Testing the Farm-Retail Price Transmission for Norwegian Salmon Exports to France

by

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Abstract

This thesis has tested the Farm-Retail price transmission for Norwegian salmon exports to France. By the use of public data for farm level price in Norway, export level price in Norway, retail level price in France, transportation costs and currency exchange rates the price transmission for the Norway-France value chain has been investigated. Tests of asymmetric price transmission were also conducted. Results show that the farm-export linkage is stronger than the export-retail linkage with respect to the price pass through. Both transportation costs and currency exchange rates significantly influences the price transmission elasticity. There is evidence of asymmetric price transmission in the value chain. The price changes at the export level respond more to a decrease in the farm level price than to an increase. The Salmon Agreement between Norway and the EU significantly influenced the market mechanism.

Key words: Salmon, Norway-France, price transmission and asymmetry

Sammendrag

Denne oppgave har testet pris transmisjonen på verdikjeden fra lakseoppdretter i Norge til butikk markedet i Frankrike. Ved hjelp av oppdrettspris, eksportpris, butikkpris, transportkostnader og valutakurser har pris transmisjonen langs verdikjeden blitt undersøkt. Det er blitt utført tester for sjekke for asymmetrisk pris transmisjon. Resultatene viser at oppdretter-eksportør leddet er sterkere enn eksportør-butikk leddet med hensyn til fullverdig pris overføring. Både transportkostnader og valutakurser har signifikant påvirkning på pris transmisjonselastisiteten. Det er bevis for asymmetrisk pris transmisjon i verdikjeden. Prisendringene på eksportleddet reagerer mer på en nedgang i oppdrettsprisen enn på en oppgang. Lakseavtalen mellom Norhe og EU har en signifikant påvirkning på prisdannelsen i markedet.

Nøkkelord: Laks, Norge-Frankrike, pris transmisjon og asymmetri

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1 Introduction

"Whenever oil prices fall, there is always this stickiness in gasoline prices on the way down. You never see this stickiness on the way up."
Ed Rothschild, energy expert at Citizen Action. *New York Times, (Wald) July 2, 1990.*

In agricultural economics the topic price transmission has been subject to considerable attention (see e.g., Meyer and von Cramon-Taubadel (2002a) and Goodwin and Harper (2000)). Nevertheless, research addressing this issue in relation to fish markets has been scarce, the couple of exceptions being Asche and Sebulonsen (1998) and Kinnucan and Myrland (2000). The scope of this thesis will be to apply empirical methods of estimating asymmetric price transmission to the case of Atlantic salmon exported from Norway to France.

A brief review of the literature on asymmetric price transmission provides evidence of miscellaneous methods and approaches applied on the topic. Outside of agriculture, gasoline and fuel markets have been tested for asymmetric price transmission (see e.g., Borenstein et al. (1997) and Karrenbrock (1991)), while Balke and Fomby (1997) and Enders and Granger (1998) find evidence of asymmetric adjustment between interest rates of different maturities. Also, Peltzman (2000), in an extensive study of price transmission for several hundred producer and consumer goods in the US, found that fewer number of firms lead to more asymmetry and that more concentration lead to less asymmetry.

In agricultural economics most attempts to test for the presence of asymmetric price transmission have been based on a method for detecting irreversible supply reactions developed by Wolffram (1971) and later adopted by Houck (1977) and Ward (1982). Furthermore, Kinnucan and Forker (1987) tested for the asymmetry in farm-retail transmission for dairy products in the United States, based on Houck's model for estimating nonreversible functions. By using a threshold cointegration model that permitted asymmetric adjustments to positive and negative price shocks, Goodwin and Harper (2000) analysed price transmission in the U.S. pork sector.

There is considered to be a global market for salmon. Research done by Asche and Sebulonsen (1998), Asche et al. (1999) and Asche et al.(2002) show that there is a global market for salmon, including salmon from all major producers at the export level. Guttormsen (2002) found that in the global market price levels differ. For instance, the prices are higher in Japan than in the EU and in the United States, but prices for each species and product follow a long-term pattern.

During the last few years there has been a controversy both in the media and in the industry over the salmon prices. The price level on salmon made a significant shift from very high prices around 2000, to relatively low prices the following years up until last year (2006). During times of sustained pressure on margins, the salmon farming industry looks for answers to underlying mechanisms behind the low prices and profitability. "...the presence of asymmetric price transmission is often considered for policy purposes to be evidence of market failure" Meyer and von Cramon-Taubadel (2002b, p. 1). Bearing these facts in mind, this thesis will to some extent shed light on the situation regarding Norwegian export of salmon to France.

According to the Norwegian Seafood Export Council (NSEC) 2006, France is the most important market for Atlantic salmon, followed by Denmark (although it is largely a transit country for Norwegian seafood on its way to the EU), Poland, Great Britain and Russia. These five countries accounted for over 54 % of total exports, compared to 48 % the previous year. Due to the relative importance of France in the global salmon market this market can play a representative role among other importing countries. Charron and Richardson (2001) state that France is indicative of trends in terms of among other prices, consumer behaviour and potential market development in Europe.

By adopting a model developed by Kinnucan and Myrland (2001), this thesis will develop a model that investigates price transmission for Norwegian salmon exported to France. Asymmetric price transmission will also be tested for by using a model developed by Houck (1977). By using monthly time series, data for fish farmer price in Norway, export price to France and retail price in France, the price linkages at these three levels in the value chain for fresh Atlantic salmon, will be investigated. The model will also incorporate transportation costs and currency exchange rates to see whether these factors affect the price mechanism.

In July 1997 a Salmon Agreement (SA) between Norway and the European Union raised the export tax on Norwegian salmon entering the EU from 0,75 % to 3,00 %. The proceeds of the levy were used by Norway to fund generic marketing of Atlantic salmon (Brittain and Bull, 1997). Besides the financing of the generic marketing, the SA included two important elements, namely a minimum price level on salmon imported to the EU, and an indicative ceiling on annual growth. Although an important issue when discussing Norwegian salmon export to France, this particular aspect has been investigated by other researchers (see e.g. Asche *et al.*, 1998; Kinnucan and Myrland, 2000; , 2002). The SA ended in May 2003, and its effect on the price mechanism will be measured.

1.1 Problem positioning

I will narrow my focus in this thesis to merely looking at price transmission elasticities, so that the objective of the research reported in this thesis can be summed up in the following:

To investigate the price mechanism along the retail, wholesale and farmer levels of the Norwegian-French salmon marketing chain.

Furthermore, I will try to answer the following four questions:

1) Are the price changes transmitted equally when prices increase and decrease?
2) Did the SA have an effect on the price transmission elasticities?
3) Does currency exchange rate elasticity influence the price mechanism?
4) To which extent does transportation costs have an impact on French retail prices?

My incentive for addressing these specific issues is while the asymmetry aspect has undergone relatively thorough research, asymmetric price transmission on salmon has not been subject to much attention. As such, I hope that my effort will provide an illuminating contribution. Even though long-term transportation contracts to some extent can decrease the industry’s level of uncertainty regarding production/marketing costs, there still are exogenous factors influencing the marginal cost of transportation. Fuel costs, rate of interest and time costs, all contribute to explaining the level of transportation costs. Thus, transportation costs are essential when cost accounting and managerial control is focused in the salmon industry. Albeit Norway has a geographical competitive advantage over Chile in the EU-market, the situation for Scotland and Ireland is even more favourable.

From an industrial point of view the fact that most of the Norwegian salmon is exported makes[1] the strength of the Norwegian currency relative to other currencies a critical success factor in a competitive market. In conclusion, an accurate assessment and quantification of the impact transportation costs and exchange rate currencies has on retail prices in France will hopefully provide a helpful knowledge to the salmon industry.

1.2 Overview of thesis

In **chapter 2** a brief summary of relevant theory and a review of literature are presented. The chapter is divided into three sections, namely asymmetric price transmission, mark-up and exchange rates. This chapter represents the theoretical spine of the thesis.

Chapter 3 gives a description of my empirical data and comments on the collection of these. Some notes on how I have processed the data will also be presented here. In addition I will briefly describe Norwegian salmon exports in general, as well as the French market.

In **chapter 4** I will proceed with focus on the econometric models I use in the thesis and the formulation of them. The development and explanation of the structural model for price transmission analyses will be addressed in detail. This is supplemented with a specification of the test of asymmetric price transmission. Chapter 4 is concluded with some remarks on the interpretation of the results.

Chapter 5 presents the analyses I did and the results I found. An overview of the variables used is presented, and the results of the asymmetry and price transmission analyses are presented in tables. The results are thoroughly discussed and explained.

[1] Norway produced 597.000 tons of salmon in 2006, of which 572.600 (~96%) was exported (Source: Tall og fakta 2006. Norwegian Seafood Export Council (2006)

Finally, in **chapter 6** a brief summary of the thesis will be given, along with some concluding comments on my main findings and the implications of these.

2 Price transmission

The price mechanism is the means by which resources are allocated and re-allocated within a market-based economic system. The twin forces of market demand and supply determine the equilibrium price and this leads to the factor inputs being allocated in both goods and factor markets[2]. The law of demand states that there is an inverse relationship between the price of a good and the demand for a good. As prices fall one can see an expansion of demand. Contrarily, if prices rise one can expect to see a contraction of demand. The fact that prices change over time makes it essential for the agents at the different levels of the salmon marketing chain to understand the underlying mechanisms. In the short term the price may be affected by both deterministic factors like seasonality and stochastic factors such as disease outbreak and algal blooms Guttormsen (2002). Long-term effects are usually already reflected in the price through forecasting. In an efficient economic market individual firms can reduce risk through hedging and by trading futures (Brealey and Myers, 2003). Of late some financial institutions have started to offer currency exchange rate hedging for Norwegian exporters. The rather strong relationship between salmon prices and share prices for the salmon farming companies indicate that the financial world focuses more on short-term price movements than on long-term fundamentals.

However, markets do not usually adjust immediately to equilibrium, and that is basically because of transaction costs. This includes in general costs of obtaining information about the market and costs of finding a marketplace to transact the business (Carman, 1997). Moreover, when a commodity is internationally traded, its price in one country cannot be independent of its price in another country. In the extreme case the Law of One Price, will hold: "If there were no obstacles to trade and no transport costs, the Law of One Price implies that the price of a given commodity will be the same all over the world" (Begg *et al.*, 2000, p. 136). Without trade barriers[3] and transport costs, suppliers sell in the market with the highest price but consumers purchase in the market with lowest price. The commodity can simultaneously be traded in two countries only if its price is the same in

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[2] www.tutor2u.net

both markets. If there were no barriers to trade, one would expect that prices in the different trading countries follow a similar pattern over time, due to the arbitrage opportunities that would otherwise exist. This is the essence of many market definitions in economics. Stigler (1969), for instance, defines market as the area within which the price of a commodity tends to uniformity, allowance being made for transportation costs. Analyses omitting transportation costs from the price-linkage function can lead to specification errors (see e.g., Haigh and Bryant, 2001), while treating transportation costs as constant could tend to produce biased price transmission elasticity estimates (e.g., Asche, 2001)

Stigler's definition corresponds with the Law of One Price which states that in conditions of perfect competition the price of a commodity in one geographical market is equal to the price in another geographical market and the cost of transportation. Imagine two markets *d* and *x*. The cost of transportation from d to x is written C_{xd}, where $C_{xd} = \beta_0 + \beta_1 P_d$. Then the price in market *x* is expressed as follows:

(1) $$P_x = P_d + C_{xd}$$

However, empirically this relationship seldom holds, as the cost of transportation may or may not be unique. In addition, perfect information does not exist in the real world. Price differences between the various levels in the vertical chain are called marketing margins (in the literature also referred to as vertical price spreads or mark-ups) (Carman, 1997).

2.1 Asymmetric price transmission

Asymmetric price transmission has been a subject of considerable attention in agricultural economics. Asymmetric price transmission is not only important because it may point to gaps in economic theory, but also because its presence is often considered for policy purposes to be evidence of market failure Meyer and von Cramon-Taubadel (2002a). Price theory is one of the foundations of neo-classical economics. Within this paradigm, flexible prices are responsible for efficient resource allocation and price transmission integrates markets vertically and horizontally. Economists who study market efficiency

[3] The European Union's Single Market Act is an attempt to remove all barriers to trade between the member countries of the EU.

therefore investigate price transmission processes. In the classical free-trade model with zero transportation costs, the international price transmission is implicitly assumed to be perfect. This conjecture is dubious according to Bredahl, Meyers and Collins (1979, p. 58), who state:

"The assumption of perfect price transmission is a convenient simplification but has a profound impact on the calculated elasticities and raises serious questions about their applicability to the real world"

Moreover, asymmetry can have important implications for policymakers. Since it is commonly assumed that asymmetric price transmission is caused by market power, empirical evidence of asymmetry is often claimed to justify Government intervention. The very same logic apply for other markets, for instance the gasoline market, where retail gasoline prices often fluctuate more widely than consumer prices in general. Some analysts and politicians have criticized these retail gasoline price movements, alleging that they do not respond symmetrically to price changes at earlier stages of the marketing chain. In particular, they believe that retail gasoline prices do not reflect decreases in oil and wholesale gasoline prices as rapidly and fully as they do price increases (Karrenbrock, 1991).

