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Oglend, A., & Straume, H.-M. (2019). Pricing efficiency across destination markets for Norwegian salmon exports. *Aquaculture Economics & Management, 23*(2), 188-203. doi:10.1080/13657305.2018.1554722

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Pricing Efficiency across Destination Markets for Norwegian Salmon Exports

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Abstract: This paper investigates how pricing efficiency of Norwegian salmon exports varies across destination market characteristics. Efficiency is defined as the rate at which individual transaction prices adjust to common market information, and is estimated by dynamic fixed effects panel models with parameters conditional on trade attributes using micro-level trade data. Our results show that contract type (Incoterms) used in transactions can be used to segment the Norwegian export markets into three types: 1) high value trade to large distant markets, 2) medium value trade to close high-income markets, and 3) lower value large bulk trades to lower income close markets. We find that pricing efficiency is lowest for committed trades over long distance using planes, and highest for less committed large bulk trades to close markets. Despite significant heterogeneity, the majority of salmon price variation (around ¾) is common, providing a clear justification for the representativeness of a salmon price index.

Keywords: trade, price, index, efficiency, aquaculture

JEL classification: C55, F14, Q21, Q22

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This work was supported by the Research Council of Norway under Grant CT # 233836. We thank two anonymous referees for helpful comments.

1. Introduction

Norway is the world's second largest seafood exporter, and farmed salmon accounts for close to two thirds of the value of Norwegian seafood exports (Norway Exports 2017). Norwegian production exceeds domestic consumption, and the vast majority (~95%) of salmon from Norway is exported (Asche and BjØrndal, 2011; Brækkan and Thyholdt, 2014). From 2006-2014, 97 different countries imported salmon from Norway, and growth in production has required growth in markets to sustain value. The growth in markets is evidenced by growth in number of export transactions and importing firms, which doubled from January 2006 to December 2014. In the same period, the average distance to the first destination country for Norwegian salmon increased by 20%.

It is uncertain how market expansion affects the uniformity of salmon pricing. The trade literature suggests that there is vast heterogeneity in export prices at the product level, that prices increases with the geographical distance to the final destination market, and that correlation between sale prices in agricultural markets declines with trade distance (Shiue, 2002; Manova and Zhang, 2012; Hornok and Koren, 2015; Görg et.al., 2017). This paper uses micro-level firm data on Norwegian salmon exports to attempt to answer how expansion in markets affects the uniformity of salmon pricing[1]. Specifically, we investigate how pricing efficiency in export transactions (defined as the rate at which individual trade prices respond to common market information represented by the Fish Pool Index) differ across destination markets. Trade to different destination markets are characterized with different attributes such as travel distance, market size and income, attributes which we control for in the empirical analysis. It is of interest to investigate factors that affects pricing efficiency, as pricing efficiency is important to secure efficient resource allocation, and thus constitutes an important part of overall economic efficiency

[1] At the transaction level prices are calculated as monthly average f.o.b. unit values (NOK/kg).

and growth (Buccola, 1989). In addition, weaker pricing efficiency implies higher price risk. Efficient prices correlate more strongly with the Fish Pool futures settlement price. Our results imply that as markets expand from the core traditional export markets, the more idiosyncratic nature of these transaction prices means higher price risk, and weaker hedging efficiency using futures, or diversification benefits of trade using multiple trade partners (i.e. lower diversification of within company price risk in a portfolio of trade partners). Most exporters trade with multiple trade partners.

