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Contracts in the Salmon Aquaculture Industry: An Analysis of Norwegian Salmon Exports

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Abstract *Sales and distribution innovations have increased productivity in the salmon aquaculture industry. In this article, we investigate the use of fixed price contracts for Norwegian salmon exports to France based on all export transactions between the two countries. Our analysis shows that almost 25% of these exports were traded using fixed price contracts and contract prices were renegotiated at different intervals, including as infrequently as once a year. Some contracts allow the contracting parties to adjust contract prices when the export price moves significantly. Benchmark analysis, which shows a marginal 0.5% difference between average unit revenue for the year from spot sales relative to contract sales, indicates that contracts primarily change revenue time profiles. The use of contracts creates a wedge between salmon export prices and spot prices in periods of price volatility, which in turn reduces price transmission.*

Key words Contracts, salmon aquaculture.

JEL Classification Codes L14, Q22.

Introduction

Salmon aquaculture is an ongoing success story, as production has increased from a few thousand tonnes in 1980 to around 1.4 million tonnes in 2009. Norway, with a 51% share of world production in 2009, is the world's leading producer. There are two key factors that make this production growth profitable. The first is that significant productivity growth has reduced real production cost to less than 33% of the cost level of the early 1980s (Asche 1997, 2008; Tveteras 1999, 2002; Guttormsen 2002; Kumbhakar and Tveteras 2003; Asche, Roll, and Tveteras 2009; Nilsen 2010). The second is that systematic marketing, generic advertising, product development, and improved logistics have increased demand (Bjørndal, Salvanes, and Andreassen 1992; Asche 1996; Kinnucan *et al*. 2003; Kinnucan and Myrland 2005, 2007; Asche 2008; Xie, Kinnucan, and Myrland 2009; Asche and Bjørndal 2011).

The structure of the industry has changed over time, as it has grown from an owner-operated industry of several hundred small single farm firms to a more integrated industry of fewer but larger firms (Kvaløy and Tveteras 2008). The industry consisted of more than 800 active firms in the mid 1980s. This had fallen to 186 active firms in 2008, with the four largest accounting for almost 50% of Norwegian production (Asche and Bjørndal 2011). This change in industry structure has been driven by increased operating capital requirements and the search for economies of scale and scope in production and sales.

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Contracts are a tool designed to reduce risk and transaction costs. They provide the contracting parties with offsetting benefits and have a long history in agriculture and mineral markets (Kvaløy 2006). Industry sources indicate that the use of contracts in salmon farming has increased substantially in recent decades. Information about the use of contracts and their details is not normally made public by the contracting parties. This makes the measurement of their dispersion difficult (Vukina and Zeng 2010), and our empirical knowledge is limited.

In this article, we attempt to measure the use of contracts that fix prices over a period by examining price patterns in the Norwegian export data. The unusually large price variations in 2006 make this year an excellent one in which to examine to what extent fixed price contracts are used (see figures 1–4)[1]. The average export price for the first 5 weeks of 2006 was close to 27 Norwegian kroner (NOK) per kilo before it started to increase. The price peaked in weeks 25–26 at about NOK 44 per kilo. The average price for the last 5 weeks of the year was close to NOK 28 per kilo, which is almost the same as for the first 5 weeks.

Our approach is unique and exploits the fact that we have access to data on each individual transaction carried out by every export firm. With this data structure, we can investigate whether prices for some transactions and for some firms have a unique pattern and deviate from the general price movement. The authors are not aware of any studies using a similar approach to identify a fixed price contract in general or studies on the use of contracts in the salmon aquaculture industry, with the exception of Dybvig and Tveretas (2003), which is based on a survey.

Contracts

Agricultural products have long production times and are often highly perishable. Because of this, the agriculture industry was one of the earliest to use short- and long-term contracts. Contracts are primarily used to reduce risk and transaction costs (Lafontaine and Slade forthcoming). Contracts restrict the actions of one or both parties, but at the same time provide offsetting benefits. A well functioning spot market allows agents to trade at competitive prices. Spot market trading does, however, result in volatile cash flows and can increase sales costs. These negative aspects can, at least partly, be mitigated using contracts. It is important to understand that contracts, while mitigating some risks, also introduce others, such as holdup (Kvaløy 2006), and that an exhaustive contract does not exist. The only way to obtain full control over several levels in the supply chain is to vertically integrate. Vertical integration completely removes transactional risk but also removes the efficiency created by competition.