2.1.1 Types of asymmetry

Two basic types of asymmetry are depicted in figures 1 and 2 in the context of price transmission, where a price (p^{out}) is assumed to depend on another price (p^{in}) that either increases or decreases at a specific point in time.[4] In figure 1, the magnitude of the response by p^{out} to a change in p^{in} depends on the direction of this change. In figure 2, the speed of the response by p^{out} depends on the direction of the change in p^{in}.

[4] Asymmetry is closely related to the issue of price rigidity or 'stickiness'. See e.g., Meyer and von Cramon-Taubadel (2002a) and references cited therein.

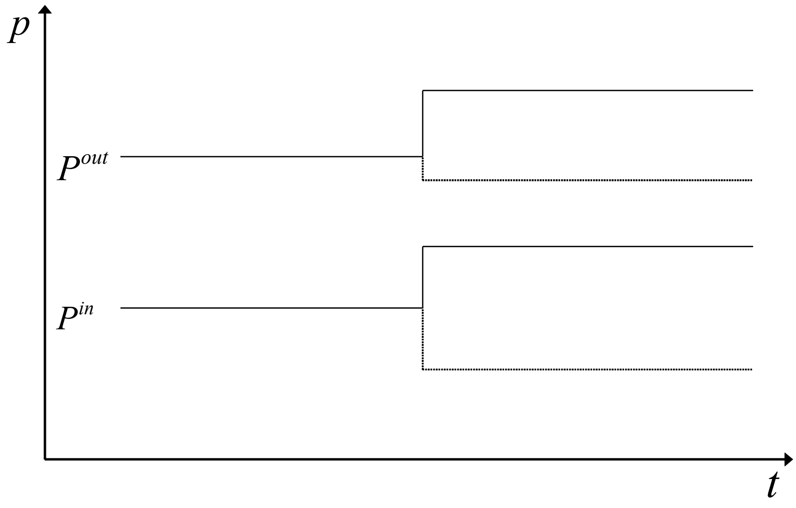

Figure 1 – Asymmetric price transmission – magnitude

Clearly, combinations of the two fundamental asymmetries are conceivable. In figure 3, an increase in p^{in} takes two periods (t_1 and t_2) to be fully transmitted to p^{out}. The corresponding transmission of a decrease in p^{in} is asymmetric with respect to both speed and magnitude because it requires three periods (t_1, t_2 and t_3) and is not full.

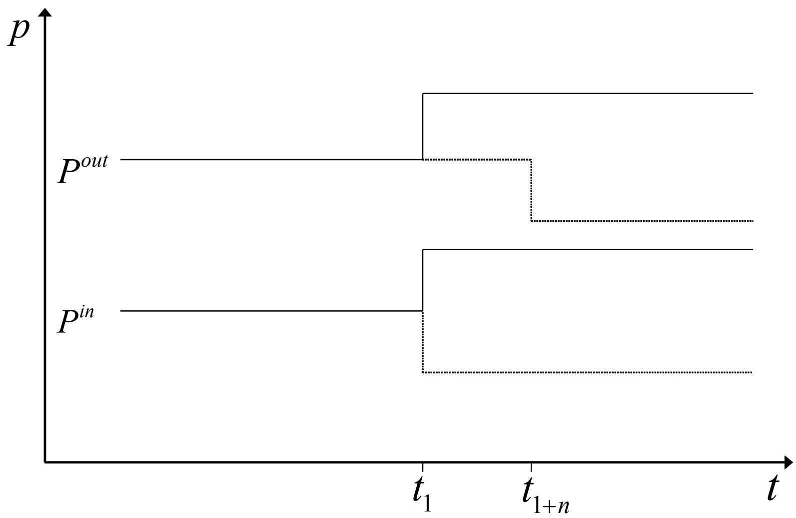

Figure 2 – Asymmetric price transmission – speed

Price transmission, and thus symmetry, can be vertical or spatial (horizontal). As an example of vertical symmetry, farmers and consumers often complain that increases in farm prices are more fully and rapidly transmitted to the wholesale and retail levels than are similar decreases in farm prices. An example of spatial asymmetry would be a rise in the US wheat price causing a more pronounced reaction in Canadian wheat prices than a corresponding reduction of the same magnitude.

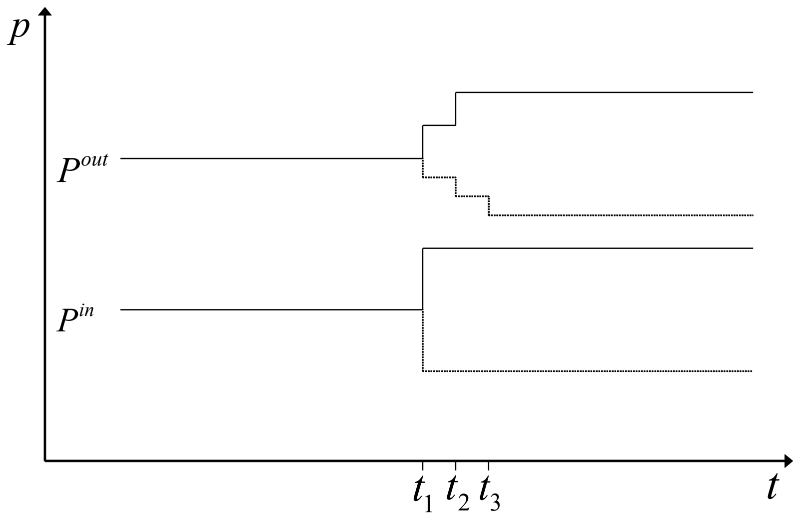

Figure 3 – Asymmetric price transmission – combination

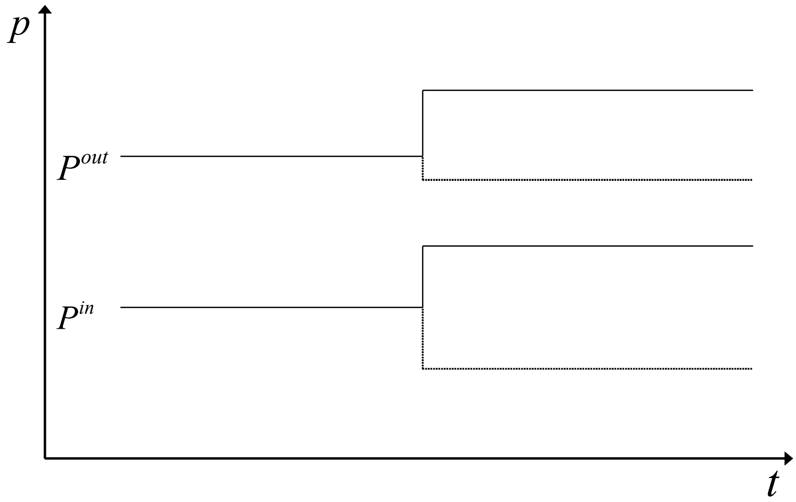

Figure 4 – Positive asymmetric price transmission

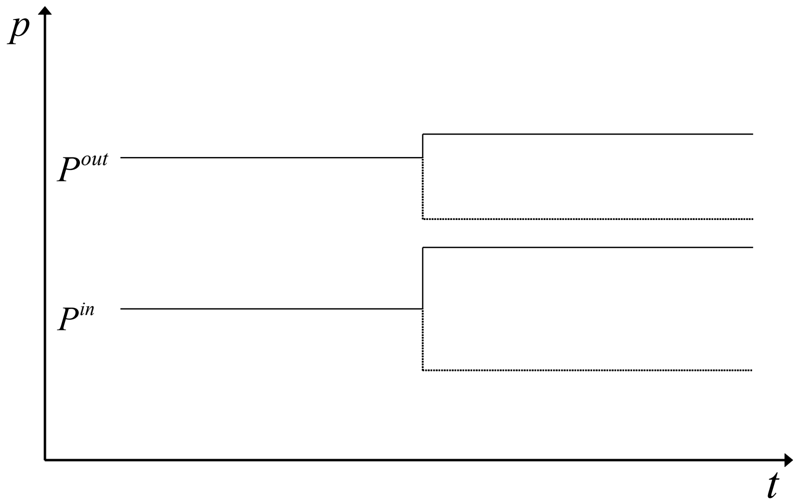

Figure 5 – Negative asymmetric price transmission

Following a convention employed by Peltzman (2000), asymmetry can be either positive or negative. If p^{out} reacts more fully or rapidly to an increase in p^{in} than to a decrease, the asymmetry is termed ‘positive’ (figure 4). Correspondingly, ‘negative’ asymmetry denotes a situation in which p^{out} reacts more fully or rapidly to a decrease in p^{in} than to an increase (figure 5). This convention can be misleading if interpreted in a normative fashion; if p^{in} and p^{out} represent farm and retail prices for a commodity, respectively, ‘negative’ asymmetry is ‘good’ for the consumer, while ‘positive’ asymmetry is ‘bad’.

2.1.2 What causes asymmetric price transmission?

Market power: The vast majority of publications on the topic of asymmetric price transmission include considerations of non-competitive market structures. Response of retail prices to changes in wholesale or farm-level prices is generally not instantaneous but is instead distributed over time. It is therefore commonly asserted, in the agriculture sector in particular, that imperfect competition allows middlemen to make use of market power (Kinnucan and Forker, 1987). This market power is often expected to lead to positive asymmetry. Hence, it is expected that increases in input prices, which reduce marketing margins will be transmitted faster and more completely than decreases because of market power (Karrenbrock, 1991). Ward (1982) suggests that market power can lead to negative asymmetry if oligopolists are reluctant to risk losing market shares by increasing prices. On the other hand, Bailey & Brorsen (1989), consider market power leading to positive asymmetry. If a firm believes that no competitor will match a price increase but all will match a price cut, positive asymmetry will result. Otherwise, if the firm conjectures that all firms will match an increase but none will match a price cut, negative symmetry will result. Hence, it is not clear *a priori* whether market power will lead to positive or negative asymmetry (Bailey and Brorsen, 1989).

The presence of imperfect information has led Borenstein *et al.* (1997) to assume that downward stickiness of retail prices in an oligopolistic environment will lead to positive asymmetry. Assuming imperfect information about the prices charged by other firms, the old output price, after a change in the input price, offers a natural focal point. While cost increases will lead to an immediate increase in output prices, because retail margins are squeezed, cost decreases won’t lead to immediate output price decreases because firms will maintain prices above the competitive level as long as their sales remain above a threshold level (Borenstein et al., 1997).

Balke *et al.* (1998) also consider oligopolistic firms engaged in an informal collusion, rather than a cartel, to maintain higher profits. Because of the importance of reputation under such conditions, asymmetric price adjustments can arise. For example, in the presence of input price increases all firms will quickly adjust output prices upwards to signal their competitors that collusion will be maintained. However, if input prices fall, firms will wait to lower output prices to avoid signalling an undermining of the unspoken agreement.

Bedrossian and Moschos (1998) stress profitability considerations, suggesting that different levels of profitability among firms within an industry can lead to asymmetry. It is suggested that a relatively profitable firm can more easily take the risk[5] of delaying a price adjustment following a decline in input prices than a firm with lower profitability, because of higher profits.

Borenstein *et al.* (1997) propose that search costs faced by consumers lead to local monopolies that can lead, in turn, to asymmetry. A local monopoly can arise if the costs of searching for a lower price are perceived to be higher than the expected profits from a lower price. Generally speaking, such transaction costs are hard to identify and more often than not omitted in price transmission analyses.

Despite the great variety of hypothesised links between market power and asymmetry, choosing an appropriate proxy for market power still represents a major problem. It is well known that the commonly used concentration measures will be less than perfectly correlated with market power, see e.g., Capps *et al.* (1995).

Adjustment and menu costs: Another major explanation for asymmetric price transmission is provided by adjustment costs. Adjustment costs arise if a firm increases or decreases its output or the price of its product. If these costs are asymmetric with respect to an

[5] I.e., lose customers and eventually market shares

increase or a decrease in output quantities and/or prices, the adjustment will be asymmetric. In the case of price changes, adjustment costs are also called menu costs.

For the US beef market, Bailey and Brorsen (1989) show that packers, unlike feedlots, face significant fixed costs. So in the short-run, margins may be reduced to keep the plant operating. Therefore, farm prices may rise more quickly and fall more slowly, as a result of competition between different packers, i.e. negative symmetry. In contrast, Peltzman (2000) makes a case for positive asymmetry, arguing that it is easier for a firm to disemploy inputs in the case of an output reduction than it is to recruit new input to increase output. This recruitment of inputs will lead to search costs and price premium that skew the adjustment costs to the increasing phase.

