hence, the whole observation period should be divided into two sub-periods: before and after the structural break, i.e. 1999-2011 and 2012-2016.

5.1.6 Final empirical models

To sum up, the final empirical model is the dynamic first difference version of the LA/AIDS model with lag-dependent variable that is stated as:

$$dR_{i,t} = \varphi_i dR_{i,t-1} + \sum_{j=1}^{n} \gamma_{ij} dlnp_{j,t} + \sum_{k=2}^{12} \delta_{ik} D_{k,t} + \beta_i dln\left(\frac{y_t}{P_t^*}\right) + \lambda_i e_{i,t-1} + \upsilon_{i,t}$$
$$for\ i = 1, 2, \dots, n\ and\ t = 1, 2, \dots, T$$

The final model includes monthly dummy variables and has both homogeneity and symmetry imposed. In order to account for the structural break, the whole observation period is divided into two samples: before and after the structural break. The first sample contains observations from 1 to 156 and covers the period from January 1999 to December 2011, while the second sample contain observations from 157 to 216 and covers the period from January 2012 to December 2016.

Therefore, the first demand system for species (Model 1) contains two separate sub-models, corresponding to before and after the structural break periods, which are estimated and compared. The equation for trout ($i = 2$) is omitted in both sub-models in order to avoid singularity in the variance-covariance matrix of the residuals. Then, both sub-models are re-run with equation for Alaska pollack ($i = 4$) dropped in order to recover the coefficients of the equation for trout.

Similarly, the second demand system for salmon supply sources (Model 2) contains two separate sub-models, corresponding to before and after the structural break periods, which are estimated and compared. The equation for Chile ($i = 3$) is omitted in both sub-models in order to avoid singularity in the variance-covariance matrix of the residuals. Then, both sub-models are re-run with equation for ROW ($i = 4$) dropped in order to recover the coefficients of the equation for Chile.

In total, there are four sub-models to be estimated. All sub-models are estimated using seemingly unrelated regression (SUR) method. The empirical results are reported and discussed in Chapter 6 and 7.

5.2 Estimating the Ordered Logit Model of Salmon Choice

The general set up for the ordered logit model for consumer choice was presented in Section 3.2, and data used in the further estimations were described in Section 4.2.

The aim of the salmon choice model is to examine how socioeconomic and demographic factors, experience, perceptions and preferences regarding salmon products influence the decision to consume salmon. Choice is the dependent variable and is expressed as frequency of salmon consumption for both at-home and restaurant consumption. In order for the choice model to be consistent with the main import demand systems, it is important to assume that higher salmon *consumption* frequency also means higher salmon *purchase* frequency.

The general equation used for the model of salmon consumption choice is specified as follows:

$$FreqSalmon = \beta_0 + \beta_1 Male + \beta_2 Age35\_49 + \beta_3 Age50\_65 + \beta_4 HdSize + \beta_5 NrChild + \beta_6 Married + \beta_7 Town + \beta_8 City + \beta_9 Income2 + \beta_{10} Income3 + \beta_{11} EdMed + \beta_{12} EdHigh + \beta_{13} Norway + \beta_{14} Scotland + \beta_{15} France + \beta_{16} Fresh + \beta_{17} Frozen + \beta_{18} Smoked + \beta_{19} Lean + \beta_{20} Easy + \beta_{21} Healthy + \beta_{22} Inspire + \beta_{23} Eco + \beta_{24} Quick + \beta_{25} Safe + \beta_{26} Taste + \beta_{27} Family + \beta_{28} Money + \beta_{29} WeekDay + \beta_{30} WeekEnd + \beta_{31} Out + e$$

In order to avoid the problem of perfect multicollinearity it is required to form the base group which consists of respondents who are: between 18 and 34 years old, live in a rural area, have a total gross annual household income lower than 17,500 Euro and have a primary or lower secondary school education.

The econometric software RStudio is used for the estimations. The model of salmon consumption choice is estimated using the Maximum Likelihood Estimation (MLE) method. The empirical results are presented and discussed in Chapter 6 and 7.

After running the model, it is necessary to test the joint significance of the estimated coefficients. The Likelihood Ratio (LR) test is applied and the following hypotheses are set up:

$$H_0: \beta_k \text{ are jointly equal to zero}$$
$$H_1: \beta_k \text{ are not jointly equal to zero}$$
$$for\ k = 1, 2, \ldots, 31$$

If the likelihood ratio (LR) ≥ critical Chi-square value χ^2 or if the *p*-value ≤ 0.05, then the null hypothesis is rejected. From Table 15 it is shown that null hypothesis is rejected which means that the estimated coefficients are jointly statistically significant.

Table 15 – The LR test of the joint significance of the estimated coefficients for the model of salmon consumption choice.

Degrees of freedom	**LR**	**Critical value χ^2 at 5% significance level**	***p*-value**
31	812.86	44.985	0.000 ***

Note: *** significant at 1%; ** significant at 5%; * significant at 10%

Chapter 6: Results and analysis

6.1 The LA/AIDS model – Model 1

The first demand system for species (Model 1) is estimated for two separate periods: before and after the structural break, i.e. 1999-2011 and 2012-2016. The empirical results for the sub-models corresponding to before and after the structural break periods are reported in Table 16 and 17, respectively.

The estimations are generally satisfactory. For both sub-models, the R^2 ranges between 0.364 and 0.591. Since in the AIDS model the statistical significance of estimated parameters *per se* has little economic significance, one can therefore focus on elasticities (Xie, 2008; Xie et al., 2009; Xie & Myrland, 2010). Table 18 reports the estimated Marshallian (uncompensated) own-price elasticities and expenditure elasticities. Whereas Table 19 reports the estimated Hicksian (compensated) cross-price elasticities.

Table 16 – SUR estimates of parameters for the dynamic first difference LA/AIDS model. Model 1. Sub-model for the period from January 1999 to December 2011.