Contract theory describes a number of different types of contract arrangements. Lafontaine and Slade (forthcoming) indicate that it is common practice to contract on little else than price when products are fairly homogeneous and where production technology is well understood. Still, a price contract can incorporate a number of different arrangements, such as linear pricing rules, market prices plus a fixed fee, or nonlinear pricing schemes, such as quantity discounts. None of the parties are, in general, expected to gain a price advantage by entering a contract. A contract is intended to reduce risk and transaction costs, and contract prices should be an unbiased estimate of the spot price.

Polinsky (1987) indicates that a spot price contract tends to insure a seller against production cost uncertainty and a buyer against valuation uncertainty, while a fixed price contract insures a seller against demand side uncertainties and a buyer against supply side uncertainties. Thus, which contract form preferred by the parties depends on their relative aversion to risk and the magnitude of the supply side and demand side

[1] The salmon market has repeatedly experienced exogenous shocks that lead to increased price volatility (Oglend and Sikveland 2008), the most recent being the disease problems in Chile (Asche *et al*. 2009).

uncertainties. Exporter (seller) and importer (buyer) that are equally risk averse will, in general, share the risk.

Salmon aquaculture and agriculture have many aspects in common, such as long production times and perishable products, which provide similar a premise for contracting. Industry sources state that a wide range of contracts are used in the salmon industry.[2] These contracts are said to primarily be used to achieve two objectives. The first is to regularize quantity flow, allowing better production planning for producers, better capacity utilization in the supply chain, and reduction of quantity risk for both parties. Retail chains typically prequalify three to five suppliers that are able to guarantee to supply a minimum quantity that meets given quality parameters. The seller has no guarantee that the retail chain will purchase the total quantity that is guaranteed, but in most cases the purchase of a minimum quantity is guaranteed. The second objective is to reduce price volatility.[3] This is achieved in numerous ways, including linking the price to some market price, possibly after reducing the variation by a given formula and fixing the price for shorter or longer periods of time. One relatively common practice is a contract that specifies a base price and a bound around this with a reference price. If the reference price only moves within the bound, the base price is paid. However, if the reference price moves beyond the bound, then the base price is adjusted for the difference between the bound and the reference price. The longest fixed price contract the authors are aware of is one in which the price is renegotiated once a year.

Data and Methods

The main objective of this article is to provide empirical evidence of the utilization of contracts to reduce price risk through examining Norwegian salmon exports. We will, consequently, not be examining all contracts, but focus only on cases with a price pattern that deviates sufficiently from the average export price such that this deviation is detectable. Norway's foreign trade statistics are generated from customs' documents submitted at the time of export. The authors were given access to the customs database for salmon that contains detailed transactional data on all salmon exports from Norway in 2006. Each transaction or observation in the data contains a product ID (from the Harmonized Commodity Description and Coding System); export date; transport ID (*e.g.*, truck, ship, train); delivery term ID (*e.g.*, FOB, DDP); net value; quantity; currency; and exchange rate, if the domestic currency was not used; import country ID; and export firm ID. The firm level data was organized as panel data, with individual firms being the panel ID variable and date being the time ID variable.

Farmed salmon, HS03021201 (fresh, whole, and gutted), is considered to be a fairly homogenous product. The firm level data on farmed salmon shows great variation on a daily basis.[4] Price variations are mainly due to variations in product size, the most important quality attribute. However, this cannot be tested using our data, as the trade statistics do not differentiate between weight classes. There are systematic differences in price levels between countries. We therefore focus on a single market to reduce price variations to the greatest extent possible. France has been the most important market for fresh Norwegian salmon for many years and was selected as the focus of our analysis. The firm level data contained 9,267 observations, with an average of 178 observations per week. There were 43 unique export firms in the data, the 12 largest accounting for more than 92% of exports. Fifteen firms exported fresh salmon to France once a week or more, on average.

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[2] The authors have followed the industry closely in recent years and have conducted five interviews specifically for this research.

[3] Price volatility has been increasing in the salmon market (Oglend and Sikveland 2008).

[4] This is as expected, as there are significant quality differences for salmon, and the price varies with these characteristics (Asche and Guttormsen 2001).