Ward (1982) points out that retailers of perishable products might hesitate to raise prices for fear of reduced sales, and thus, spoilage (i.e., negative symmetry). Ward's explanation is challenged by Heien (1980). He argues that changing prices is less of a problem for perishable products than it is for those with long shelf life. For the latter higher time costs of changing prices and losses of goodwill are expected (for example the reprinting of price lists or catalogues and the cost of informing market partners).

In summary, as was the case for the explanations of asymmetry in which market power is involved, attempts to explain asymmetric price transmission using adjustments costs can lead to contradictory and ambiguous results. A difference between market power and adjustment costs could be that while both could produce asymmetries in speed of price transmission, only market power is capable of leading to long lasting asymmetries in the magnitude of adjustment to positive and negative input price shocks. Furthermore, as argued by Bailey and Brorsen (1989), adjustment costs probably do not vary by location, so spatial asymmetric price transmission is unlikely to be caused by adjustment costs.

A number of additional explanations for asymmetric price transmission have been proposed. Especially in agriculture, price support, often in the form of floor prices, is quite common. Kinnucan and Forker (1987) argue that such political intervention can lead to asymmetric price adjustment. If it leads wholesalers or retailers to believe that a reduction in farm prices will only be temporary, it will trigger government intervention, while an increase in farm prices is more likely to be permanent.

Kinnucan & Forker (1987) mention the potential of asymmetric price transmission in the marketing margin model developed by Gardner (1975). In this model, the farm-level price spread depends on shifts in retail-level demand and shifts in farm-level supply. Gardner deduces a stronger impact of retail-level demand shifts than of farm-level supply shifts. Hence, an asymmetric distribution of either demand or supply shifts would also lead to observable asymmetric price transmission.

Bailey and Brorsen (1989) show that asymmetric price adjustment can arise due to asymmetric information. If larger firms benefit from economies of scale in information gathering, asymmetric information between competing firms is the result. The authors also point out that asymmetries in price series data can be the result of a distorted price reporting process.

Inventory management is sometimes proposed as a possible cause of asymmetric price transmission. Reagan and Weitzman (1982) argue that in periods of low demand firms will adjust produced quantity and increase inventory rather than decrease output prices. In periods of high demand, on the other hand, firms will increase prices. In combination with asymmetric perceived costs of low and high inventory stocks, because of the fear of a stock out, this would lead to positive asymmetry.

While this list of potential explanations for asymmetry is probably not exhaustive, the general impression is of a bouquet of often-casual explanations, with each being able to produce a wide range of asymmetric price transmission.

2.2 Mark-up

Following the notion cited in Carman (1997), mark-up is also referred to in the literature as vertical price spreads and marketing margins. For many years, social and political institutions have been concerned about food price behaviour, and, as a consequence, the behaviour of marketing margins, which have been used as an index of economic efficiency, bargaining power and market transparency, among other things. The term *marketing margin* refers to the part of the consumer's food expenditure which is absorbed by the food-marketing sector. Thus, marketing costs are distinguished from production costs. The point of division is typically defined as the farm-gate. Expenses occurring before the farm-gate are production costs, while expenses occurring beyond the farm-gate are marketing costs (Briz and de Felipe, 1997). In primitive economies where producers and consumers deal directly with one another, the market equilibrium is determined by producers receiving the same price as is paid by consumers. But in modern economies, which are based upon specialization of labour, marketing systems have developed. The middlemen in the marketing agencies typically operate under conditions that are considerably less than competitive. The crux of the discussion at this point is that the providers of marketing services must receive some compensation (or some margin of payment) if those services are to be available.

According to Goodwin (1994), an agricultural marketing system typically performs three basic functions: concentration, equalization and dispersion. The initial marketing function, concentration, pulls together a volume of product sufficient for the other two functions to be efficiently performed. Examples of marketing businesses that the function of concentration would include fish auction markets and slaughter processing units.
Once the function of concentration has been accomplished, the function of equalization can begin. Some of the equalizing activities performed by the agricultural marketing system include sorting, grading, processing and packaging. Examples of marketing businesses that engage in equalizing activities include filet production fish packing, canning and freezing. Upon completion of the equalization function, the agricultural marketing function of dispersion may be undertaken. This function includes activities such as transportation, warehousing, wholesaling and retailing.

Probably the easiest type of marketing margin to understand is the constant cost per unit marketing margin. This marketing margin tends to add a constant monetary value per unit of product to the price received by the basic producer. This constant cost per unit type of marketing margin is fairly typical, for example, for fresh fruits and vegetables. One of the reasons for the existence of the constant cost per unit type of marketing margin is that the vast majority of the costs faced by the marketing agencies tend to be variable costs. The major costs for marketing fresh fruits and vegetables, for example, are harvesting labour, grading and sorting labour, packaging materials, and transportation, all of which vary almost perfectly with the volume of product handled. Thus, in the cost structure for marketing with respect to average variable costs and average total costs, the two would be almost identical. Marginal costs likewise would follow a similar pattern, implying that each added unit of product marketed would add essentially a constant amount to the total marketing cost.

Another type of marketing margin is the constant percentage of retail price. This type of marketing margin is fairly typical for products for which the marketing process involves very large fixed investments and substantial economies of scale. An example of the constant percentage marketing margin is provided by dairy products. Some studies have shown that direct-cost pricing (mark-up coefficient on raw fish) is a common practise in the fish industry (Guillotreau and Le Grel, 2001).

There is also the increasing cost per unit type of marketing margin, which is fairly typical for products for which marketing firms face significant levels of fixed investment costs, but have substantial variable costs as well. While economies of scale may be available, most of these scale economies are realized at relatively low level of output. Meat products, and in particular the fresh meat products, tend to exhibit increasing cost per unit marketing margins. Under these circumstances, marketing firms will not process products unless the price spread is sufficient to cover the cost of handling the final unit of product (Goodwin, 1994).

It is important to stress that marketing margins are not purely profit earned by wholesalers and retailers, but also take into account marketing costs, i.e. costs beyond farm-gate. Mark-up is closely related to price transmission, which I have previously discussed, and the fact that margins can vary imperfectly at the different market levels is often caused by asymmetry. Relative changes in marketing margins are not solely caused by the profit maximization incentive of middlemen. The cost of transportation is an important contributor to variations in marketing margins. In the case of this study, the product is being transported between each stage in the distribution chain; hence transportation costs are added all the way. Salmon going from Norway to France also face different currencies, and the bilateral exchange rate between the two countries is also likely to influence the margins. I will discuss this aspect more thoroughly in the next section of this chapter. The mathematical approach to a mark-up rule can be given by applying eq. (1) from this chapter.

2.3 Exchange rates

When a commodity is traded internationally currency exchange rates may be a considerable source of alteration of the market equilibrium. Depending on your point of view, a change in the currency exchange rate will influence either the demand curve or the supply curve. For the supplier, who sees the world through his own currency exchange rate, a change in the currency exchange rate will be manifested in a shift in the demand of the commodity supplied. Conversely, a change in the currency exchange rate for the demander will be manifested as a shift in the supply. Houck (1986) defines exchange rates among international currencies as the prices of one nation’s money in terms of other currencies. Thus, domestic conditions like prices, costs, inflation, and other values for goods and services are reflected onto the international scene.

The impact of relative changes in the currency exchange rates will be one of the aspects scrutinized in this study. To understand the rudimentary dynamics of currency exchange rates I have adopted an approach on this topic based on Houck (1986).

Consider two trading nations, A and B, with monetary separate units, called alphas (α) and betas (β) respectively. Let us now investigate how shifting currency exchange rates affect a partial equilibrium analysis in an imaginary international commodity market. Our focal point will be Nation A, with the currency α, who is a net exporter of product *q*. Correspondingly; Nation B will be a net importer of product *q*.

First, consider the demand curve (figure 6) and the following effect of devaluation, that is, a weakening relative to another currency so that one may buy fewer units of the other currency with the same nominal amount. A devaluation of α from the supplier's point of view will be followed by a shift in the demand curve from D_B^0 to D_B^1 as shown in figure 6. Consequently, a revaluation, which is a strengthening relative to another currency so that one may buy more units of the other currency with the same nominal amount, will be followed by a shift in the demand curve from D_B^0 to D_B^2.

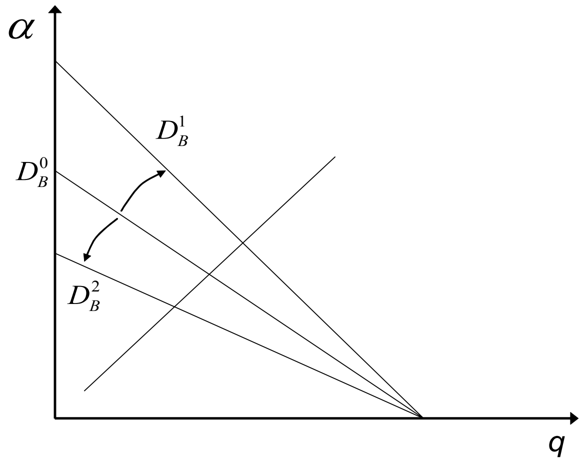

Figure 6 – Demand curve adjustments

The consequence of a devaluation of α is in fact that more alphas can be purchased with the same nominal amount of betas. Hence, Nation B by using the same amount of β can after the devaluation buy more units of product *q* as demand increases. Oppositely, when the α revaluates fewer alphas can be purchased for a given amount of betas and the demand for *q* measured in alphas will decrease. Thus, we see that exchange rates adjustments affect trade and prices, here expressed as shifts in the demand curve for product *q*.

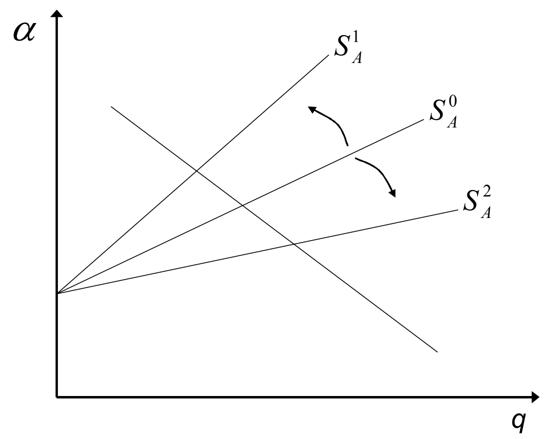

Figure 7 – Supply curve adjustments

Turning to the supply curve (figure 7) and the demander's viewpoint, the effect when α devaluates is that the α can be purchased for fewer units of the demander's β. From equilibrium, S_A^0, this shift is indicated in the figure as a rotation to S_A^1. Contrarily, a revaluation would make the supply shift from equilibrium to S_A^2.

According to Houck (1986) currency exchange rates adjustments can have real economical implications. For example, from 1996 the British pound revalued considerably relative to NOK, and the pound also revalued relative to EUR (i.e., NOK/GBP +25 % and NOK/EUR +20 %). For Scottish salmon exporters the consequences of this revaluation would be similar to that of an introduction of a 20 % export tariff on the salmon export to the European Union. Moreover, a depreciation of NOK or an appreciation of EUR could make the minimum price of the SA binding. Correspondingly, an appreciation of NOK or a depreciation of the EUR could nullify the effect of a minimum price.

Thus, the impact of fluctuating exchange rates can have serious price effects in the international marketplace. Moreover, recent analyses suggest world salmon markets are highly integrated (Asche et al., 1999; Asche, 2001), which would support the assumption underlying the model that international price transmission (i.e., the exchange rate transmission elasticity) is incomplete.

With the foregoing in mind and remembering equation (1), which states that the price of a commodity in one geographical market is equal to the price in another geographical market and the cost of transportation. This equation must be extended to account for the influence of different currencies, and we get the following:

(2) $$P_x = \left(P_d + C_{xd}\right) Z_{dx}$$

Where P_x is the price given in β, P_d the price given in α, Z_{dx} is the currency exchange rate between α and β, and C_{xd} is the transportation costs expressed in α. Thus, equation 2 expresses the price in Nation X (the country exported to) given in the β currency. The bilateral currency exchange rate Z_{dx} adjust the variables expressed in α so that the equation is corrected for the exchange rate differences that otherwise would apply.

3 Data

In this chapter I will describe my data set and how I went forth to collect it.

3.1 Collection

In order to measure the price transmission on salmon, the exchange rate and transportation elasticities, I had to collect the data from several sources. Monthly time series data from January 1995 to December 2006 was used for econometric analyses. I have collected salmon farmer prices from Fiskerinæringens Landsforening (FNL), wholesale prices from Norwegian Seafood Export Council (NSEC), retail prices from Institut Nationale de la Statistique et des Etudes Economiques – France (INSEE) (through Statistisk Sentralbyrå, SSB), exchange rates from http://pacific.commerce.ubc.ca/xr/data.html and transportation data was obtained from Transportøkonomisk Institutt (TØI) (again through SSB).