Our analysis shows that salmon destination markets can be fruitfully segmented into three types based on contract type (Incoterms) used in transactions. Long distance trade of salmon is associated with CIP (Carriage and Insurance Paid) contracts. CIP contracts are equivalent to CIF contracts, but adapted to other transportation methods than transport by sea. The exporter pays for freight and insurance, while ownership is transferred at the destination market terminal. Transportation of salmon using this contract is done using planes, and consequently shipments are of low weight. CIP trade relationships are relatively stable and committed in terms of duration. The destination markets for these transactions are typically high paying markets in Asia such as Japan, Hong Kong and Singapore demanding high quality fresh salmon for sushi. Specialized trade and long distance trade suggests higher arbitraging costs and more sluggish price adjustments. Our results show that CIP trades have a price premium over the more traditional closer markets, and that pricing is less efficient and more sluggish in response to common market information. The most efficient pricing is associated with use FCA (Free Carrier) transactions. For this contract, the seller delivers the good ready for export at the export country terminal, loaded onto the buyer's specified mode of transportation. At this instance, the title of ownership is transferred to the importer. As such, the buyer carries a larger share of the transportation cost and risk. FCA trades are associated with large bulk shipments to lower income, close markets, such as Russia, Ukraine and Turkey. These trade relationships are of relatively short duration, and has the lowest average transaction price. FCA trades can be considered price leading for salmon exports. They respond quickly to common market information. This can be explained by less committed trade relationships and the closeness to market.

It is well known that the salmon price is volatile (Oglend and Sikveland, 2009; Dahl and Oglend, 2014; Bloznelis, 2016). This provides an incentive to sell forward using bilateral contracting to reduce revenue risk. As an alternative risk management tool, the Fish Pool futures exchange has offered futures contracts for salmon since 2006. Since the large negative price shock in 2011 associated with the Chilean production recovery, growth in participation in the futures market has stagnated (Asche et al., 2016; Misund and Asche, 2016). Salmon futures are settled using a salmon price index constructed by the exchange. The stated objective of the index is to give a correct reflection of the salmon market price, be possible to re-examine/verify, and remain transparent and neutral to all parties. The usefulness of such a contract price to manage price risk depends on the representativeness of the index for actual transaction prices (known as basis risk). We will use the fish pool index as a measure of common salmon price variation, and subsequently map pricing efficiency of transactions to how well they track changes in the fish pool index. Our results show that changes common price variation accounts for around ¾ of the change in transaction prices, suggesting a high degree of common pricing in the salmon export market. However, there is significant heterogeneity, as revealed by the Incoterms. For instance, transactions to close markets track the fish pool index better, and as such are better hedged using the futures than more distant trades. Our results imply that as markets expand, heterogeneity in pricing increases which reduces the representativeness of a single index price. Providing a standardized risk management tool requires high participation to ensure revenue for the service provider and reduced transaction costs for the participants. Keeping a single price index neutral to all parties as the market expands is difficult while still preserving an informative settlement price. To reduce the effect of pricing heterogeneity in the salmon price index, our findings suggest eliminating CIP transactions when constructing the index. This improves the signal of the index.

Our results also relates to a growing strain of literature in international trade investigating trade relationships at the micro level. Besedes and Prusa (2006) show that trade in homogeneous goods are associated with less committed trade relationships than differentiated products. Nitsch (2009) finds similar results for imports to Germany. This is consistent with heterogeneity in pricing. As better microdata has become available, several studies has focused on survival in trade relationships at the firm-level. The findings indicate that the survival time of export relations are in general short (Görg et. al., 2012; Esteve-Pèrez et. al., 2013), a result that also is evident for trade in seafood (Asche et. al., 2018; Straume, 2017). These findings disrupt the traditional theories in trade, suggesting that trade is stable due to large fixed costs of exporting (Baldwin and Krugman, 1989; Melitz, 2003). Related to this, we find that pricing flexibility declines in the length of trade relationships; more committed trade relationships appear to have a lower rate of price updating to reflect new common pricing information, and as are less efficient and informative in a price index.

The rest of the paper is structured as follows. In the next section, we present the data and some initial finding. Following this, we present our methodology for estimating pricing efficiency using micro-level transaction prices. We then estimate pricing efficiency and discuss the results before we conclude.