Independent variable	**Salmon** $(i = 1)$	**Trout** $(i = 2)$	**Cod** $(i = 3)$	**Alaska pollack** $(i = 4)$
$dlnp_{salmon}$	0.045 (1.387)	-0.013 (-1.318)	0.012 (0.624)	-0.043** (-2.051)
$dlnp_{trout}$	-0.013 (-1.318)	-0.008 (-0.790)	-0.002 (-0.465)	0.023*** (2.677)
$dlnp_{cod}$	0.012 (0.624)	-0.002 (-0.465)	-0.010 (-0.616)	0.000 (0.025)
$dlnp_{Alaska}$	-0.043** (-2.051)	0.023*** (2.677)	0.000 (0.025)	0.019 (0.967)
$dln\frac{y}{P^*}$	-0.021 (-0.508)	-0.010 (-1.367)	0.008 (0.222)	0.023 (1.180)
D_2	-0.095*** (-5.859)	0.001 (0.516)	0.065*** (5.034)	0.025*** (3.601)
D_3	0.011 (0.812)	0.003** (2.128)	0.002 (0.190)	-0.017*** (-2.681)
D_4	0.017 (1.351)	-0.003** (-2.001)	-0.017* (-1.672)	0.005 (0.763)
D_5	0.021* (1.790)	-0.001 (-0.499)	-0.031*** (-3.136)	0.010* (1.753)
D_6	0.005 (0.406)	0.002 (1.520)	-0.014 (-1.362)	0.006 (1.078)
D_7	0.024* (1.707)	0.003* (1.692)	-0.016 (-1.411)	-0.010 (-1.551)
D_8	0.035*** (2.903)	-0.003** (-2.099)	-0.010 (-0.961)	-0.022*** (-3.842)
D_9	0.010 (0.659)	0.002 (1.161)	-0.006 (-0.486)	-0.004 (-0.508)
D_{10}	0.005 (0.393)	-0.001 (-0.373)	0.001 (0.052)	-0.006 (-1.010)
D_{11}	0.017 (1.385)	-0.001 (-0.628)	-0.002 (-0.164)	-0.014** (-2.361)
D_{12}	0.064*** (5.248)	-0.002 (-1.306)	-0.049*** (-4.873)	-0.013** (-2.155)
$dR_{i,t-1}$	-0.528*** (-8.066)	-0.250** (-2.282)	-0.539*** (-7.551)	-0.438*** (-6.232)
$e_{i,t-1}$	-0.229*** (-3.172)	-0.578*** (-4.088)	-0.219*** (-2.768)	-0.274*** (-3.690)
R^2	0.477	0.545	0.471	0.364

Note: Numbers in parentheses are *t*-ratios;
*** significant at 1%; ** significant at 5%; * significant at 10%

Table 17 – SUR estimates of parameters for the dynamic first difference LA/AIDS model. Model 1. Sub-model for the period from January 2012 to December 2016.

Independent variable	**Salmon** $(i=1)$	**Trout** $(i=2)$	**Cod** $(i=3)$	**Alaska pollack** $(i=4)$
$dlnp_{salmon}$	-0.036 (-0.432)	-0.030 (-0.795)	0.044 (0.925)	0.021 (0.517)
$dlnp_{trout}$	-0.030 (-0.795)	0.029 (0.612)	0.013 (0.552)	-0.012 (-0.396)
$dlnp_{cod}$	0.044 (0.925)	0.013 (0.552)	-0.029 (-0.711)	-0.028 (-1.209)
$dlnp_{Alaska}$	0.021 (0.517)	-0.012 (-0.396)	-0.028 (-1.209)	0.019 (0.561)
$dln\frac{y}{P^*}$	-0.034 (-0.588)	-0.007 (-0.240)	-0.011 (-0.262)	0.052* (1.893)
D_2	-0.074*** (-3.246)	0.001 (0.428)	0.067*** (3.499)	0.007 (0.727)
D_3	0.025 (1.428)	-0.000 (-0.113)	-0.003 (-0.253)	-0.021** (-2.426)
D_4	0.020 (1.211)	0.000 (0.098)	-0.003 (-0.255)	-0.010 (-1.208)
D_5	-0.001 (-0.086)	-0.001 (-0.271)	-0.014 (-1.227)	0.018** (2.398)
D_6	-0.000 (-0.030)	0.000 (0.198)	-0.025** (-2.184)	0.017** (2.116)
D_7	0.023 (1.537)	-0.000 (-0.231)	-0.032*** (-2.669)	0.003 (0.401)
D_8	0.029* (1.862)	0.001 (0.498)	-0.010 (-0.817)	-0.021*** (-2.855)
D_9	-0.006 (-0.321)	-0.002 (-0.725)	0.023 (1.556)	-0.007 (-0.665)
D_{10}	-0.005 (-0.282)	0.001 (0.480)	0.003 (0.265)	-0.002 (-0.308)
D_{11}	0.027* (1.726)	0.001 (0.279)	-0.026** (-2.205)	-0.003 (-0.429)
D_{12}	0.066*** (4.286)	-0.001 (-0.292)	-0.052*** (-4.424)	-0.014* (-1.803)
$dR_{i,t-1}$	-0.580*** (-4.179)	-0.087 (-0.304)	-0.678*** (-4.073)	-0.226 (-1.642)
$e_{i,t-1}$	-0.244 (-1.496)	-0.433 (-1.476)	-0.244 (-1.277)	-0.551*** (-3.047)
R^2	0.550	0.398	0.572	0.591

Note: Numbers in parentheses are *t*-ratios;
*** significant at 1%; ** significant at 5%; * significant at 10%

Table 18 – Estimated Marshallian (uncompensated) own-price elasticities (E_{ii}) and expenditure elasticities (A_i). Model 1.

	January 1999 - December 2011		***January 2012 - December 2016***	
	$\boldsymbol{E_{ii}}$	$\boldsymbol{A_i}$	$\boldsymbol{E_{ii}}$	$\boldsymbol{A_i}$
Salmon	-0.903*** (-13.987)	0.964*** (13.686)	-1.022*** (-8.260)	0.947*** (10.588)
Trout	-1.710** (-2.232)	0.124 (0.141)	1.835 (0.488)	0.323 (0.128)
Cod	-1.043*** (-15.170)	1.028*** (8.292)	-1.103*** (-6.085)	0.954*** (5.486)
Alaska pollack	-0.867*** (-5.231)	1.187*** (7.485)	-0.861*** (-2.489)	1.513*** (5.581)

Note: Numbers in parentheses are *t*-ratios;
*** significant at 1%; ** significant at 5%; * significant at 10%

Table 19 – Estimated Hicksian (compensated) cross-price elasticities (E^*_{ij}). Model 1.

January 1999 - December 2011				
Quantity demanded from	**Prices**			
	Salmon	**Trout**	**Cod**	**Alaska pollack**
Salmon	– –	-0.012 (-0.678)	0.298*** (9.413)	0.050 (1.414)
Trout	-0.622 (-0.678)	– –	0.092 (0.231)	2.238*** (2.833)
Cod	0.630*** (9.413)	0.004 (0.231)	– –	0.124*** (3.816)
Alaska pollack	0.240 (1.414)	0.201*** (2.833)	0.280*** (3.816)	– –
January 2012 - December 2016				
Quantity demanded from	**Prices**			
	Salmon	**Trout**	**Cod**	**Alaska pollack**
Salmon	– –	-0.037 (-0.620)	0.320*** (4.247)	0.134** (2.102)
Trout	-2.268 (-0.620)	– –	1.485 (0.664)	-1.055 (-0.362)
Cod	0.816*** (4.247)	0.061 (0.664)	– –	-0.013 (-0.134)
Alaska pollack	0.847** (2.102)	-0.107 (-0.362)	-0.031 (-0.134)	– –

Note: Numbers in parentheses are *t*-ratios;
*** significant at 1%; ** significant at 5%; * significant at 10%

6.1.1 Marshallian own-price elasticities

For the first sub-period, all of the estimated own-price elasticities are statistically significant and negative, which is consistent with demand theory. For the second sub-period, only the own-price elasticity for trout is not significant, whereas, the rest of the estimated own-price elasticities are all significant and negative.