As noted above, substantial variation in the annual price pattern of 2006 makes it an ideal year for searching for fixed price trades. We define price contracting as a short- or long-term agreement between a Norwegian exporter and a French importer to trade farmed salmon at a price that is fixed for a period of time. Successive transactions that lie within a specified price range or interval are identified by the analysis. Preliminary analysis suggests that an interval of NOK 0.25 or €0.03, depending upon whether the contract is denoted in NOK or Euro, is sufficient to identify contracts. Frequency tables and histograms were then used to identify intervals that contained a series of trades at a given price interval for each firm. We divided the dataset into two groups, one of mostly rising prices (weeks 1–25) and one of mostly falling prices (weeks 26–52). This was carried out to avoid similar prices early in the year and late in the year being included within the same intervals. Identification was made easier by high transaction series regularity in a given interval (*e.g.*, transactions carried out on the same day each week) and because the quantity of each transaction was often the same.

Empirical Results

Only relatively large firms that trade frequently can be identified as having used price contracts. This means that the 15 firms that make at least one trade a week, on average, are of greatest interest. We identified 7 of these 15 firms as those that used contracts with fixed prices for some transactions. One firm only used fixed prices, while another firm used fixed prices for 60% of its exports, measured by quantity. A third firm made around 33% of its exports at fixed prices, whereas the remaining four firms traded nearly 17% of their exports at fixed prices. These seven firms accounted for 75% of the total export quantity, which is an indication that large firms are more likely to use price contracts than small firms. We identified 17,109 out of 76,238 tonnes that were exported at fixed prices, equivalent to 22.4% of exports to France.

We will present graphic representations of the transactions of three firms to illustrate the extent to which contracts are used. The solid line (all figures) represents the average daily export price for all firms.

Firm 1 accounted for around 3% of total Norwegian exports of fresh salmon to France in 2006, which makes it a medium-sized exporter. Figure 1 is a bubble chart that shows firm 1's daily export activity in 2006. Note that the bubbles that indicate prices and the corresponding dates are weighted by the quantity. The smallest bubbles represent around 0.5 tonnes, while the largest bubbles represent almost 20 tonnes, which is equivalent to a full truck load. Firm 1's average daily export quantity was approximately nine tonnes. Please note that there can be several observations or export transactions on a single day but that there are not transactions on all days. We cannot identify any fixed price exports from figure 1. Firm 1 was therefore categorized as a firm that only used spot prices, which is confirmed by the correspondence between the bubbles and the average export price.

Firm 2 was one of the largest exporters, accounting for 9% of the total Norwegian export of fresh salmon to France in 2006. Figure 2 shows that firm 2 used a mix of spot and fixed prices. The fixed/spot price mix was 60/40 by quantity. There appears to be one set of contract sales at fixed prices in the range NOK 25–26 or €3.3 per kilo throughout the year, and another set of contracts with fixed prices in the range NOK 32–33 or €4.0 per kilo throughout the second half of the year. The quantities sold at fixed prices, which are indicated by bubble size, were large and stable. The average quantity for fixed price transactions was 18 tonnes, while the average quantity for spot price contracts was 17 tonnes.

An important question is whether a firm loses or gains due to its contracting strategy. In order to assess such a question, we performed a benchmark analysis investigating how firm 2's revenue compares to the industry average. This was conducted by multiplying the daily export quantity sold at fixed prices by the corresponding industry average daily

export price, providing a benchmark revenue. An indication of the firm's performance can then be found by comparing the benchmark revenue to the actual revenue obtained. We find that firm 2 lost significantly on its contract strategy, as the benchmark revenue was 14% higher than the firm's actual revenue obtained.