2. Salmon Exports Transactions Data

The data used in this paper consists of disaggregated micro-data of exports of Norwegian fresh farmed whole salmon. The data contains the entire population of all exporter/importer transactions from 2006 to 2014, which in itself covers a large share of the first hand market for Norwegian salmon. Data are collected from custom declarations, and gives anonymous id's for the exporting and importing firm, the date for the transaction, the statistical value (in NOK), the weight of the shipment (in kg), the contract form used and the country of destination.

Observed trade between an identified exporter and importer in a given month defines a trade relationship. The trade price p_{it} for relationship i in month t is constructed as the average of their transaction prices that month. There are 108 monthly observations of the cross-section from January 2006 to 2014. The first month vanishes due to first differences in the empirical investigation. In addition, we exclude exporters and importers with less than 100 transactions over the sample period to focus on active traders. We also exclude trade relationships that only trade in one month as they contain no information on adjustment in prices. There are 86 exporters 1152 importers and 6510 trade relationships over the full sample. The average trade relationship lasts one year, but with considerable skewness; 50% of relationships last less than 5 months. Overall, we have 94,658 trade price observations. From the data we can see that exporters are more diversified than importers. An average exporters trade with an importer accounts for 4.3% of its total volume of trade that a month. Importers have an average commitment of 69%, with the majority of importers being fully committed to one exporter.

To measure a common salmon price, we use the salmon futures markets contract settlement price. Futures contracts for salmon have no delivery option and all contracts are settled against a salmon price index (the Fish Pool Index, FPI) in the expiration month of the contract. The FPI is constructed as a weighted average of different salmon prices[2], with the main weighting towards exporter prices. Weights have

[2] Specifically, prices that have been used as: Selling Price Farmers, Farmers Index (FI), Nasdaq Index of Salmon Exporters Price (Nasdaq) price, FHL price, Export price (FHL), Statistics Norway customs Statistics (SSB), NOS clearing price, Exporters purchase price (NOS), Mercberna Market Price (MMP) Barcelona, Fish Pool European Buyers Index (FPEBI), Rungis index Paris Price (Rungis).

changed over time; the current index weights 85% into an export price index provided by Nasdaq, 10% into a Statistics Norway index based on customs declarations in Oslo, and 5% in a Fish Pool created European Buyers index. Nasdaq operates as the clearing house for the contracts. Using the futures market clearing price as a measure of the full information price has the benefit of providing information on how individual trade prices correlate with the contract settlement price, and so allows inference of hedging efficiency using the futures.

Table 1 shows some descriptive statistics about the unconditional trade prices. The FPI price is denoted by c_t, and all prices in the tables are in logs. The unconditional distribution of (log) trade prices p_{it} is close to symmetric, with approximately 90% of transaction prices being within +/- 35% of the mean price. The unconditional standard deviation is 23%. Looking at the cross-section of trade prices for each month, we find that the average monthly cross-sectional variance is 11.3%. Since this variation excludes shifts in the distribution over time, we can deduce that around ¾ of the variation in trade prices is due to temporal shifts in the mean of the distribution, which approximates the share of common pricing in the market.

The table also shows that individual trade prices and the FPI has similar mean percentage price change and standard deviation. Furthermore, regressing $\triangle\, p_{it}$ on $\triangle\, c_t$ gives an elasticity estimate 0.83 and an R^2 of 0.47. The elasticity and fit corroborates the high degree of common pricing of export trades. Similarly, deducting the FPI price from the individual trade prices reduces variance of trade prices by 77%.

The final row of the table refers to the number of monthly trade relationships, N_t. On average, each month has 885 active trade relationships. These statistics hides an increasing trend over the period due to growth in the industry. However, given a large number of relationships, variation in N_t is not expected to play a major role in the analysis.