The data on salmon farmer prices was provided by FNL. The data set gives information on the amount and price of slaughtered salmon, distributed on the various weight classes for any given week, measured in headed and gutted weight (product weight). Due to the unavailability of monthly data in the period from January to December 1995, I used weekly averages to obtain the monthly data. Also, given the fact that the data provided were divided into weight classes I used a weighted average to obtain one observation for a given week. In addition, for the earlier part of the set, 1995 more specifically, I had to punch data from a paper copy.

As for the wholesale data set provided by NSEC, the processing went much smoother due to the well-known format in which it was presented. The data set supplies monthly prices on the Norwegian salmon exported to France (free on board, FOB) as they are reported to SSB. The wholesale prices used are for headed and gutted salmon.

Many thanks to the Library at SSB where I got data on salmon retail prices sold in France collected by INSEE. The data set, “Indice des Prix a la Consommation”, is an index on various salmon products sold at French hyper- and supermarkets. The French salmon data series was modified by splicing two price indexes[6]

3.2 Description

The success of any econometric analysis ultimately depends on the availability of the appropriate data. I will therefore spend some time discussing the nature of my data. Three types of data may be available for empirical analysis, time series, cross sectional and pooled (combination of time series and cross sectional) data. Table 1 shows summary statistics for the time series data used in my thesis.

Table 1 – Summary statistics for variables used

NAME	N	MEAN	ST. DEV	VARIANCE	MIN.	MAX.
FNL (P_1)	144	24.67	4.67	21.80	15.60	43.25
EFF (P_2)	144	27.34	3.80	14.43	19.35	41.14
IPC$(P_{3,EUR})$	144	7.75	0.69	0.47	6.55	10.25
IPC$(P_{3,NOK})$	144	62.78	5.94	35.34	53.47	84.95
TRA	144	112.69	10.39	107.87	97.10	133.00
NOK_EUR	144	8.10	0.29	0.09	7.29	8.94
EUR_NOK	144	0.12	0.00	0.00	0.11	0.14

Key: Transportation costs = TRA, Norwegian kroner NOK / EUR = NOK _EUR and EUR / NOK = EUR_NOK. For practical purposes the IPC$(P_{3,EUR})$ was converted to yield IPC$(P_{3,NOK})$. I.e., all the variables are given in NOK.

3.2.1 Type of data

A time series is a set of observations on the values that a variable takes at different times. Such data may be collected at regular time intervals, such as daily (e.g., stock prices),

[6] See e.g. http://shazam.econ.ubc.ca/examples/splice.sha for more information on this procedure.

weekly (e.g., salmon prices provided by NSEC), monthly (e.g., unemployment rate, the Consumer Price Index), quarterly (e.g., GNP) or annually (e.g., government budgets). The data thus collected may be quantitative (e.g., income, prices, money, wages) or qualitative (e.g., male or female, college graduate or not). Qualitative variables, also called dummy variables or categorical variables, can be every bit as important as the quantitative variables (Gujarati, 1995).

Although time series data are used in many econometric studies, they present some special problems for econometricians. Most empirical work based on time series data assumes that the underlying data is stationary. Loosely speaking a time series is stationary if its mean value and its variance do not vary systematically over time. Another problem frequently encountered in time series data is autocorrelation among the disturbances u_i entering into the population regression function. In the classical linear regression model (CLRM) no autocorrelation is one the underlying assumptions. Put simply, the CLRM assumes that the disturbance term relating to any other observation is not influenced by the disturbance term relating to any other observation (Gujarati, 1995, p. 401).

3.2.2 The sources of data

The data used in empirical analysis may be collected by a government agency (e.g., the Department of Commerce), an international agency (e.g., the IMF or the OECD), a private organization (e.g., FNL), or an individual. The data collected by these agencies may be experimental or non-experimental in nature. In the social sciences the data that one generally obtains are non-experimental in nature, that is, not subject to the control of the researcher. Often, this lack of control often creates special problems for the researcher in pinning down the exact cause or causes affecting a particular situation.

3.2.3 The accuracy of data

Although plenty of data are available for econometric research, the quality of the data is often not that good. There are several reasons for that. First, as noted, most social science data are non-experimental in nature. Therefore, there is the possibility of observational errors, either of omission or commission. Second, even in experimentally collected data errors of measurement arise from approximations and round offs. Third, in questionnaire-type surveys, the problem of non-response can be serious. A researcher

can be lucky to get a 40 % response to a questionnaire. Analysis based on such partial response may not truly reflect the behaviour of the 60 % who did not respond, thereby leading to what is known as (sample) selectivity bias. Fourth, the sampling methods used in obtaining the data may vary so widely that is often difficult to compare the results obtained from the various samples. Fifth, economic data are generally available at a highly aggregate level. Such highly aggregated data may not tell us much about the individual or micro units that may be the ultimate object of the study. Sixth, because of confidentiality, certain data can be published only in highly aggregate form. The FNL, for example, is not allowed to disclose data from an individual county if there are three or less farmers reporting slaughtered volume of salmon.
Because of these and many other problems, the researcher should always keep in mind that the results of research are only as good as the quality of the data.

Finally, I conclude that my data set is a time series; it is of a quantitative nature; it is collected by various private, governmental and national agencies and it is of a non-experimental nature.

3.3 Norwegian salmon production

The EU salmon market, and the French one in particular, is Norway's most important market. France is followed by Denmark (although it is largely a transit country for Norwegian seafood on its way to the EU), Poland, Great Britain and Russia. Norwegian export of Atlantic salmon to the most important markets is shown in figure 8. On the global market Atlantic salmon (*Salmo salar)* has traditionally obtained higher prices than the Pacific species (*Onchorynchus* spp., i.e., Sockeye, Coho, Chinook, Chum and Pink), even though the latter are available in larger quantities. In fact, in 1982, 80 % of the French import originated from the wild-caught Pacific species (Guillotreau *et al.*, 2005). Sea-raised rainbow trout is also considered as a substitute to salmon in some markets, Japan in particular. In 1997 the production of farmed salmon worldwide exceeded the catch of wild salmon. The scenario remains the same today; the increase in the global salmon output is provided by farmed salmon. Norwegian production of Atlantic salmon has risen from 74 879 tons round weight in 1988 to 572 000 tons in 2006, as can be seen in figure

9. In 2006 Norwegian salmon revenues surpassed 17 billion NOK, which is a new record for the salmon industry (Tall og fakta, 2006).

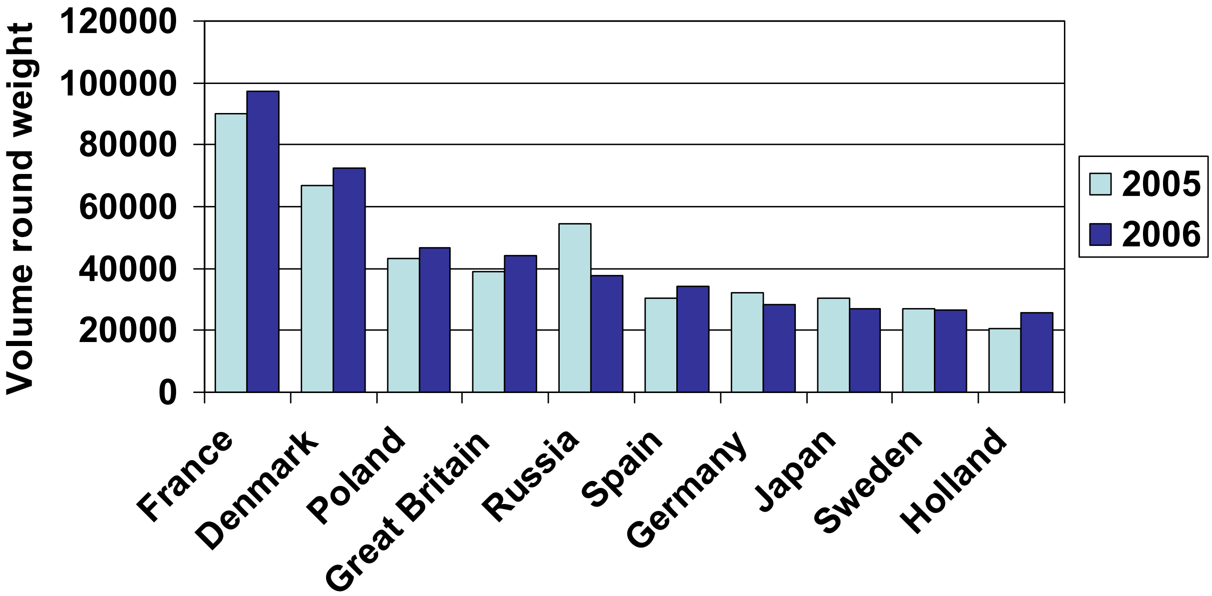

Figure 8 – Norwegian export of Atlantic salmon – by market
(Source: NSEC and SSB)

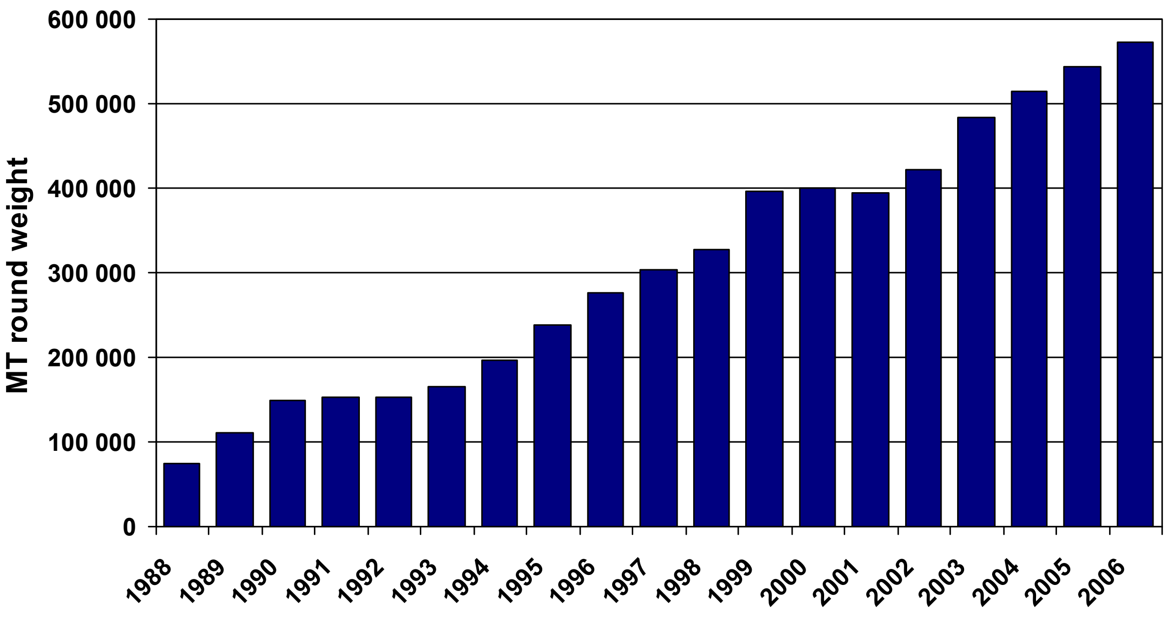

Figure 9 – Norwegian export of Atlantic salmon 1988-2006
(Source: NSEC and SSB)

On the international scene Norway produced 572 000 tons of Atlantic salmon in 2005, which is 46 % of the world production of 1.2 billion. Norway was followed by Chile (31 %), Great Britain (10 %) and North America (9 %). The most important Atlantic salmon producing countries are shown in figure 10.