Asche et al. (2005) denoted an own-price elasticity of -1 as a focal point. They also indicated that it is expected for the more price elastic goods to have the greater substitution possibilities, and therefore the keener competition.

The own-price elasticity of salmon is -0.903 and -1.022 for the period before and after the structural break, respectively. This means that demand for total import of salmon has become more price elastic during the study period. The own-price elasticity after the structural break is very close to focal point, but somehow this finding still contradicts a common trend for less elastic demand for salmon. Increased sensitivity to price may be explained by strong growth in demand and increase in real price of salmon.

French demand for the whitefish species, cod and Alaska pollack, has been stable during the whole study period. Demand for cod is found out to be price elastic and close to focal point of -1, whereas demand for Alaska pollack is relatively price inelastic.

The own-price elasticity of trout is -1.710 in the period before the structural break. It is expected for trout to by very elastic, since there is a tendency for more valuable fish to have more elastic demand (Asche et al., 2005).

6.1.2 Expenditure elasticities

For both sub-periods, all of the estimated expenditure elasticities are positive and statistically significant, except for that of trout which is not significant. This means that salmon, cod and Alaska pollack are normal goods and benefit from the income-induced increases in market size (Xie et al., 2009).

Salmon appears to be a necessity good with the expenditure elasticity that has been quite stable during the whole study period. It was expected for salmon to be a necessity since it has the largest growing market share in the group. Moreover, salmon is mostly imported to

France as fresh, and there is a common trend for fresh salmon to become less expenditure elastic (Xie, 2008).

At the same time, cod moved from being a luxury good before the structural break to being a necessity good after the structural break, with the expenditure elasticities equal 1.028 and 0.954, respectively. It was also expected for cod to become a necessity good since it has the second largest market share in the group. Alaska pollack has the highest expenditure elasticity during the whole study period and appears to be a luxury good. This is very surprising since Alaska pollack has the lowest average price within the group.

6.1.3 Hicksian cross-price elasticities

There is a competition between goods since consumers consider the goods to be substitutable to some extent. The degree of substitution is measured by cross-price effects. According to Asche et al. (2003), if the goods turn out to be substitutes, they do compete in the same market.

This thesis is only focuses on the Hicksian (compensated) cross-price elasticities since they are considered to be of more relevance in the demand analysis as they show the pure substitution effect of the price change (Fofana & Clayton, 2003). Moreover, they provide a deeper insight into the relative strength of substitution relationships between species (Asche et al., 1998; Wan et al., 2010; Xie, 2008; Xie & Myrland, 2010, 2011).

For the first sub-period, six of the twelve cross-price elasticities are significant at 1% level of significance, whereas for the second sub-period, only four of the twelve cross-price elasticities are significant at 5% level of significance or better.

There is a positive demand relationship between salmon and cod during the whole study period. The cross-price elasticity of cod with respect to the price of salmon is 0.630 and 0.816 for the period before and after the structural break, respectively. Whereas, the cross-price elasticity of salmon with respect to the price of cod is 0.298 and 0.320 for the period before and after the structural break, respectively. Hence, one can say that a change in the price of salmon has a considerably stronger effect on the demand for cod than vice versa. This finding is important and indicates that salmon is a stronger substitute for cod, while cod is a weaker substitute for salmon. Thereby, one can conclude that salmon and cod are substitutes and they can compete on the same market.

In the period after the structural break, salmon also has a positive relationship with Alaska pollack. The cross-price elasticity of Alaska pollack with respect to the price of salmon is 0.847. Whereas, the cross-price elasticity of salmon with respect to the price of Alaska pollack is 0.134. This finding suggests that, after the structural break, salmon has started to act as a stronger substitute for Alaska pollack, while Alaska pollack has acted as a weak substitute for salmon.

The demand relationship between the whitefish species, cod and Alaska pollack, is positive and statistically significant only before the structural break. Cod and Alaska pollack substitute each other, but it is necessary to notice that cod is a closer substitute for Alaska pollack than vice versa. Such result is not surprising since cod has a larger average market share than Alaska pollack and, hence, appears to be a stronger substitute.

Another interesting relationship is between Alaska pollack and trout, which is only significant in the period before the structural break. The cross-price elasticity of trout with respect to the price of Alaska pollack is 2.238, which indicates that Alaska pollack is a very strong substitute for trout. At the same time, the cross-price elasticity of Alaska pollack with respect to the price of trout is only 0.201, which indicates that trout is a weaker substitute for Alaska pollack. Such strange finding may be explained by a minor average market share of trout within the group (1%) against a relatively larger market share of Alaska pollack (around 12-10%), which makes Alaska pollack a very strong substitute for trout.

No statistically significant complements are found during the cross-price effects analysis.

6.2 The LA/AIDS model – Model 2

The second demand system for salmon supply sources (Model 2) is estimated for two separate periods: before and after the structural break, i.e. 1999-2011 and 2012-2016. The empirical results for the sub-models corresponding to before and after the structural break periods are reported in Table 20 and 21, respectively.

For both sub-models, the R^2 ranges between 0.287 and 0.735, which is fairly satisfactory. Since in the AIDS model the statistical significance of estimated parameters *per se* has little economic significance, one can therefore focus on elasticities. Table 22 reports the estimated Marshallian (uncompensated) own-price elasticities and expenditure elasticities. Whereas Table 23 reports the estimated Hicksian (compensated) cross-price elasticities.

Table 20 – SUR estimates of parameters for the dynamic first difference LA/AIDS model. Model 2. Sub-model for the period from January 1999 to December 2011.

Independent variable	**Norway** $(i = 1)$	**UK** $(i = 2)$	**Chile** $(i = 3)$	**ROW** $(i = 4)$
$dlnp_{Norway}$	0.116*** (3.534)	-0.039* (-1.758)	-0.011 (-0.743)	-0.066*** (-3.045)
$dlnp_{UK}$	-0.039* (-1.758)	0.029 (1.152)	-0.010 (-0.672)	0.019 (1.180)
$dlnp_{Chile}$	-0.011 (-0.743)	-0.010 (-0.672)	-0.002** (-2.439)	0.023* (1.932)
$dlnp_{ROW}$	-0.066*** (-3.045)	0.019 (1.180)	0.023* (1.932)	0.024 (1.107)
$dln\frac{y}{P^*}$	0.052*** (2.667)	-0.012 (-0.834)	-0.033*** (-3.326)	-0.007 (-0.424)
D_2	0.002 (0.215)	-0.014* (-1.741)	0.014*** (2.601)	0.005 (0.529)
D_3	0.013 (1.239)	-0.001 (-0.173)	-0.006 (-1.238)	-0.007 (-0.813)
D_4	0.004 (0.372)	0.000 (0.066)	-0.011** (-2.377)	0.006 (0.790)
D_5	0.013 (1.401)	-0.014* (-1.857)	0.001 (0.181)	-0.002 (-0.302)
D_6	0.015 (1.595)	-0.007 (-0.937)	0.006 (1.431)	-0.014* (-1.849)
D_7	0.002 (0.252)	0.017** (2.403)	-0.005 (-1.011)	-0.014* (-1.753)
D_8	-0.014 (-1.446)	0.019*** (2.638)	0.008* (1.740)	-0.013* (-1.699)
D_9	-0.022** (-2.050)	-0.011 (-1.315)	-0.002 (-0.451)	0.036*** (4.000)
D_{10}	-0.029*** (-2.915)	-0.011 (-1.490)	-0.001 (-0.160)	0.037*** (4.401)
D_{11}	-0.016 (-1.638)	0.021*** (2.909)	-0.004 (-0.824)	-0.003 (-0.336)
D_{12}	0.030*** (3.101)	0.013* (1.725)	-0.009* (-1.930)	-0.033*** (-4.065)
$dR_{i,t-1}$	-0.254*** (-4.651)	-0.289*** (-4.618)	-0.418*** (-5.901)	-0.221*** (-3.911)
$e_{i,t-1}$	-0.267*** (-5.509)	-0.183*** (-3.777)	-0.167*** (-3.373)	-0.204*** (-4.869)
R^2	0.389	0.287	0.411	0.374