3. Methodology

Salmon is a homogenous commodity and the export market consists of many exporters and importers operating. We use the observed spread $c_t - p_{it}$ to define individual transaction pricing errors. In a competitive spot market with perfect information and no transaction costs, the observed spread should contain no information on future transaction price movements. With limited information, costly contracting and/or risk aversion, contracts are imperfect. For instance, a transaction price in a contract might be tied to predetermined fixed prices with renegotiation clauses (this is suggested by Larsen and Asche (2011)), or to lagged public price measures (such as the FPI). For our purpose, transaction prices that respond weakly to changes in the common price (as measured by the FPI) are defined as inefficient. Rigidity in updating transaction prices creates sluggishness in how prices adjust over time, and the current pricing error will provide information on future price adjustments.

In this section, we present the methodology used in this paper to infer the rate of pricing efficiency in trade prices conditional on trade market attributes. This will allow us to infer which attributes of the transactions are associated with greatest pricing efficiency, i.e. which trades are price leading. Since our analysis uses monthly price frequencies, a fully efficient trade price will adjust to the common price fully within one month. To assess pricing efficiency, we investigate the following error-correction model for single transactions,

$$\Delta p_{it} = \mu_i + \beta \Delta c_t + \alpha(c_{t-1} - p_{it-1}) + u_{it}, \tag{1}$$

Where u_{it} is an individual, possibly heteroskedastic and weakly dependent, error process. This model allows us to quantify how individual transaction prices, p_{it}, dynamically respond to changes in the common salmon price, c_t. Specifically, the instantaneous elasticity of adjustment to the common price is β. An 1% change in the common price is associated with a $\beta\%$ instantaneous change in the transaction price. The parameter α dictates the rate at which the remaining $1-\beta$ percent pricing error is corrected. That is, n periods after a common price change, the pricing error is reduced to $(1-\beta)(1-\alpha)^{n-1}\alpha$.

The individual transaction price converges geometrically to the equilibrium spread $c - p_i = \frac{\mu_i}{\alpha}$. The role of the intercept μ_i is to allow for differences in equilibrium price levels across transaction prices. In a fully efficient market, the individual transaction prices tracks the common price exactly such that we should observe,

$\beta = 1$ for all i, such that $p_i = c_t - \frac{\mu_i}{\alpha}$ holds at all times, and the pricing error provides no information on future price adjustments. If $\beta < 1$, the existence of a stable level relationship between the transaction price and the common price requires $\alpha = (0,1]$.

To help interpret the joint role of the β and α parameters on pricing efficiency, we will refer to the adjustment time estimate,

$$h(x) = \left[\frac{\log(x) - \log(1-\beta)}{\log(1-\alpha)} + 1\right].$$

This gives the time, $h(x)$, needed to adjust $(1-x) * 100$ percent of a given pricing error ($c_{it} - p_{it}$). Note that $h(1-\beta) = 1$ such that $\beta * 100$ percent of the error is adjusted within 1 month. As α tends to zero, the adjustment time tends to infinity. Another way to interpret the adjustment time is in the sense of price leadership. For two trade relationships i and j, if $h_i(x) < h_j(x)$ for some range $x \in (a, b)$, then relationship i is a price leader over relationship j within the given price adjustment range. This implies that the price of i is predictive of the future price of j. To higher $h(x)$ to more sluggish the individual trade price adjusts to the common price. To lower $h(x)$, to more efficient it is. The benefit of referring to $h(x)$ is that the joint impacts of β and α can be evaluated in one measure. As efficiency increase, $h(x)$ tends to unity as all common price variation is instantaneously reflected in the transaction price (specifically, within one month).