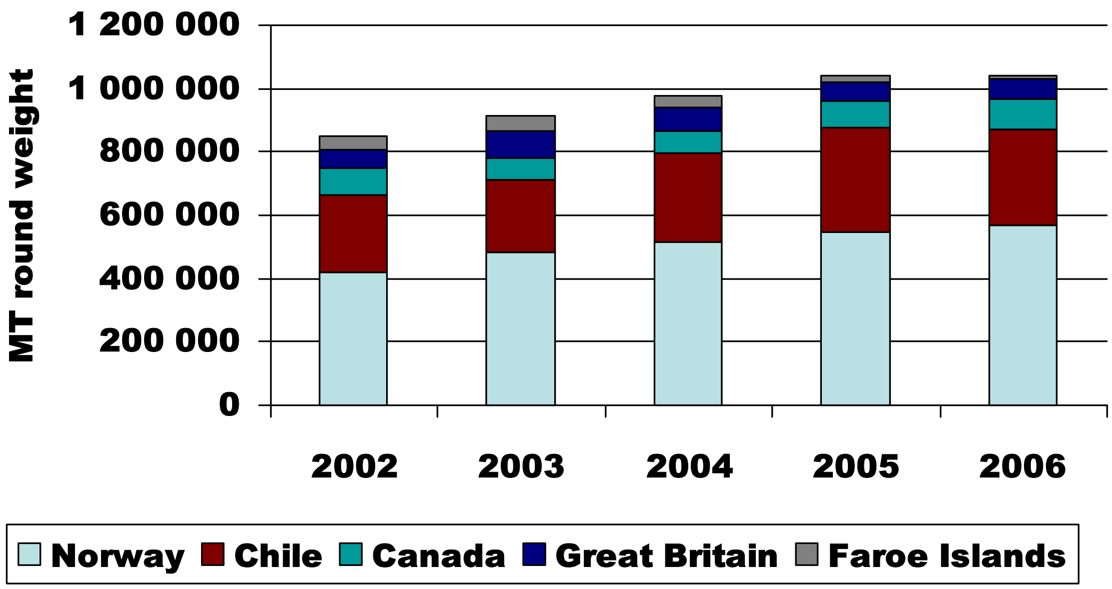

Figure 10 – Top 5 exporters of Atlantic salmon worldwide
(Source: NSEC)

3.4 The French market

In the French market for Atlantic salmon Norway is the market leader with 55 %. Fresh salmon is the most eaten fish product in France both in value and volume. Norway's market share for fresh salmon is 68 %. Approximately half of the French salmon consumption is smoked salmon; the other half is fresh salmon. Norwegian export to France was ~89000 tons round weight in 2005, and Norway is one of few European suppliers who are able to deliver fresh salmon in large quantities. Hyper- and supermarkets in France controls 84 % of the turnover of fresh salmon, and 94 % of the smoked salmon turnover (Markedsplan Laks og Ørret 2007-2009, 2007).

Figure 11 shows Norway's export of fresh salmon to France from January 1995 to December 2006. There clearly is a trend throughout the period in which the volume sold increases in the months September to December. The volume usually culminates in

December, which of course corresponds with Christmas. Empirically, the lowest observation for volume is 1 780 tons in January 1996, while the highest observation is 9 177 tons in December 2006. As for the wholesale price, the lowest one obtained was 19.35 NOK/kg in July 2003, while the highest price obtained for the period was 41.14 NOK/kg in June 2006. Clearly, for the duration of the period from 1995 to 2006, the substantial increase in salmon prices that started in late 2005, culminated in a series of record high prices in 2006. The trend with soaring prices coincides with the world salmon prices. The average salmon price in 2005 was 26,58 NOK/kg and 31,86 NOK/kg in 2006. NSEC points out that the global increase in salmon prices is caused by an increase in the global demand, while there has been a standstill in the global supply (Aandahl, 2007).

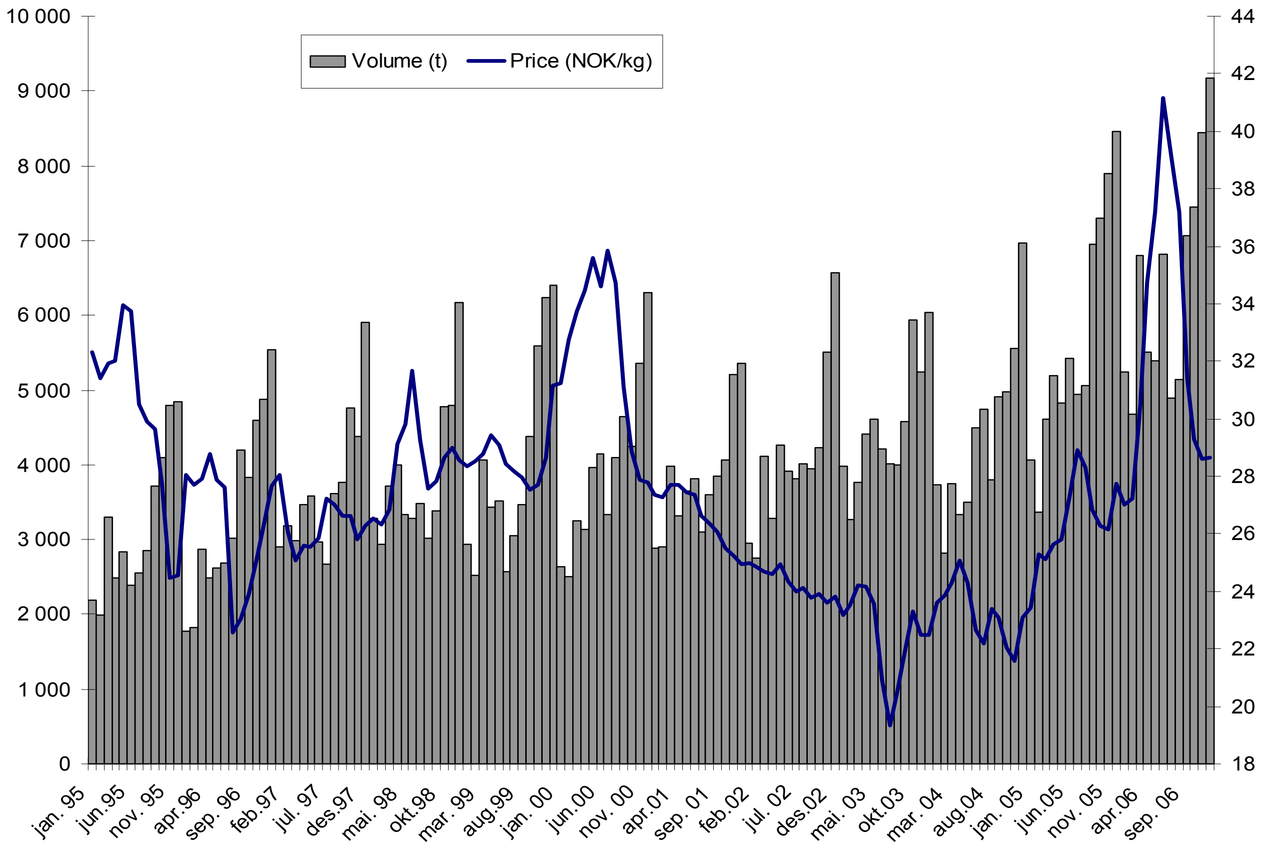

Figure 11 – Norwegian exports of fresh salmon to France 1995-2006

(Source: NSEC and SSB)

3.5 Historical review of prices and margins

Retail prices of salmon did fall from 1995 to mid-1997, after which they have been relatively constant around 63 NOK/kg on a live weight basis. The wholesale and slaughter prices however, have been relatively constant, around 27 NOK/kg and 25 NOK/kg respectively[7] (Figure 12).

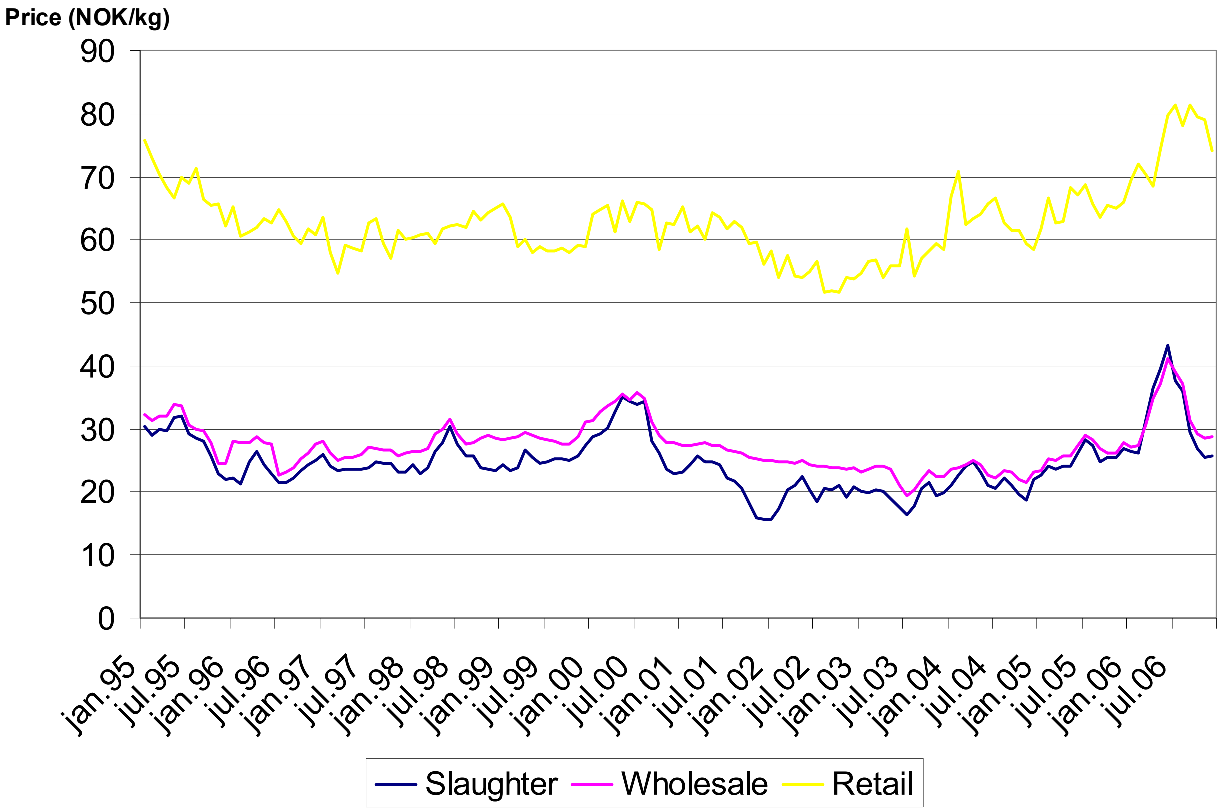

Figure 12 – Salmon prices at slaughter, wholesale and retail levels 1995-2006

(Source: INSEE, NSEC and FNL)

To help identify the source of the increase in this margin over time, the slaughter-to-retail price margin can be decomposed into the slaughter-to-wholesale margin and the wholesale-to-retail margin. Compared to the wholesale-to-retail spread, the slaughter-to-wholesale spread for salmon has been relatively constant throughout the period from 1995 to 2006. There was a high of 9.4 NOK/kg in early 2002 and a low of – 2.2[8] NOK/kg in the spring of 2006. However, at the end the period the spread recovered to nearly 3

[7] Exact mean values are slaughter (FNL) = 24.67, wholesale (EFF) = 27.40 and retail (IPC) = 62.78 with 144 observations.

NOK/kg (Figure 13). Over the same 1995-2006 period, the wholesale-to-retail price margin for salmon has decreased markedly, from a high of about 50.5 NOK/kg in November 2006 to a low of 26.8 NOK/kg in April 2000.

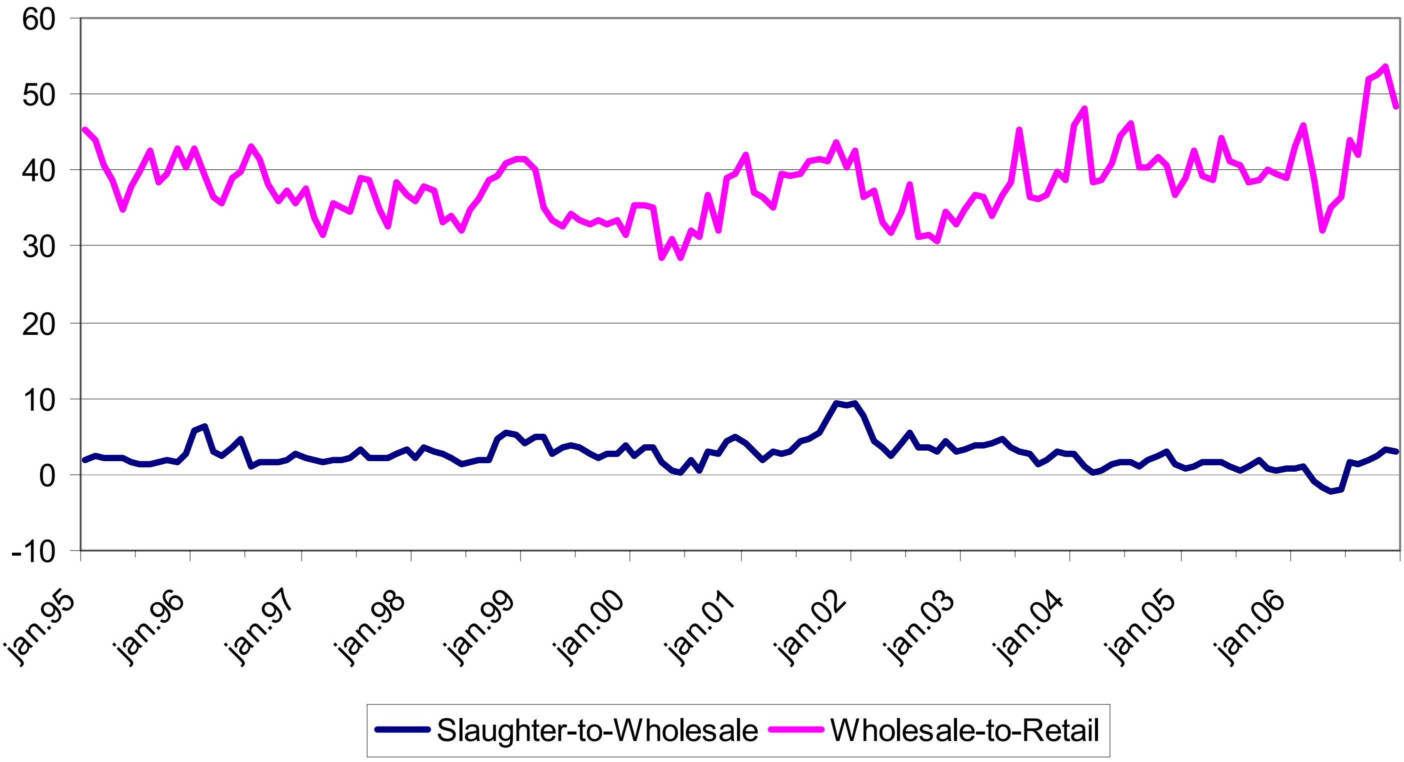

Figure 13 – Salmon marketing margins 1995-2006

(Source: INSEE, NSEC and FNL)