Note: Numbers in parentheses are *t*-ratios;
*** significant at 1%; ** significant at 5%; * significant at 10%

Table 21 – SUR estimates of parameters for the dynamic first difference LA/AIDS model. Model 2. Sub-model for the period from January 2012 to December 2016.

Independent variable	**Norway** $(i = 1)$	**UK** $(i = 2)$	**Chile** $(i = 3)$	**ROW** $(i = 4)$
$dlnp_{Norway}$	0.061 (1.416)	0.018 (0.589)	0.026 (1.113)	-0.106*** (-3.633)
$dlnp_{UK}$	0.018 (0.589)	-0.017 (-0.444)	-0.019 (-0.711)	0.018 (0.746)
$dlnp_{Chile}$	0.026 (1.113)	-0.019 (-0.711)	-0.031 (-1.388)	0.024 (1.207)
$dlnp_{ROW}$	-0.106*** (-3.633)	0.018 (0.746)	0.024 (1.207)	0.064** (2.091)
$dln\frac{y}{P^*}$	-0.028 (-0.892)	-0.011 (-0.468)	-0.012* (-1.857)	0.051** (2.067)
D_2	-0.003 (-0.218)	-0.007 (-0.602)	-0.008 (-0.964)	0.016 (1.342)
D_3	0.022 (1.459)	0.010 (0.845)	-0.001 (-0.186)	-0.025** (-2.080)
D_4	-0.002 (-0.166)	0.012 (1.135)	0.004 (0.692)	-0.019* (-1.759)
D_5	-0.015 (-1.177)	0.010 (0.981)	0.002 (0.263)	0.004 (0.424)
D_6	-0.030** (-2.342)	0.019* (1.907)	-0.001 (-0.110)	0.011 (1.108)
D_7	-0.023* (-1.766)	0.011 (1.106)	0.004 (0.601)	0.009 (0.892)
D_8	0.003 (0.224)	0.006 (0.578)	0.002 (0.311)	-0.010 (-1.027)
D_9	0.022 (1.562)	-0.021* (-1.931)	0.003 (0.501)	-0.002 (-0.155)
D_{10}	-0.006 (-0.477)	-0.009 (-0.861)	-0.012* (-1.935)	0.029*** (2.775)
D_{11}	0.008 (0.598)	0.020** (2.043)	-0.004 (-0.561)	-0.022** (-2.164)
D_{12}	0.035** (2.488)	-0.007 (-0.608)	-0.005 (-0.760)	-0.022* (-1.893)
$dR_{i,t-1}$	-0.325*** (-3.291)	-0.359*** (-3.069)	-0.200 (-1.222)	-0.374*** (-3.881)
$e_{i,t-1}$	-0.441*** (-3.772)	-0.400*** (-3.117)	-1.014*** (-3.978)	-0.460*** (-3.416)
R^2	0.594	0.412	0.562	0.735

Note: Numbers in parentheses are *t*-ratios;
*** significant at 1%; ** significant at 5%; * significant at 10%

Table 22 – Estimated Marshallian (uncompensated) own-price elasticities (E_{ii}) and expenditure elasticities (A_i). Model 2.

	January 1999 - December 2011		*January 2012 - December 2016*	
	$\boldsymbol{E_{ii}}$	$\boldsymbol{A_i}$	$\boldsymbol{E_{ii}}$	$\boldsymbol{A_i}$
Norway	-0.803*** (-11.185)	1.112*** (26.521)	-0.858*** (-11.037)	0.948*** (16.315)
UK	-0.835*** (-6.355)	0.936*** (12.243)	-1.097*** (-4.497)	0.930*** (6.181)
Chile	-1.009*** (-3.644)	0.378** (1.989)	-1.809** (-2.009)	0.697 (1.592)
ROW	-0.911*** (-11.791)	0.977*** (17.618)	-0.804*** (-6.345)	1.198*** (12.511)

Note: Numbers in parentheses are *t*-ratios;
*** significant at 1%; ** significant at 5%; * significant at 10%

Table 23 – Estimated Hicksian (compensated) cross-price elasticities (E^*_{ij}). Model 2.

January 1999 - December 2011				
Quantity demanded from	**Prices**			
	Norway	**UK**	**Chile**	**ROW**
Norway	– –	0.107** (2.249)	0.030 (0.931)	0.148*** (3.179)
UK	0.262** (2.249)	– –	0.003 (0.039)	0.391*** (4.541)
Chile	0.259 (0.931)	0.010 (0.039)	– –	0.719*** (3.235)
ROW	0.238*** (3.179)	0.258*** (4.541)	0.132*** (3.235)	– –
January 2012 - December 2016				
Quantity demanded from	**Prices**			
	Norway	**UK**	**Chile**	**ROW**
Norway	– –	0.196*** (3.379)	0.087** (1.990)	0.062 (1.145)
UK	0.656*** (3.379)	– –	-0.081 (-0.481)	0.371** (2.454)
Chile	1.229** (1.990)	-0.339 (-0.481)	– –	0.892* (1.698)
ROW	0.130 (1.145)	0.232** (2.454)	0.133* (1.698)	– –

Note: Numbers in parentheses are *t*-ratios;
*** significant at 1%; ** significant at 5%; * significant at 10%

6.2.1 Marshallian own-price elasticities

For both sub-periods, all of the estimated own-price elasticities are statistically significant and negative, which is consistent with demand theory. For the period before the structural break, magnitude varies between -0.803 for Norwegian salmon and -1.009 for Chilean salmon, while for the period after the structural break, magnitude varies between -0.804 for salmon from ROW and -1.809 for Chilean salmon.

French demand for salmon from Norway has been quite stable and relatively price inelastic during the whole study period. Whereas, demand for salmon from the UK has become more price elastic and moved from -0.835 to -1.097 during the study period. More elastic demand for Scottish salmon, with a parallel stable relatively inelastic demand for Norwegian salmon, may be explained by the fact that Scottish producers set higher prices in order to "manifest" the high product quality, such that consumers has started to consider Scottish salmon as more valuable and superior to Norwegian salmon. Since the demand for salmon from the UK has become more elastic, one can expect it to have greater substitution possibilities and greater competition.