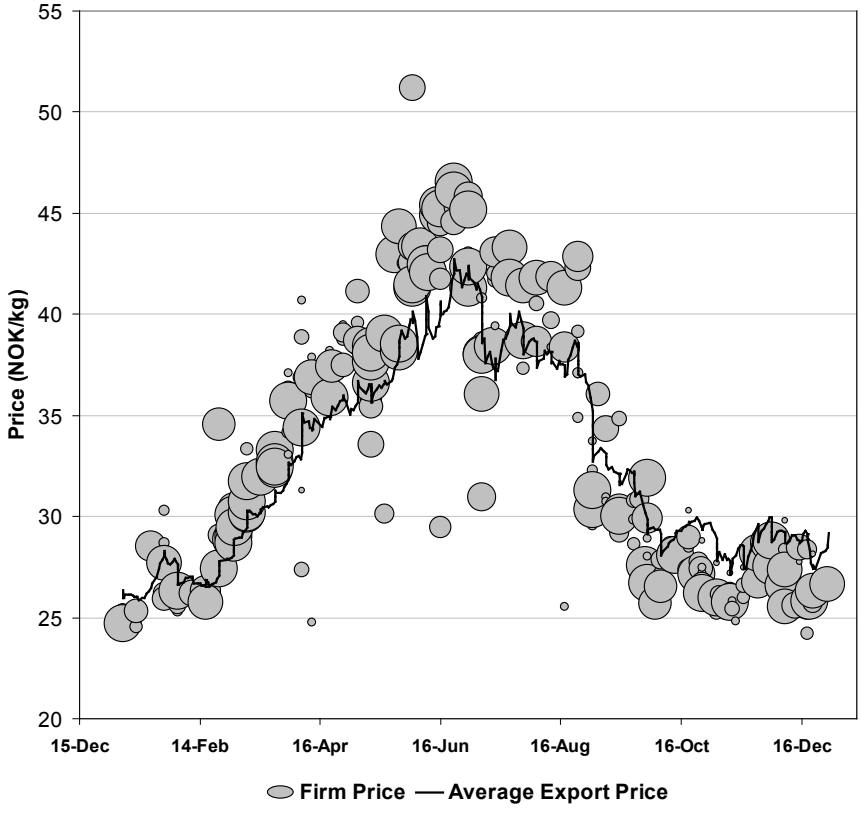

Figure 1. Firm 1's 2006 Daily Exports
Note: Solid line represents the average export price for all firms.

Firm 3 accounted for around 6% of total Norwegian exports of fresh salmon to France in 2006. Figure 3 shows a trading pattern which is very different from that of the other firms. It appears that firm 3 traded using only fixed price contracts. The prices appear to be adjusted to the export price every quarter, with the exception of the third quarter, which seems to be cut somewhat short, perhaps due to the rapid declining export price. The equally sized bubbles indicate a fairly stable almost daily export quantity of around 18 tonnes. The benchmark analysis for firm 3 shows that the contract strategy had little effect on the firm's performance. The benchmark revenue was 0.5% higher than the actual revenue. Statistically, we cannot reject the hypothesis that this firm obtained export prices that are neither higher nor lower than the industry average.

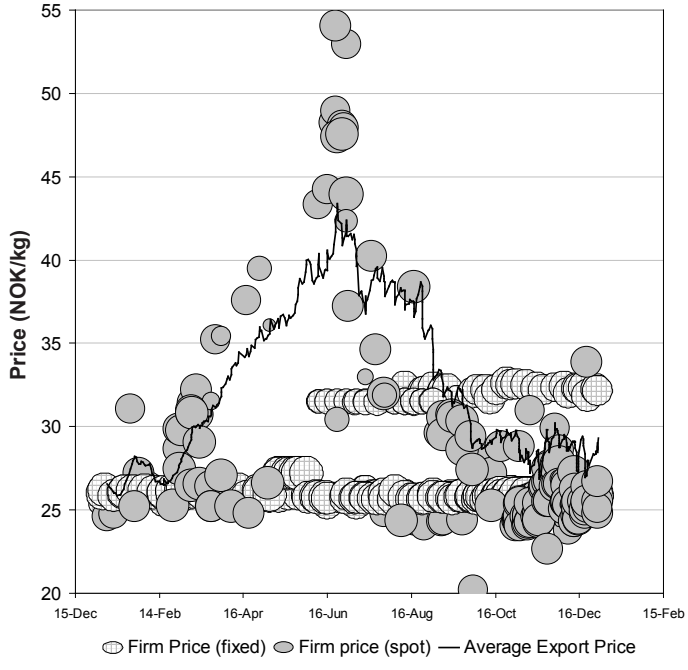

Figure 2. Firm 2's 2006 Daily Exports
Note: Solid line represents the average export price for all firms.