On the basis of the slaughter-to-wholesale and the wholesale-to-retail margins, the retailer and wholesaler segments receive the lion's share of the salmon krone as exhibited in figure 14. The figure is based on annual mean values, in contrast to the monthly data shown in figures 11 through 13. Sector shares were found by using the slaughter price, slaughter-to-wholesale and wholesale-to-retail margins relative to the retail price in France.

[8] The slaughter level prices were higher than the prices at the wholesale level from March to June 2006.

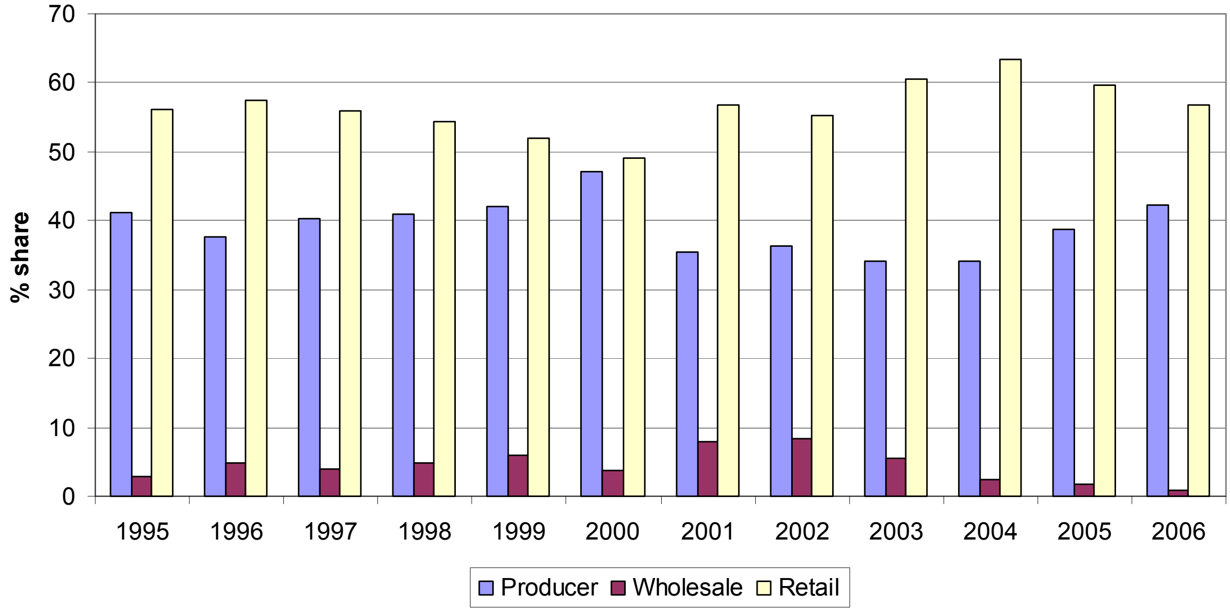

Figure 14 – Sector shares of the retail salmon krone

(Source: INSEE, NSEC and FNL)

4 Methodology and Procedure

In this chapter I will describe the procedure on structural models for price transmission and the model for testing for asymmetric price transmission. I will also specify the four operational functions used, and finally a note on the interpretation of the results is included.

4.1 A brief historical review

Before proceeding with the procedure behind the applied models, I will present a brief review of the development of the estimation of asymmetric price adjustments. Farrel (1952) investigated irreversibility empirically, the scope of his analysis was irreversible demand functions. In agricultural economics the price transmission process was scrutinized by Tweeten and Quance (1969) by adapting a dummy variable approach to estimate irreversible supply functions. Wolffram (1971) criticized this model, and instead introduced a variable splitting approach involving first differences in the estimated equation. Wolffram's model was improved by Gollnick (1972), which according to Meyer and von Cramon-Taubadel (2002a), simplified the test for asymmetric price transmission. In 1977 Houck presented a model based on and further developed from the framework of Wolffram, but which in essence was more operationally clearer. Ward (1982) elaborated Houck's model to include lags of exogenous variables, and over the last two decades Ward's approach has by far been the basis of most of the work in the price transmission field. Of late however, various other models for testing for asymmetry have gained support and claimed to be more appropriate under certain circumstances. Specifically, Von Cramon-Taubadel and Loy (1999) presented an asymmetric error correction model based on Granger and Lee (1989). The model can be used to test for asymmetric price transmissions and is more appropriate if the data in question contains a unit root. Finally, Abdulai and Rieder (1999), and Goodwin and Harper (2000) both used a threshold autoregressive test for unity roots to test for the presence of asymmetric price transmission.

4.2 Procedure on the structural model

A mathematical approach to the formulation of a model, which describes how the price in one price level of the value chain is affected by the price in another price level, can be written as $P_x = f(p_d)$. The empirical data I have collected for this model is the salmon farmer level price, the export level price to France and the consumption level price at supermarkets in France. I also have time series data on currency exchange rates and on transportation costs. Because the price series data presented in this thesis are functions of the same basic information, the series must be related. For simplicity, imagine a situation where the export level price to France, P_x is explained by the salmon farm level price in Norway, p_d;

(3) $$P_x = f(p_d)$$

However, the consumption level price in France, P_x, is a gross price that includes transportation, tariffs and other international marketing costs (Kinnucan and Myrland, 2001). In this study I have included the relative impact on P_x by some other factors: The cost of transportation, the bilateral currency exchange rate (EUR/NOK and NOK/EUR) and a dummy variable correcting for the Salmon Agreement. Thus the conceptual framework of this thesis is as follows:

$$P = f\begin{pmatrix} \textit{time, price at other level in the value chain, currency exchange rate,} \\ \textit{cost of transportation and impact of the Salmon Agreement} \end{pmatrix}$$

Following the model proposed by Kinnucan and Myrland (2001) and by Paudel (2002), I posit a simple mark-up rule as follows:

(4) $$P_x = \left(p_d + c_d\right)Z$$

Where *x* indexes the export market; P_x is the foreign market price for salmon expressed in the foreign currency (EUR); P_d is the domestic price of salmon expressed in domestic currency (NOK); c_d is the transportation cost expressed in domestic currency; and Z

(= EUR/NOK) is the bilateral exchange rate. [9]Taking the total differential of equation (4) yields:

(5) $$d\ P_x = Z_x d\ p_d + p_d d\ Z + d\ C_d$$

Where $C_d = c_d Z$ is the cost of transportation expressed in foreign currency (EUR). Dividing the above equation through by P_x, and noting that $P_x = p_x Z$ where p_d is the *domestic* currency (NOK), yields:

(6) $$d\ P_x / P_x = \left(p_d / p_x\right) d\ p_d / p_d + \left(p_d / p_x\right) d\ Z / Z + \left(c_d / p_x\right) d\ C_d / C_d$$

which may be simplified to yield:

(7) $$P_x{*} = \beta_0 p_d{*} + \beta_1 Z{*} + \beta_2 C_d{*}$$

where asterisked variables indicate relative changes, so that $P_d{*} = d\ P_d / P_d$, and $\beta_0 = \beta_1 < 1$. Which means the mark-up model in equation (4) implies that the price transmission and currency exchange rate-elasticities are equal and less than one. However, there is also a restriction on the transportation cost-elasticity, β_2. More specifically, from equation (4) we have:

$$P_x / Z = p_x = p_d + c_d$$

which implies that $c_d = p_x - p_d$. Thus, from equation (6) it follows immediately that $\beta_2 = \left(1 - \beta_0\right)$, i.e. the transportation cost-elasticity equals one minus the price transmission cost elasticity, or simply that $\beta_0 + \beta_2 = 1$. The restriction could be tested in the estimated models; however such tests are outside the scope of this thesis and will therefore not be investigated.

[9] Prices and currency exchange rates are expressed in nominal terms. Thus, I implicitly assume that inflation rates the two countries in question are approximately the same.

Thus, the specified empirical model yields:

(8) $$P_{x,t} = \beta_0 + \beta_1 p_{d,t} + \beta_2 Z_t + \beta_3 C_{d,t} + \beta_4 SA_t + u_{x,t}$$

Where t indexes the observation $\left(t = 2,3,...,144 \text{ for January 1995 through December 2006}\right)$; SA is a dummy variable (SA= 0 in the period running from July 1997 to May 2003, and 1 otherwise) to indicate the effect of the export tax specified in the Salmon Agreement on export prices to the EU; and $u_{x,t}$ is a stochastic disturbance term, which may well represent all those factors that affect the foreign market price for salmon but are not taken into account explicitly (Gujarati, 1995, p. 5).

By incorporating the SA in the model we can test whether the agreement influenced the market mechanisms. The null-hypothesis is that the export tax and the minimum price restrictions implemented by the SA had an impact on the price mechanism.

4.3 Procedure on the asymmetric model

The next step in this study will be to investigate the existence of asymmetry in the value chain of Norwegian salmon exported to France. To check whether there exists asymmetry in the price mechanism, I will apply a model developed by Houck (1977). Houck's basis was the model developed by Wolffram (1971), which dealt with nonreversibilities through segmenting the variables. By simplifying the specification of linear nonreversibilities Houck's approach is de facto operationally easier to run.

In the model he imagined that the variable Y depends upon the values taken by X and that both are time-series variables. The hypothesis he examined is that a one-unit increase in X from period to period have a different absolute impact on Y than do a one-unit decrease in X.

The relationship can be written as:

(9) $$\Delta Y_i = \alpha_0 + \alpha_1 \Delta X_i^{POS} + \alpha_2 \Delta X_i^{NEG}$$

for $i = 1,2,...,t$ where $\Delta Y_i = Y_i - Y_{i\text{-}1}$; $\Delta X_i^{POS} = X_i - X_{i-t}$ if $X_i > X_{i-t}$ and $= 0$ otherwise; $\Delta X_i^{NEG} = X_i - X_{i-t}$ if $X_i < X_{i-t}$ and $= 0$ otherwise; X_0 is the initial value of X; and Y_0 is the initial value of Y. α_0 might be zero, positive or negative. A nonreversibility occurs in ΔY if $\alpha_1 \neq \alpha_2$. To link equation (9) to the initial position, note that the value of Y at any point t is:

(10) $$Y_t = Y_0 + \sum_{i=1}^{t} \Delta Y_i$$

for $i = 1,2,...,t,t+1,...,T$, where T is the total number of observations beyond the initial value. The difference between the current and the initial value of Y is the sum of the period-to-period changes that have occurred, so that:

(11) $$Y_t - Y_0 = \sum_{i=1}^{t} \Delta Y_i$$

by inserting equation (9) into equation (11) and simplifying, gives:

(12) $$Y_t - Y_0 = \alpha_0 t + \alpha_1 \left(\sum \Delta X_i^{POS} \right) + \alpha_2 \left(\sum \Delta X_i^{NEG} \right)$$

Letting Y_t^*, R_t^{POS} and D_t^{NEG} equal $Y_t - Y_0$, $\sum \Delta X_i^{POS}$, and $\sum \Delta X_i^{NEG}$, respectively,

(13) $$Y_t^* = \alpha_0 t + \alpha_1 R_t^{POS} + \alpha_2 D_t^{NEG}$$

where R_t^{POS} is the sum of all period-to-period increases in X from its initial value up to period t, and D_t^{NEG} is the similar sum of all period-to-period decreases in X. The variable R^{POS} is always positive, and D^{NEG} is always negative. If α_0 is not zero, it appears in equation (13) as a trend coefficient. In the case where a consumption level price response to changes in the export level price is equal (or symmetric) for both price decreases and increases, then $\alpha_1 = \alpha_2$. Methodically this can be expressed as follows:

$$H_0 : \alpha_1 = \alpha_2 \qquad \text{(symmetric price transmission)}$$
$$H_1 : \alpha_1 \neq \alpha_2 \qquad \text{(asymmetric price transmission)}$$

Thus, if α_1 differ significantly from α_2 there is evidence of asymmetric price transmission.