Demand for salmon from Chile has been the most price elastic in the period before the structural break (-1.009) and has become even more price elastic after the structural break by moving to -1.809. This finding was expected due to the significant reduction of supply of Chilean salmon and a continuing process of production recovery as the result of the salmon disease crisis.

The own-price elasticity for salmon from ROW is relatively price inelastic and equals -0.911 and -0.804 for the period before and after the structural break, respectively. This means that demand for salmon from ROW has become less price elastic during the study period, which is consistent with a common trend for less elastic demand for salmon.

6.2.2 Expenditure elasticities

For the first sub-period, all of the estimated expenditure elasticities are positive and statistically significant. For the second sub-period, only the expenditure elasticity for salmon from Chile is not significant, whereas, the rest of the expenditure elasticities are all significant and positive.

Salmon from the UK appears to be a necessity good with the expenditure elasticity that has been very stable and quite close to 1 during the whole study period. At the same time, Norwegian salmon moved from being a luxury good before the structural break to being a necessity good after the structural break with the expenditure elasticities equal 1.112 and 0.948, respectively. It was expected for Norwegian salmon to become a necessity since Norway is the leading salmon supplier. In addition, Norwegian salmon has taken over a bit of the market shares from other salmon supply sources during the study period. Norwegian salmon is mainly imported as fresh product and therefore follows a common tendency for fresh salmon to become less expenditure elastic (Xie, 2008).

Salmon from ROW moved from being a necessity good in the period before the structural break to being a luxury good in the period after the structural break with the expenditure elasticities equal 0.977 and 1.198, respectively.

Chilean salmon has the lowest expenditure elasticity of 0.378 for the period before the structural break. This is not surprising since salmon from Chile has the lowest average price in the group and is almost entirely imported as frozen fillets, while it is proved that frozen salmon is less expenditure elastic than fresh salmon in the EU market (Asche, 1996; Xie, 2008).

6.2.3 Hicksian cross-price elasticities

For both sub-periods, eight of the twelve cross-price elasticities are significant at 10% level of significance or better.

There is a positive demand relationship between salmon from Norway and the UK. The estimated cross-price elasticity of salmon from the UK with respect to the price of salmon from Norway is 0.262 and 0.656 for the period before and after the structural break, respectively. Whereas, the cross-price elasticity of salmon from Norway with respect to the price of salmon from the UK is 0.107 and 0.196 for the period before and after the structural break, respectively. These findings indicate that Norwegian salmon has become a much stronger substitute for Scottish salmon, especially after the structural break. While Scottish salmon has been a weaker substitute for Norwegian salmon during the whole study period.

There is also a positive and stable relationship between salmon from the UK and ROW. Scottish salmon and salmon from ROW substitute each other during the whole period, however, Scottish salmon appears to be a weaker substitute for salmon from ROW than vice versa. Hence, one can conclude that change in the price of salmon from Norway or ROW has a considerably stronger effect on the demand for salmon from the UK than vice versa.

As expected, there is a significant positive relationship between salmon from ROW and Chile. The estimated cross-price elasticity of salmon from Chile with respect to the price of salmon from ROW is 0.719 and 0.892 for the period before and after the structural break, respectively. Whereas, the cross-price elasticity of salmon from ROW with respect to the price of salmon from Chile is 0.132 and 0.133 for the period before and after the structural break, respectively. These findings suggest that salmon from the ROW is a stronger substitute for Chilean salmon than vice versa.

What is especially interesting, is that there is no significant demand relationship between Chilean and Norwegian salmon in the period before the structural break. However, in the second period after the structural break, one can actually observe that the cross-price elasticity of salmon from Chile with respect to the price of salmon from Norway is 1.229, whereas the cross-price elasticity of salmon from Norway with respect to the price of salmon from Chile is only 0.087. One can observe that Norwegian salmon has started to act as a very strong substitute for Chilean salmon after the structural break, whereas, Chilean salmon has only a minor and weak substitution effect for Norwegian salmon. This finding clearly demonstrates the consequences of the Chilean salmon decease crisis, since the significant reduction of supply of Chilean salmon and on-going process of Chilean production recovery have caused a substantial demand growth for salmon from Norway.

No statistically significant complements are found during the cross-price effects analysis.

6.3 The Ordered Logit Model of Salmon Choice

The ordered logit model of salmon choice examines how socioeconomic and demographic factors, experience, perceptions and preferences regarding salmon influence the salmon consumption choice, which is expressed as frequency of salmon consumption both at home and at restaurant/café. The empirical results are presented in Table 24.

Table 24 – Estimated coefficients and marginal effects for the ordered logit model of frequency of salmon consumption.

Independent variable	Coefficient[a]	*t*-Ratio	*Marginal effects*				
			Prob (y=0)[b]	**Prob (y=1)**	**Prob (y=2)**	**Prob (y=3)**	**Prob (y=4)**
Intercept	-0.641***	-3.318					
Male	0.083	1.205	-0.2 %	-1.6 %	-0.2 %	0.9 %	1.0 %
Age35_49	0.014	0.159	0.0 %	-0.3 %	0.0 %	0.1 %	0.2 %
Age50_65	0.052	0.553	-0.1 %	-1.0 %	-0.1 %	0.6 %	0.7 %
HdSize	0.120**	2.465	-0.2 %	-2.3 %	-0.2 %	1.3 %	1.5 %
NrChild	-0.051	-1.021	0.1 %	1.0 %	0.1 %	-0.6 %	-0.6 %
Married	0.242***	2.961	-0.5 %	-4.8 %	-0.4 %	2.7 %	3.0 %
Town	0.275***	3.532	-0.5 %	-5.4 %	-0.6 %	3.0 %	3.5 %
City	0.576***	5.883	-1.0 %	-10.6 %	-2.4 %	5.8 %	8.1 %
Income2	-0.143*	-1.848	0.3 %	2.8 %	0.3 %	-1.6 %	-1.8 %
Income3	0.267*	1.770	-0.5 %	-5.0 %	-0.9 %	2.8 %	3.6 %
EdMed	0.318***	3.592	-0.6 %	-6.2 %	-0.6 %	3.5 %	4.0 %
EdHigh	0.389***	3.702	-0.7 %	-7.4 %	-1.2 %	4.1 %	5.2 %
Norway	0.588***	6.593	-1.1 %	-11.3 %	-1.5 %	6.2 %	7.7 %
Scotland	0.748***	7.532	-1.3 %	-13.6 %	-3.1 %	7.4 %	10.7 %
France	0.884***	6.248	-1.3 %	-14.8 %	-5.6 %	7.4 %	14.2 %
Fresh	0.779***	9.392	-1.9 %	-15.8 %	0.3 %	8.6 %	8.7 %
Frozen	0.307***	4.177	-0.6 %	-5.9 %	-0.8 %	3.3 %	4.0 %
Smoked	0.099	1.411	-0.2 %	-1.9 %	-0.2 %	1.1 %	1.2 %
Lean	0.393***	4.251	-0.7 %	-7.3 %	-1.5 %	4.0 %	5.4 %
Easy	0.261***	3.615	-0.5 %	-5.1 %	-0.5 %	2.8 %	3.3 %
Healthy	0.411***	5.832	-0.8 %	-8.0 %	-0.8 %	4.5 %	5.2 %
Inspire	0.547***	5.157	-0.9 %	-9.9 %	-2.5 %	5.4 %	8.0 %
Eco	0.314***	2.641	-0.6 %	-5.9 %	-1.1 %	3.3 %	4.3 %
Quick	0.163**	2.147	-0.3 %	-3.2 %	-0.4 %	1.8 %	2.1 %
Safe	0.231**	2.229	-0.4 %	-4.4 %	-0.7 %	2.4 %	3.1 %
Taste	0.229***	3.015	-0.5 %	-4.5 %	-0.3 %	2.5 %	2.8 %
Family	0.125*	1.649	-0.2 %	-2.4 %	-0.3 %	1.4 %	1.6 %
Money	0.114	1.427	-0.2 %	-2.2 %	-0.3 %	1.2 %	1.5 %