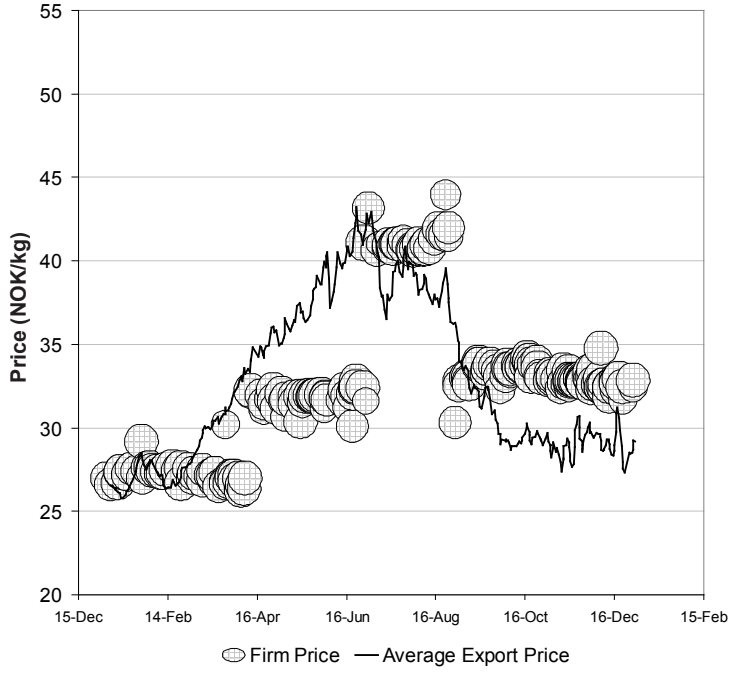

Figure 3. Firm 3's 2006 Daily Exports
Note: Solid line represents the average export price for all firms.

We have shown that the aggregated export price in 2006 was generated by a mix of fixed contract prices and spot prices. This implies that the spot market price is not necessarily represented by the export price, as fixed contract prices can limit or delay export price movements. We can test to what extent this is the case using the data made available to us. We split the data set in two to investigate this issue. One set of observations contained no evidence of fixed price contracts. We label those as the synthetic spot price. The other set contained the remaining sales that we identified as having been made at fixed prices—the contract price.

We tested the difference between these prices and the export price using a classic two sample mean-comparison t-test with unequal variances. We investigated whether the prices were different throughout the entire year and in each quarter using aggregated weekly data. The following null hypotheses were specified:

(A: Export vs. spot) $H_0 : P_t^E = P_t^S$

(B: Export vs. contract) $H_0 : P_t^E = P_t^C$,

where P^E is the export price, P^S is the synthetic spot price, and P^C is the contract price. The t subscript denotes weeks. The results are reported in table 1. We cannot reject the null hypothesis that the export price and the synthetic spot price are equal when we use weekly data for the whole year. However, figure 4 indicates there are greater differences between prices in the second and last quarters compared to the first and third. We therefore conduct quarterly comparisons instead of annual. In these tests, we can reject the null hypothesis in the second and fourth quarters. This implies that the synthetic spot price and the export price were significantly different in these quarters. The average difference is close to NOK 1.7 per kilo in the second quarter and about NOK 0.8 per kilo in the fourth quarter.

We observe from figure 4 that the synthetic spot price increase seems to be steeper than the increase in the export price. This is probably due to the lag caused by the sticky fixed prices. Figures 1 and 2 show sales at prices well above the average export price at the time when the export price peaked. This suggests that the spot market price was actually higher than the NOK 43–44 per kilo indicated by the export price.

The industry's export value was almost NOK 2.5 billion in 2006, equivalent to about 300 million Euros at an exchange rate of NOK 8/€. We conducted benchmark analysis on the industry level, resulting in benchmark revenues being NOK 13.6 million or 0.5% higher than the actual revenue obtained. Statistically, we cannot reject the hypothesis that firms' contract strategies caused industry revenues to neither drop nor rise.

Figure 4 also shows contract quantity as a proportion of total export quantity. There appears to be an inverse relationship between export price and quantity. Only 10% of fresh salmon was exported at fixed prices in weeks 25–26, when export prices exceeded NOK 40 per kilo. Up to 33% of exports were traded at fixed prices in the weeks before and after this, when prices were lower. At least two important insights can be derived from this relationship. Firstly, a few firms did trade using fixed price contracts throughout 2006, even when export prices exceeded NOK 40 per kilo. The prices in some of these contracts were fixed around NOK 25–26 per kilo. This confirms that some firms were tied to long-term contracts lasting for at least one year and that some of these contracts were independent of the prevailing export or spot price. Secondly, many contracts appear to stop shortly after export prices start to increase sharply, and many contracts appear to start shortly after the export price starts to fall in June. This can indicate that some contract prices are renegotiated at a frequency that is greater than annually. The strong inverse relationship between export price and contract quantity proportion in figure 4 also indicates that a substantial proportion of contracts have a price bound that was exceeded

by the strong price movement. We were unable to continue tracking these prices as contracts when the export price moved beyond this bound. We were, however, able to track contract trading when the export price crossed this upper limit on its way down.