4.4 Procedure on the operational models

Equation (8) is the general model in this study, but it will to some degree differ depending on which estimations I run. A brief description of the various specified operational models is described in the following. For simplification purposes the specified models will employ simpler and more specific variable names than the one outlined in the specified empirical model. Thus, table 2 is an overview of all variables used in the analyses, along with a brief definition.

Table 2 – Overview of data and variable values

Variable	Definition	Value / Mean
FNL = P_1 EFF = P_2 IPC = P_3		
$P_{1,t}$	Farm level price at time t (NOK)	24.67
$P_{1,t-1}$	Farm level price lagged one period	
$P_{2,t}$	Export level price to France at time t (NOK)	27.34
$P_{2,t-1}$	Export level price to France lagged one period	
$P_{3,t}$	Consumption level price in France at time t (EUR)	7.75
C_t	Cost of transportation at time t (NOK)	112.69
$Z_{NOK/EUR,\,t}$	Currency exchange rate at time t (NOK/EUR)	8.10
$Z_{EUR/NOK,\,t}$	Currency exchange rate at time t (EUR/NOK)	0.12
D_{SA}	Dummy variable correcting for Salmon Agreement	

Note: SA from observation 31 to 101 (that is from July 1997 to May 2003). SA = 0 in the period between July 1997 and May 2003 and 1 prior to and after this period of time.*

The first estimation I will run measures the price transmission between the price at the salmon farm level and the price at the export level to France. This estimation does not involve any currency exchange rate variable as both prices are given in NOK.
Thus, the following equation will be used:

(14) $$P_{2,t} = \beta_0 + \beta_1 P_{1,t} + \beta_2 P_{1,t-1} + \beta_3 P_{1,t} SA_t + \beta_4 SA_t + u_t$$

where $P_{2,t}$ is the export level price of salmon to France at time t, $P_{1,t}$ is the Norwegian farm level price, $P_{1,t-1}$ is the Norwegian farm level price lagged one period (month), $P_{1,t}SA_t$ is a dummy variable that measures the effect of the Salmon Agreement between Norway and the EU, and u_t is a random error term.

My second estimation measures the price transmission between the export level price to France and the consumption level price at supermarkets in France. This equation also incorporates variables for cost of transportation and currency exchange rate.
My next estimation is as follows:

(15) $$P_{3,t} = \beta_0 + \beta_1 P_{2,t} + \beta_2 P_{2,t-1} + \beta_3 P_{2,t-2} + \beta_4 P_{2,t-3} + \beta_5 P_{2,t} SA_t + \beta_6 P_{2,t-1} SA_t + \beta_7 P_{2,t-2} SA_t + \beta_8 P_{2,t-3} SA_t + \beta_9 SA_t + \beta_{10} Z_{EUR/NOK,t} + \beta_{11} Z_{EUR/NOK,t} SA_t + \beta_{12} C_t + \beta_{13} C_t SA_t + u_t$$

where $P_{3,t}$ is the consumption level price in France given in NOK at time t, $P_{2,t}$ is the current export level price of salmon to France given in NOK, $P_{2,t-n}$ is the export level price of salmon to France lagged *n* periods (month), $P_{2,t}SA_t$ measures the effect of the Salmon Agreement between Norway and the EU, $P_{2,t-n}SA_t$ is the same variable lagged n periods, C_t is the transportation cost given in NOK, and Z_t is the bilateral currency exchange rate. Both the latter variables are also estimated during the duration of the SA. The conversion of all variables to Norwegian Kroner is not in accordance with the theoretical specification of the model, but nonetheless conducted for practical purposes.

As for the practical application of Houck's model in this study, I will use equation (13) in my third estimation, testing for asymmetric price transmission. Thus, the specified model for estimating how a price change at one level of the farm-retail chain is affected by positive or negative changes in the price at another level yields:

(16) $$\Delta P_{2,t} = \alpha_0 + \alpha_1 \Delta P_{1,t}^{POS} + \alpha_2 \Delta P_{1,t}^{POS} SA_t + \alpha_3 \Delta P_{1,t}^{NEG} + \alpha_4 \Delta P_{1,t}^{NEG} SA_t + \alpha_5 SA_t + u_t$$

Where ΔP^{POS} and ΔP^{NEG} indicates positive and negative price changes respectively. My null-hypothesis is that there is symmetric price transmission, and the alternative hypothesis that there is asymmetric price transmission.

The last estimation is based on a combination of equations (15) and (16), and a test of asymmetric price transmission in the export – retail linkage is conducted. This equation also incorporates variables for the SA, cost of transportation and currency exchange rate. Thus, the last estimation is as follows:

(17) $$\Delta P_{3,t} = \alpha_0 + \alpha_1 \Delta P_{2,t}^{POS} + \alpha_2 \Delta P_{2,t}^{POS} SA_t + \alpha_3 \Delta P_{2,t}^{NEG} + \alpha_4 \Delta P_{2,t}^{NEG} SA_t + \alpha_5 SA_t + \alpha_6 Z_{EUR/NOK,t} + \alpha_7 Z_{EUR/NOK,t} SA_t + \alpha_8 C_t + \alpha_9 C_t SA_t + u_t$$

4.5 Interpretation of results

Prior to running the estimations a few words on interpretation of the results is appropriate. Price transmission elasticities will be measured in the model, and will indicate how strongly shifts in the price influence the development of the price throughout the farm-retail value chain. I will also investigate to what extent the cost of transportation and exchange rate influence the price mechanism.

The results of the various tests I run in this study are presented in chapter 5. A test is a decision rule that tells us when to reject H_0 and when not to reject H_0; tests are also specified by a test statistic and a rejection region. The maximum Type I error probability of a test is called its level of significance and is denoted by α. The significance probability or

P-value of an observed test statistic is the smallest α for which this observation leads to a rejection of H_0 (Johnson and Bhattacharyya, 1996).

Consideration of the goodness of fit of the fitted regression line to a set of data is important when attempting to find out how well the sample regression line fits the data. Generally there will be some positive $\hat{u}_i$ and some negative $\hat{u}_i$, and we hope that these residuals around the regression line are as small as possible. The coefficient of determination r^2 (two-variable case) or R^2 (multiple regression) is a summary measure that tells how well the sample regression line fits the data. Verbally, R^2 measures the proportion or percentage of the total variation in Y explained by the regression model. The value of R^2 lies between 0 and1, and the latter means a perfect fit, that is $\hat{Y}_i = Y_i$ for each *i* (Gujarati, 1995). I will be using the R^2 in this thesis.

The most applied test for detecting serial correlation is that developed by statisticians Durbin and Watson. It is popularly known as the Durbin-Watson *d* statistic, and it is simply the ratio of the sum of squared differences in successive residuals to the RSS (Residual Sum of Squares). The bounds of *d* are $0 \le d \le 4$, any estimated *d* value must lie within these limits. If there is no serial correlation (of the first order), *d* is expected to be about 2. *Therefore, as a rule of thumb, if d is found to be 2 in an application, one may assume that there is no first-order autocorrelation, either positive or negative.* If there exists perfect positive correlation in the residuals, then *d* = 0, thus the closer *d* is to 0, the greater the evidence of positive serial correlation. Correspondingly, if there is perfect negative correlation among successive residuals, then *d* = 4. Hence, the closer d is to 4, the greater the evidence of negative serial correlation.

An assumption underlying this study is that of Leontief market technology, that is, capital and labour must be used in a fixed proportion. This implies that there is a production function in which no substitution between inputs is possible. Applied to the case of salmon exports this means the same processing technology and the same proportions of input are used throughout the period in question.

5 Results

5.1 Price transmission between the farm level and the export level

The first model I ran examined the relationship between the price at the export level (EFF), P_2 and at the farm level (FNL), P_1. The estimated model I used is found in equation (14), and the price transmission elasticities are presented in table 3

Table 3 – Price transmission elasticities between the farm level and the export level

Variable	Elasticity	P-value
$P_{1,t}$	0.6185	0.000
$P_{1,t-1}$	0.1030	0.003
$P_{1,t} * SA$	- 0.0986	0.000
SA	0.1190	0.000
Durbin-Watson *d*	1.7681	
R^2	0.9623	

The Durbin-Watson *d* is 1.7681, with *n* = 143 and *k'* = 4. This value is within the 0.05 level of significance with critical values d_L = 1.679 and d_U = 1.788, hence there is inconclusive evidence regarding the presence or absence of positive first-order serial correlation. The R^2 of 0.9642 indicates how much of the total variation in the dependent variable, P_2, is explained by the explanatory variables. In this case, more than 96 % of the data fits the sample regression line.

By studying table 3 one finds that the price transmission elasticity from the farm level (FNL) to the export level (EFF) is 0.7215. Stated more simply, a one percent change in the farm level price will cause the export level price to increase by less than one percent (i.e., 0.72), and the transmission of price is incomplete. Both the lagged value of the farm level price and the farm level price elasticities, 0.1030 and 0.6185 respectively, are statistically significant within a 99 % level. Thus, both farm level prices is important in the determination of prices in the lower level of the supply chain. The current farm level price has a stronger impact on the export level price than the past price at the farm level

Furthermore, an elasticity of - 0.0986 indicates that the effect of the SA reduces the export level price somewhat, and this statistic is significant. The hypothesis is that the initiation of the SA did influence the price mechanism. Even though the Salmon Agreement reduced the price transmission from 0.7215 to 0.6229 as a short-run adjustment, the influence of the SA at this level in the value chain is not very strong.

5.2 Price transmission between the export level and the retail level

The next estimation measures the relationship between the export level price and the consumer level price. This model also includes variables for transportation costs and the currency exchange rate (EUR/NOK). Function (15) was used. The price transmission elasticities are shown in table 4.

The Durbin-Watson *d* of 2.0100 indicates that the *d*-value is greater than d_U = 1.924, and there is no evidence of positive first-order autocorrelation. The goodness of fit coefficient, R^2 is 0.8788, and the model has a very good explanation of the variables.

In the overall picture the price transmission elasticity between the consumer level and the export level is 0.5473. In other words, about 55 % of the changes in the export level are transferred to the retail level. Three out of four elasticities are significant within a 5 % level, ranging from 0.18 to 0.21. The overall elasticity is weaker than the corresponding elasticity from equation (14), but is consistent with the findings of Kinnucan and Myrland (2001). The reason why it differs from equation (14) may be that there are more variables involved in this model than in the former. This model also includes the exogenous variables transportation costs and currency exchange rates. Clearly, the price mechanism is weakened as the salmon moves up the value chain, and the market mechanism seems to be more efficient in the farm-export linkage. This suggests that the market is more integrated at the lower level of the value chain than in the upper level.

The impact of the Salmon Agreement on the export level price yields an elasticity of - 0.1287, which means that under the influence of the SA the price transmission elasticity is reduced from 0.5473 to 0.4186. Two out of four elasticities are significant within a 5 % level, ranging from - 0.03 to - 0.08 By way of comparison, the relative difference is approximately the same as the one observed in the farm-export linkage in equation (14). The reduction is not very strong, but the relatively inelastic pattern from the farm-export linkage is repeated and the SA weakens the price transmission elasticity.

Table 4 – Price transmission elasticities between the export level and the retail level

Variable	Elasticity	P-value
$P_{2,t}$	0.1783	0.010
$P_{2,t-1}$	0.1836	0.045
$P_{2,t-2}$	-0.0206	0.819
$P_{2,t-3}$	0.2060	0.002
$\boldsymbol{\sum P_{2,t}}$	**0.5473**	
$P_{2,t} * SA$	-0.0803	0.041
$P_{2,t-1} * SA$	-0.0264	0.109
$P_{2,t-2} * SA$	0.0101	0.539
$P_{2,t-3} * SA$	-0.0321	0.021
$\boldsymbol{\sum P_{2,t} * SA}$	**-0.1287**	
SA	-0.2178	0.163
$Z_{EUR/NOK, t}$	-1.6477	0.000
$Z_{EUR/NOK, t} * SA$	0.4422	0.016
C_t	0.3735	0.000
$C_t * SA$	-0.1358	0.044
Durbin-Watson *d*	2.0100	
R^2	0.8788	

The currency exchange rate between EUR and NOK has a significant effect on the price at the retail price level in France within the limit of 0.01. The estimated coefficient is -1.6477, and it is by far the most influential regressor in this estimation. For the Norwegian exporter this implies a strengthened Krone and an inward shift of his excess demand curve. For the French importer revaluation of the NOK has the reverse effect, shifting the excess supply curve outward. Thus, the Norwegian exporter’s production surplus is reduced with a strengthened Krone. The result is not coherent with the findings of Kinnucan and Myrland (2001). However, during the SA the currency exchange rate elasticity is 0.4422, and it is significant within the 0.05 limit. This suggests that the currency exchange rate elasticity weakened the Krone during the SA. At any rate results show that both elasticities strongly influence the price mechanism at this level of the value chain, even though the elasticity outside the SA is quite predominant.