WeekDay	0.991***	10.329	-1.5 %	-16.9 %	-5.8 %	8.5 %	15.6 %
WeekEnd	0.272***	2.755	-0.5 %	-5.1 %	-0.9 %	2.9 %	3.7 %
Out	0.399***	4.312	-0.7 %	-7.5 %	-1.5 %	4.1 %	5.5 %
μ_1	2.459***	13.246					
μ_2	3.732***	19.474					
μ_3	4.989***	25.076					
Summary statistics							
Number of observations			3022				
Value of the log-likelihood function			-4035.296				
Chi-square statistics χ^2 (with 31 degrees of freedom)			812.86***				
Pseudo-R^2			0.249				

[a] Note: *** significant at 1%; ** significant at 5%; * significant at 10%

[b] Ordinal ranked consumption categories: (y=0) never, (y=1) 1-8 times a year, (y=2) once a month, (y=3) 2-3 times a month, (y=4) once a week or more.

Pseudo-R^2 statistic is equal to 0.249 which is quite low. Nevertheless, most of the estimated coefficients are statistically significant, and only 6 of 31 explanatory variables are not significant.

Since the parameter estimates of the ordered logit model do not have a straightforward interpretation, one can therefore focus on the changes in marginal probabilities calculated at the sample means, i.e. the average marginal effects (AME).

6.3.1 Socioeconomic and demographic factors

Gender of consumers do not have any significant impact on salmon consumption choice, which is consistent with findings of Nayga and Capps (1995) and Myrland (1998). Moreover, no significant relationship is found between age and salmon consumption frequency, which contradicts findings of Olsen (2003) and Myrland et al. (2000) who found out that, for Norwegian consumers, age is positively related to the frequency of consumption of fish/ seafood in general. However, absence of significant effect from age is somehow consistent with the conclusions of Nilssen and Monfort (2000) that age composition among French consumers is not considered to be important for elaboration of salmon based products.

Number of children in the household does not have significant effect either, whereas, the total household size is found to play a small role in explaining salmon choice. Given a one person increase in total household size, the marginal probability of consuming salmon twice a month or more increases only by 2.8%. Additionally, consumers that are married/registered partners or co-habitants are 5.7% more likely to eat salmon twice a month or more. Nevertheless, such findings still indicate an important impact of being a family on salmon consumption frequency.

Area of residence is reported as an important factor positively affecting the frequency of salmon consumption. Consumers who live in a town/residential area and in a bigger city are more likely to eat salmon twice a month or more by 6.5% and 13.9%, respectively, compared to those who live in a rural area. That means that urbanization, in general, has a significant positive impact on salmon consumption frequency.

Total gross annual household income may also play some role in determining salmon choice. Respondents with an income above average, i.e. higher then 60,000 Euro, are *more* likely to consume salmon twice a month or more by 6.4% compared to respondents with an income below average, i.e. lower than 17,500 Euro. But what is surprising is that respondents with an average income, i.e. between 17,500 Euro and 60,000 Euro, are *less* likely to consume salmon twice a month or more by 3.4% compared to those with income below average. The finding that respondents with income above average eat *more* salmon than those with lower income is consistent with some of the earlier studies, which show that, generally, frequent fish/seafood consumption is associated with a higher level of income (Erdogan, Mol, & Cosansu, 2011; D. Hicks, Pivarnik, & McDermott, 2008; Nayga & Capps, 1995). However, the finding that respondents with an average income appear to eat *less* salmon than those with low income clearly contradicts the previous finding. It is also important to notice that both income variables are only significant at 10% significance level, which may explain such a strange result.

Level of education appears to have a significant positive impact on salmon choice. Consumers with a medium level of education, i.e. have an upper secondary school or a secondary vocational education or a two-year post-secondary school education, are more likely to eat salmon twice a month or more by 7.5% compared to those who only have a primary or a lower secondary school education. Consumers with a higher education, i.e. have an undergraduate or a postgraduate degree, are more likely to eat salmon twice a month or more by 9.3% compared to those with low level of education. Such results support findings of Myrland et al. (2000) who suggested that consumers with higher education levels are more likely to be influenced by arguments from nutritionists that consuming fish/seafood improves health and, moreover, such consumers demand better products. In addition, Nauman et al. (1995) mentioned that consumers with college degree or higher are more likely to prefer salmon and, therefore, consume it regularly.

6.3.2 Experience

Consumers' familiarity with salmon supply sources has a significant positive effect on salmon consumption choice. Respondents who strictly prefer salmon originating from Norway are more likely to eat salmon twice a month or more by 13.9% compared to those who prefers salmon of other origin. Whereas, respondents who strictly prefer salmon originating from Scotland (UK) are more likely to eat salmon twice a month or more by 18.1% compared to those who prefers salmon of other origin. These findings confirm that French consumers consider salmon from Scotland as a slightly superior product to Norwegian salmon.

Previous experience with salmon product forms also determines salmon choice. The increased marginal probability of consuming salmon twice a month or more for regular purchases of fresh salmon and frozen salmon is 17.3% and 7.3%, respectively. However, it is interesting that regular purchases of smoked salmon do not have any significant impact on salmon choice. Hence, it is obvious that fresh salmon is the most central product form and plays an essential role in frequency of salmon consumption.

6.3.3 Perceptions

Perception variables are reported to have a significant positive effect on frequency of salmon consumption. The increased marginal probability of eating salmon twice a month or more for consumers that choose salmon because of inspiration from preparation is 13.4%. Having the perceptions that salmon brings health benefits and can be consumed as lean alternative brings the increased marginal probability of eating salmon twice a month or more of 9.7% and 9.4%, respectively. Those consumers who care about consumption safety and environmental friendliness are more likely to eat salmon twice a month or more by 5.5% and 7.6%, respectively. Consumers who choose salmon because of ease of preparation and good taste are more likely to eat salmon twice a month or more by 6.1% and 5.3%, respectively. The increased marginal probability of eating salmon twice a month or more for consumers that choose salmon because it can be quickly prepared and because family likes it is only 3.9% and 3.0%, respectively. Considering salmon as product that is worth the money spent on it, i.e. good value for money, does not have any significant effect on salmon choice.