Table 1
Test Results

	Hypothesis A	Hypothesis B
Annual	–0.318	2.617*
Q1	–0.113	0.727
Q2	–1.347	9.809*
Q3	–0.220	1.452
Q4	2.416*	–6.998*

* indicates significant *t*-value at a 5% level.

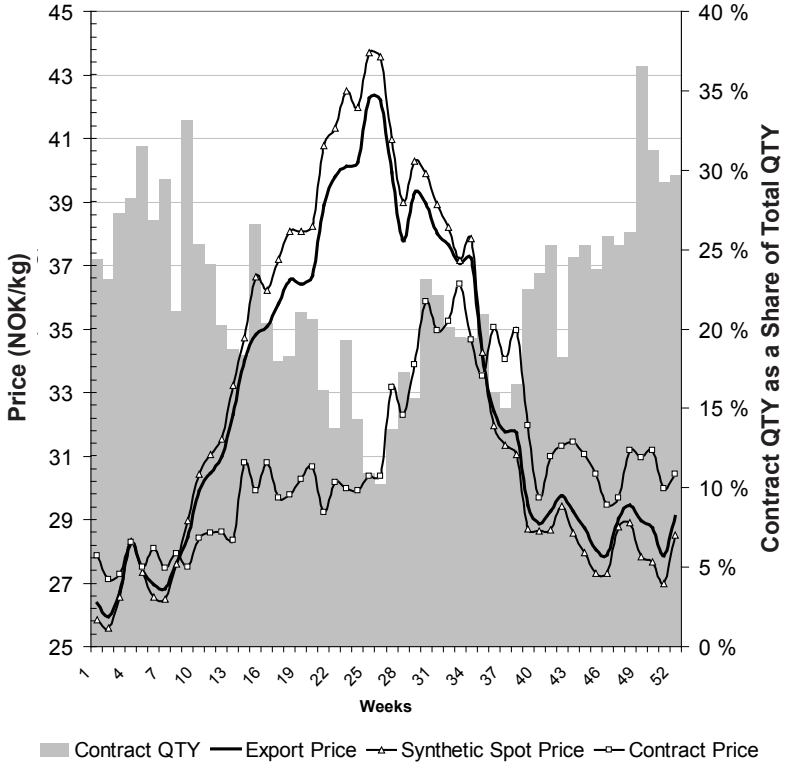

Figure 4. 2006 Industry Level Prices and Contract Quantities

Concluding Remarks

The structure of the salmon industry has changed as it has grown, improving competitiveness. Developments include improved production technology, more efficient logistics and distribution, and an increased product range. One element in this development is the use of contracts to regulate the sales process in order to reduce risk and transaction costs. Obtaining information on contract sales is often difficult, as it is often considered to be sensitive.

In this article, we use a somewhat unconventional approach to investigate the pricing format of actual exports of Norwegian salmon to France. This approach implies that we identify only contracts with fixed pricing schemes. Our approach is made possible by receiving access to all Norwegian export transactions to France in 2006, identified by firm. Furthermore, there were very large price variations in 2006, which makes it possible to identify sequences of sales at stable prices in a period that deviates from the main price pattern.

We find that almost 25% of actual sales were conducted using a contract in which the price is fixed for a period of time. The data also indicates that contract prices are renegotiated at a number of different frequencies, including once a year. The fact that the proportion of sales at fixed prices is reduced when the price increases rapidly is also an indication that many of the contracts fix price in a range, but follow the export price or are renegotiated when price volatility becomes high. The proportion of sales that used a contract with a pricing formula is significantly higher than the 25% that used fixed prices.

Benchmarking contract sales against sales using the average export price shows that annual revenue is neither significantly higher nor lower than expected. Fixed price contracts primarily change the profile of revenue flows. It is also important to note that the use of contracts creates a wedge between the export price and the spot price for salmon in periods of high price variation, reducing price transmission. Finally, the contract and spot sales currency mix might create additional variation and cause incomplete exchange rate pass through, reducing price transmission (Asche and Tveterås 2008; Larsen and Kinnucan 2009).

This study indicates that a substantial proportion of Norwegian salmon sales to France are conducted using fixed price contracts and provides some insight into the use of contracts with a fixed price. This, however, only covers a portion of contract sales, and further research is required to obtain a full understanding of the use of contracts in the Norwegian salmon industry.

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