The cost of transportation also shows significant results within the 1 % level. The effect of changes in the transportation cost gives an elasticity of 0.3735. This indicates that the transportation cost does affect the price at the retail level of the Norway-France value chain. The estimated coefficient is consistent with that of Kinnucan and Myrland (2001), only slightly lower. Furthermore it seems like the two salmon markets are well integrated and that the market mechanism is efficient with respect to transportation costs. Also, bearing in mind the results from the impact of the currency exchange rates, both exogenous variables have a strong effect of the retail price in France. Nevertheless, during the SA the cost of transportation elasticity is -0.1358, also a significant result within the 5 % level. The result indicates that during the SA, when transportation costs increased, the price transmission is reduced some.

5.3 Summary of price transmission results

A brief summary of the results from chapter 5.1 and 5.2 on the price transmission analyses follows:

- Even though I have only conducted two price transmission analyses, a general trend seems to have emerged. As the salmon moves up the value chain the estimated price transmission coefficients are weakened. The farm – export linkage is better integrated, and the price is more fully passed through at this level of the value chain than at the export – retail level.

- The influence of the SA has a significant impact on the price transmission elasticities. Although the estimated coefficients are inelastic, they all point in the same direction. The transmission is markedly reduced during the period in which the SA regulated the market. There was significant evidence of this both in the farm – export linkage and in the export-retail linkage. Thus, the SA weakened the market mechanism and obscured the price signals.

- Transportation costs do affect the price transmission elasticities estimated. There is evidence to support the claim that when the transportation costs are increased the price transmission also increases. This was the case outside the SA period of influence. During the SA, transportation cost also had a significant effect on the export – retail price transmission. When the transportation costs increase the price transmission elasticity is reduced to some extent.

- The currency exchange rate between EUR and NOK is affecting the price transmission between the export price level and the consumer level, i.e., at the retail level. The revaluation of the Norwegian Krone is a very important contributor in the price transmission at this level of the supply chain. However, during the influence of the SA the currency exchange rate elasticity is also significant, but in this period the Krone was weakened and the price transmission was increased.

5.4 Test of asymmetric price transmission in the farm – export linkage

In this chapter I will investigate whether there exists asymmetry, or imperfect price transmission in the time series. The tests were conducted following the approach adopted by Houck (1977), and explained in chapter 4.3. To sum up, a test is done to establish if an increase in the price has the same price transmission elasticity as a decrease in the price. Thus, I will be able to measure how a price change at one level in the value chain is affected by either positive or negative changes in the price at another level. Function (16) was used, and the price transmission elasticities are outlined in table 5.

Table 5 – Price transmission elasticities in the farm - export linkage

Variable	Elasticity	P-value
$P_{1,t}^{POS}$	0.6640	0.000
$P_{1,t}^{NEG}$	0.7980	0.000
$P_{1,t}^{POS} * SA$	-0.3877	0.012
$P_{1,t}^{NEG} * SA$	-0.2712	0.043
SA_t	-1.1428	0.776
Durbin-Watson *d*	1.9292	
R^2	0.6812	

The Durbin-Watson *d* of 1.9292 indicates that the *d*-value is greater than d_U = 1.802, and there is no evidence of positive first-order autocorrelation, thus we cannot reject the null-hypothesis. The coefficient of determination R^2 of 0.6812 tells me that 68 % of the variation is explained by the sample regression line.

From table 5 it is clear that there is significant evidence of asymmetry in the price transmission relationship between the export level and the farm level. The price at the export level responds more to a relative reduction in the farm level price than to a relative rise in the farm level price (the values are $P_{1,t}^{POS}$ = 0.6640 and $P_{1,t}^{NEG}$ = 0.7980).

From July 1997 to May 2003 the Salmon Agreement was in effect, and the price transmission elasticity between the export level and the farm level yielded the following results: For an increase in the price the elasticity is -0.3877 and the elasticity for a decrease is -0.2712. Both values are significant within a 5 % level of confidence, and the price transmissions are reduced throughout the duration of the SA. This is consistent with the findings from the other models, thus far. Even though the export price responds more to an increase in the farm level price than to a decrease, there is evidence of asymmetry in the price transmission.

Table 6 – Statistical inference – testing two hypotheses of asymmetry

Test	Hypothesis	P-value	Decision
$P_{1,t}^{POS}$ - $P_{1,t}^{NEG}$ = 0	$H_0 : \alpha_1 = \alpha_3$ $H_1 : \alpha_1 \neq \alpha_3$	0.3496	Reject H_0
($P_{1,t}^{POS} + P_{1,t}^{POS} * SA$) – ($P_{1,t}^{NEG} + P_{1,t}^{NEG} * SA$) = 0	$H_0 : \alpha_1 = \alpha_3$ $H_1 : \alpha_1 \neq \alpha_3$	0.1945	Reject H_0

To establish whether there exists evidence of asymmetric price transmission in the time series two tests were conducted. In the first test the positive changes in the farm level price minus the negative changes in the farm level price were to equal zero. We know that if the price transmission elasticity for a positive change is significantly different from the elasticity for a negative change, there is evidence of asymmetric price transmission. It follows then that $P_{1,t}^{POS}$ - $P_{1,t}^{NEG}$ must equal zero if there is to exist symmetric price transmission. The test conducted shows a *p* = 0.3496 (in table 6), and thus, the decision rule is to reject the null-hypothesis at the 10 % level and we can conclude that the alternative hypothesis is true, i.e., there is evidence of asymmetric price transmission. From table 5 it is clear that the price changes at the export level respond more to a decrease in the farm level price than to an increase.

The first test was conducted independent of the Salmon Agreement. The next asymmetry test is done by also including the effect of the SA on the price changes; otherwise the test is the same as above. The test shows a p = 0.1945, which is consistent with the first test. Thus, we reject the null-hypothesis, and conclude that there is evidence of asymmetric price transmission for the duration of the SA.

5.5 Test of asymmetric price transmission in the export – retail linkage

In the last estimation the relationship between the retail level and the farm level price is measured and tested for asymmetry. Variables for cost of transportation and currency exchange rates are also included in this model. For this purpose function (17) was used, and the price transmission elasticities are presented in table 7.

Table 7 – Price transmission elasticities in the farm – retail linkage

Variable	Elasticity	P-value
$P_{2,t}^{POS}$	0.6940	0.025
$P_{2,t}^{POS} * SA$	- 0.0430	0.943
$P_{2,t}^{NEG}$	0.0631	0.803
$P_{2,t}^{NEG} * SA$	0.2725	0.576
SA	- 4.8846	0.667
$Z_{\mathrm{EUR/NOK},\,t}$	- 41.0830	0.605
$Z_{\mathrm{EUR/NOK},\,t} * SA$	75.0750	0.498
C_t	0.2039	0.146
$C_t * SA$	-0.2971	0.426
Durbin-Watson *d*	2.0846	
R^2	0.1970	

From table 7 we find the Durbin-Watson *d*-value of 2.0846, and like the result from equation (16), this *d*-value is also greater than d_U = 1.862. Thus, there is no evidence of positive first-order autocorrelation, and the null-hypothesis cannot be rejected. The R^2 of this model is very poor and shows that the model only explains about 20 % of the variation.

Only the positive changes of the price at the export level have significant values in this model (the elasticity is 0.6940). Thus we cannot with statistical certainty establish whether there exists asymmetry at this level of the value chain. However, the relatively low coefficient of determination for this model suggests that the relative explanatory contribution is weak. Thus, for this specific regression the applied exogenous variables shed little light on the total variation in the retail price.

- ❖ To sum up the results from the tests of asymmetry I have established with statistical certainty that there is asymmetric price transmission in the farm – retail linkage. Furthermore, it is clear that the price changes at the export level respond more to a decrease in the farm level price than to an increase. During the SA the elasticities were weakened, which concurs with the results from the other estimations. Moreover, the export price responds more to an increase in the farm level price than to a decrease in this period.

- ❖ Two tests were conducted to establish whether there exists evidence of asymmetric price transmission in the time series. The test without the influence of the SA and the test with the influence of the SA both produced evidence that support asymmetry.

- ❖ Unfortunately, poor results from my last estimation made it impossible to measure the asymmetry between the export and retail level.

6 Summary and concluding remarks

The scope of this thesis was to examine the value chain for Norwegian salmon exports to France. The objective of the analysis was to investigate the price mechanism along the retail, wholesale and farmer levels of the Norwegian - French salmon marketing chain. I also outlined some key questions that I wanted to explore, including other factors that might influence the price mechanism. In agricultural economics price transmission elasticities are frequently applied to investigate various markets, but studies on the salmon markets are scarce. Due to relatively easy access to some of the data I have processed, and the fact that France is such a principal and large importer of salmon on the global scene, made France a natural debarkation point for my journey.

The thesis and the analyses I have run have exhibited price transmission between the farm level and the export level to be quite high. By moving up the salmon marketing chain this linkage is weakened. The price transmission elasticity is more inelastic at this level, and it seems like the price is transmitted faster at the lower level of the value chain than in the upper level.

An interesting finding in this study is the relative importance of the SA on the price mechanism during the period in which it regulated the salmon market. In the farm - export linkage the relationship was inelastic, but there was evidence of influence on the price transmission elasticity. This is also the case in the export – retail linkage, with the same inelastic, but still significant influence on the price transmission. The transmission is reduced during the period of the SA's influence. Thus, the SA weakened the market mechanism and obscured the price signals.

The cost of transportation also has an effect on the price transmission elasticity on the retail level. The costs had a significant impact on the retail price outside the SA, and when the transportation costs are increased the price transmission also increases. During the SA, when transportation costs increased the price transmission elasticity, to some extent, is reduced.

Perhaps the most powerful influence by any one variable was that of the currency exchange rate between EUR and NOK. It influenced the price transmission between the export price level and the retail level. The revaluation of the Norwegian Krone is a very important contributor in the price transmission at this level of the supply chain. However, during the influence of the SA the currency exchange rate elasticity is also significant, but in this period the Krone was weakened and the price transmission was increased.

Understanding and to some degree being able to forecast salmon price is becoming more and more important, because with certainty we know that the salmon prices will continue to exhibit large fluctuations. The salmon company boom in the stock markets and the interest around the week-to-week price changes supports this fact.

There are several interesting results of this thesis, the strong link between the farm level and the export level price compared to that between the export level and the retail level. Clearly the latter is quite inelastic compared to the former, and this result tells us that retail prices in France do not transmit price changes so quickly or as massively as we might experience in Norway. Then again, this is as expected. Higher up in the value chain there is a higher degree of packaging, processing, pricing and distribution, and this is not the case at the lower levels in the value chain. Also, both the currency exchange rate and transportation costs have significant impact on the price transmission.

Still little research is done concerning salmon markets and the economical impacts for the salmon industry. With its leading role in the global salmon market it is very important for Norway to have reliable market information systems and to understand the dynamics of the international market. Because of the frequent changes in the global price mechanism this task must have the highest priority at the desks of policy-makers.

Unfortunately, there are limitations on the availability of data for this kind of an analysis. There are many middlemen in the value chain I have tried to describe, and to get the broader picture data should have been obtained from more of these intermediaries. Exact registration and tracking systems, which may very well be introduced in the nearest future, will enhance the data collecting process.

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http://www.fiskeoppdrett.no	FHL Aquaculture
http://www.godfisk.no/	Norwegian Seafood Export Council
http://www.insee.fr	Institut Nationale de la Statistique et des Etudes Economiques – France
http://www.jochenmeyer.de/paper.htm	Some of the papers I downloaded in .pdf
http://www.tutor2u.net	Online Learning Resource of the Year
http://www.intrafish.com	IntraFish Media; news and analyses
http://www.ssb.no	Statistics Norway
http://shazam.econ.ubc.ca/	Shazam Econometrics Homepage
http://agecon.lib.umn.edu	Agricultural and applied economics scholarly literature
http://www.jstor.org/	Journal storage online.
http://www.toi.no	Norwegian Centre of Transport research
http://dictionary.reference.com/	The title says it all

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