6.3.4 Preferences

All of the preferences variables are found to have significant effect on salmon consumption choice. Consumers who strictly prefer salmon for a fish/seafood dinner on a weekday (Monday-Friday) at home are more likely to eat salmon twice a month or more by 24.1%. Those consumers who strictly prefer salmon for a fish/seafood dinner on weekend at home are more likely to eat salmon twice a month or more by 6.6%. Finally, those consumers who strictly prefer salmon for a fish/seafood dinner at a restaurant or café are more likely to eat salmon twice a month or more by 9.6%. One can, therefore, suggest that French consumers mostly consider salmon to be more suitable for weekday home occasions, which makes salmon a central part of the regular diet.

All in all, for French consumers, frequency of salmon consumption, i.e. salmon choice, is mostly positively affected by the following factors: urbanization, higher level of education, strict preference for salmon originating from Scotland (UK) or Norway, regular purchases of fresh salmon, feel of inspiration from preparation of salmon, having a belief that salmon is good for health and can be consumed as a lean alternative, preference for salmon on a weekday fish/seafood dinner at home.

Chapter 7: Discussion and concluding remarks

This thesis conducted an analysis of import demand and consumption of salmon in France. The objective was to explain why salmon prices have been increasing so dramatically during the last five years and to discover which factors contributed the most. The French market is selected as a representative for the empirical study since France is the largest salmon market within the EU with a very diversified supply of product forms.

The dynamic first difference version of the Linearized Almost Ideal Demand System (LA/AIDS) was primarily applied and two separate demand systems were constructed and estimated. The first demand system carried out an analysis of the French import demand for salmon, trout, cod and Alaska pollack in order to see how salmon operates in the same market with chosen representatives of other fish/seafood species. The second demand system focused on salmon from different supply sources, namely Norway, the UK, Chile and the Rest of the World (ROW), in order to see how salmon from different countries of origin compete with each other in the same market. In order to account for the structural break, the whole observation period was divided into two samples of monthly observations: from January 1999 to December 2011 and from January 2012 to December 2016. Additionally, the ordered logit model of salmon consumption choice was estimated on a supplementary basis. The purpose of the model was to examine how different factors influence the frequency of salmon consumption for the French consumers. The applied model was based on the evoked sets concept and it was assumed that salmon choice can be explained by socioeconomic and demographic profile of a consumer, experience, perceptions and preferences regarding salmon consumption. Brief discussion of the key results is provided as follows.

Firstly, there are positive cross-price effects between salmon and whitefish species of cod and Alaska pollack. The results reveal that, during the whole study period, salmon is a strong substitute for cod, whereas cod is a weaker substitute for salmon. Moreover, after the structural break, salmon has started to act as a stronger substitute for Alaska pollack, while Alaska pollack has acted as a weak substitute for salmon. These findings are very important and indicate that change in the price of salmon has a considerably greater effect on the demand for cod and Alaska pollack than vice versa during the last five years. One can also conclude that French consumers find it easier to replace the consumption of whitefish species, but it is clearly harder to find a close substitute for salmon. As a result, salmon products face less competition from other fish/seafood products, which, makes salmon prices increase significantly.

Secondly, when focusing on the cross-price effects between salmon from different supply sources, it is possible to conclude that change in the price of salmon from Norway has a considerably stronger effect on the demand for salmon from Scotland (UK) than the other way around. One can observe that Norwegian salmon has become a much stronger substitute for Scottish salmon than vice versa, especially during the last five years. While Scottish salmon has been a weak substitute for Norwegian salmon during the whole study period. This indicates that it is harder for French consumers to replace the demand for Norwegian salmon, which may be considered as a consequence of a successful generic promotion of salmon from Norway, which forces the demand for Norwegian salmon to grow and pushes prices up. It was also proved to be difficult for Scottish salmon to compete with Norwegian salmon on the basis of the price, since, compared with Norwegian producers, Scottish producers are limited in output.

Thirdly, there is a significant positive relationship between salmon from ROW and Chile, during the whole study period, with ROW being a stronger substitute for Chilean salmon than vice versa. But the main finding is that Norwegian salmon has started to act as an extremely strong substitute for Chilean salmon after the structural break, whereas, Chilean salmon has only a minor and weak substitution effect for Norwegian salmon. These results clearly demonstrate the consequences of the Chilean salmon decease crisis, since the significant reduction of supply of Chilean salmon and on-going process of Chilean production recovery have caused a substantial growth of world demand for salmon, and especially for salmon from Norway. As a result, supply is not able to keep up with a strong growth in demand, which causes salmon prices to increase substantially.

Fourthly, when focusing on the own-price effects, it is possible to conclude that French demand for total import of salmon has become more price elastic during the study period. This finding somehow contradicts a common trend for less elastic demand for salmon that was reported in the earlier studies. Increased sensitivity to price may be explained by strong growth in demand and increase in real price of salmon. Furthermore, one can conclude that more price elastic demand for total import of salmon is driven by more elastic demand for Scottish salmon and for Chilean salmon. More elastic demand for salmon from Chile is not surprising given the consequences of the salmon disease crisis, whereas, more elastic demand for Scottish salmon may be explained by the fact that Scottish producers set higher prices in order to “manifest” the high product quality, such that consumers has started to consider Scottish salmon as more valuable and superior to Norwegian salmon. This result is supported by the finding of the supplementary model of salmon consumption choice, that respondents who strictly prefer salmon originating from Scotland are more likely to eat salmon twice a month or more by 18.1% compared to those who prefers salmon of other origin. This confirms that French consumers consider salmon from Scotland as a slightly superior product to Norwegian salmon.

The next finding is that salmon from all major supply sources follows the common trend and is becoming less and less expenditure elastic over time. It means that, generally, salmon is not considered to be a luxury good anymore and is becoming a central part of the regular diet. This result is coherent with another finding from the salmon consumption choice model, that French consumers mostly consider salmon to be more suitable for weekday home occasions since consumers who strictly prefer salmon for a fish/seafood dinner on a weekday at home are more likely to eat salmon twice a month or more by 24.1%.

Finally, for French consumers, frequency of salmon consumption and purchase is mostly positively affected by the following factors: urbanization, higher level of education, strict preference for salmon originating from Scotland or Norway, regular purchases of fresh salmon, feel of inspiration from preparation of salmon, having a belief that salmon is good for health and can be consumed as a lean alternative, preference for salmon on a weekday fish/seafood dinner at home. All these factors may partly explain the growing demand for salmon, that pushes salmon prices up.

All in all, answering the question “Why salmon prices are increasing?” is a complicated task and the answer will never be limited to a single factor, but rather to a complex of different factors. Some factors may be obvious, some are hard to measure. The findings of this thesis can serve as a basis for the further research on discovering the reasons behind the increasing salmon prices.

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Appendix A

The seafood consumer insight (SCI) surveys are organized by the Norwegian Seafood Council (NSC) and performed by Kantar TNS and their global partners. The following list of questions is only the selected part of the SCI questionnaire for French fish/seafood consumer market that is relevant for this thesis.

In this survey, the term "Fish/Seafood" is used. With "Fish/Seafood" we mean all kinds of fish, shellfish, cuttlefish, clam, mussels, etc.

1. How often do you eat salmon? We are thinking of breakfast, lunch, dinner, out and at home (all meals). Choose only one response.
   (single answer)

   ☐ Eat twice a week or more

   ☐ Eat around once a week

   ☐ 2-3 times a month

   ☐ Eat around once a month

   ☐ Eat 4-8 times a year

   ☐ Eat 1-3 times a year

   ☐ Heard of/never eat

   ☐ Never heard of

2. Which is your preferred country of origin when you buy salmon? Choose only one response.
   (single answer)

   ☐ Norway

   ☐ Scotland

   ☐ Russia

   ☐ Alaska/USA

   ☐ China

   ☐ Iceland

☐ Spain

☐ Canada

☐ France

☐ Chile

☐ Ireland

☐ Germany

☐ Other country

☐ Don't know (single answer)

3. What type of fish/seafood do you normally prefer for your weekday (Monday-Friday) fish/seafood dinner at home? Choose only one response.
(single answer)

☐ Salmon

☐ Cod (cabillaud)

☐ Salmon Trout

☐ Prawn/shrimp

☐ Mackerel

☐ Saithe

☐ Blue mussel

☐ Lobster

☐ Tuna

☐ Pangasius

☐ Crab/crawfish

☐ Skrei

☐ Scallop

☐ Oyster

☐ Sole

☐ Hake

☐ Sea bass

☐ Anglerfish

☐ Whiting

☐ Sardine

☐ Other

☐ Don't know (single answer)

4. What type of fish/seafood do you normally prefer for your weekend fish/seafood dinner at home? Choose only one response.
(single answer)

☐ Salmon

☐ Cod (cabillaud)

☐ Salmon Trout

☐ Prawn/shrimp

☐ Mackerel

☐ Saithe

☐ Blue mussel

☐ Lobster

☐ Tuna

☐ Pangasius

☐ Crab/crawfish

☐ Skrei

☐ Scallop

☐ Oyster

☐ Sole

☐ Hake

☐ Sea bass

☐ Anglerfish

☐ Whiting

☐ Sardine

☐ Other

☐ Don't know (single answer)

5. Regardless of season, what type of fish/seafood do you usually prefer when having fish/seafood at a restaurant, café, or similar? Choose only one response. (single answer)

☐ Salmon

☐ Cod (cabillaud)

☐ Salmon Trout

☐ Prawn/shrimp

☐ Mackerel

☐ Saithe

☐ Blue mussel

☐ Lobster

☐ Tuna

☐ Pangasius

☐ Crab/crawfish

☐ Skrei

☐ Scallop

☐ Oyster

☐ Sole

☐ Hake

☐ Sea bass

☐ Anglerfish

☐ Whiting

☐ Sardine

☐ Other

☐ Don't know (single answer)

6. How do you usually buy Salmon?
   (multiple answer)

   ☐ Frozen

   ☐ Fresh

   ☐ Fresh (Refreshed)

   ☐ Canned/bottled/bucket

   ☐ Smoked

   ☐ Salted

   ☐ Dried

   ☐ Marinated

   ☐ Other

   ☐ Don’t know/no opinion (single answer)

7. There are many good reasons for choosing salmon. Some of them are listed below. Which of these would you say are good reasons for choosing salmon for yourself? Choose up to 5.
   (multiple answer)

   ☐ Quick to prepare

   ☐ Easy to prepare

   ☐ Inspiring to prepare

   ☐ Tastes good

   ☐ Health benefits

   ☐ A lean alternative

   ☐ Safe to eat

   ☐ Produced/caught in an environmentally friendly way

   ☐ Value for money

☐ The family likes it

☐ Other

☐ Don't know (single answer)

8. Select the gender that applies. Are you …
   (single answer)

   ☐ Male

   ☐ Female

9. How old are you? …
   (open answer)

10. How many people are there in total in the household? …
    (open answer)

11. How many children who are under 18 are there in the household? …
    (open answer)

12. What is your marital status?
    (single answer)

    ☐ Married/registered partner

    ☐ Co-habitant

    ☐ Unmarried

    ☐ Previously married (separated, widow, widower)

13. Where do you live?
    (single answer)

    ☐ City

    ☐ Town

    ☐ Residential area

    ☐ Rural area

14. Approximately how much is the total gross annual income of the household (before tax and deductions)?
(single answer)

☐ Less than 4000 euros

☐ 4,000 Euro to under 5,500 Euro

☐ 5,500 Euro to under 7,000 Euro

☐ 7,000 Euro to under 8,000 Euro

☐ 8,000 Euro to under 9,500 Euro

☐ 9,500 Euro to under 11,000 Euro

☐ 11,000 Euro to under 12,500 Euro

☐ 12,500 Euro to under 13,500 Euro

☐ 13,500 Euro to under 15,000 Euro

☐ 15,000 Euro to under 17,500 Euro

☐ 17,500 Euro to under 20,500 Euro

☐ 20,500 Euro to under 23,000 Euro

☐ 23,000 Euro to under 28,500 Euro

☐ 28,500 Euro to under 35,000 Euro

☐ 35,000 Euro to under 45,000 Euro

☐ 45,000 Euro to under 60,000 Euro

☐ 60,000 Euro to under 75,000 Euro

☐ 75,000 Euro to under 90,000 Euro

☐ 90,000 Euro to under 113,500 Euro

☐ 113,500 Euro to under 140,000 Euro

☐ 140,000 Euro to under 160,000 Euro

☐ 160,000 Euro to under 180,000 Euro

☐ 180,000 Euro to under 204,000 Euro

☐ 204,000 Euro to under 225,000 Euro

☐ 225,000 Euro to under 250,000 Euro

☐ 250,000 Euro to under 275,000 Euro

☐ 275,000 Euro or more

☐ Don’t wish to answer

15. What is the highest level of education you have completed?
(single answer)

☐ Aucun diplôme (No diploma)

☐ Certificat d'études primaires (The Certificate of Primary Education)

☐ Brevet, BEPC (Lower grade school certificate)

☐ CAP, BEP (Lower grade vocational certificate)

☐ Bac technique ou professionnel (Vocational leaving school certificate)

☐ Bac general (General leaving school certificate)

☐ Bac + 2 ou niveau Bac + 2 (DUT, BTS, Instituteur, DEUG) (Two-year post-secondary school diploma)

☐ Diplôme de l'enseignement supérieur (2ème et 3ème cycle) (Diploma of Higher Education, i.e. university degree)

☐ Other