Since not all trade relationships last sufficiently long to reliably infer individual rates of adjustment, and since we are interested in how different trade attributes relate to pricing efficiency, we condition our parameter estimates by specific attributes. Specifically, let z_{it} define some trade attribute of relationship i at time t. This might be the contract type use, or the distance to the destination market served by the importer. Let $\mathrm{I}(\mathrm{z}_{it} \in \boldsymbol{A}_q)$ be the indicator function taking a unit value if $\mathrm{z}_{it} \in \boldsymbol{A}_q$, where $\boldsymbol{A}_q$ for $q = \{1,2,\dots,n\}$ are real valued disjoint sets that fully partition the sample attributes**.** The panel model can then be extended to,

$$\Delta p_{it} = \mu_i + \sum_{q=1}^{n} \left(\beta_q \Delta c_t + \alpha_q (c_{it-1} - p_{it-1})\right) \mathrm{I}(\mathrm{z}_{it} \in \boldsymbol{A}_q) + u_{it}, \qquad (2)$$

where μ_i is a fixed effect accounting for unobserved time invariant heterogeneity in individual trade pricing, and u_{it} is an individual, possibly heteroskedastic and weakly dependent, error process. Parameter standard errors are estimated by the non-parametric robust estimator of Arellano (1987) allowing for arbitrary within unit correlation. While the properties of this estimator is only known in conventional panel asymptotic with fixed T and increasing N, Hansen (2007) find that the estimator is consistent without imposing any conditions on the rate of growth of T relative to N.

This conditional panel model allows us to investigate how trade attributes affects pricing efficiency, and it allows us to control the resolution of heterogeneity. For instance, if $q = 1$, this is a fixed coefficient regression. If q is such that $\boldsymbol{a}_q = \mathbf{z}_i$, then unit i has individual adjustment coefficients. For factor attributes, the partitioning reduces to conventional dummy variable regressions.

4. Estimation Results

Table 2 shows the estimation results of the unconditional model (1), and model (2), which conditions slope parameters by where in the quantile of the unconditional cross-sectional price distribution a given transaction price i belongs to. The conditional model provides a test for heterogeneity in pricing efficiency. Relationships with trade prices at the tails of the cross-sectional distribution are expected to have lower pricing efficiency; in a market where the majority of pricing is efficient, the efficient prices will naturally gravitate towards the mode of the cross-sectional distribution. The unconditional model suggests a high overall pricing efficiency. The instantaneous elasticity of adjustment is 0.85, suggesting that on average 85% of the change in the common price is incorporated in individual transaction prices within one month. Using $h(0.05)$, we find that 95% of pricing errors are absorbed within 2.5 months. This provides strong support for a common salmon price and a valid and informative salmon price index. The adjusted R^2 of the model (1) regression is 0.58, suggesting that the common price accounts for a majority share of the variation in individual transaction prices.

These results imply that it makes sense to talk about one Norwegian salmon price. The common price reflects the cross-sectional average transaction price. That individual transaction prices are highly responsive to changes in this measure implies that the information relevant to price single transactions largely the same across all salmon transactions. This likely reflects in part the homogenous nature of salmon as a commodity, but also a high degree of pricing efficiency in the market. There is little to suggest that a substantial share of trade partners can price their transactions persistently different from the market as a whole.

Heterogeneity is revealed when we condition the efficiency estimates by where in the unconditional cross-section of trade prices the relationship belongs. As expected, price followers with sluggish price updating are delegated to the tails of the cross-sectional price distribution, with price leaders at the center. The estimates in the table uses the 10% quantiles as the baseline, and the p-values refer to statistical significant difference from the 10% quantile. In general, there is statistically significant pricing heterogeneity.

Figure 1 visualizes the sorting to the tails effect of inefficient trade relationships. The left panel shows the time to correct 95% of a pricing error, while the right panel shows the conditional adjustment parameters, β and α. As the common price changes, the efficient transaction prices will follow the common price, while prices that fail to adjust are delegated to the tails. Since the mode of the cross-sectional distribution is centered around the common price (as is evident by the descriptive statistics and the high unconditional rate of adjustment), the efficient prices will also be located around the mode, with the inefficient at the tails.

4.1. Incoterms as a Destination Market Segmenting Variable

Different transactions use different contract types, which specifies who is responsible for shipping and insurance. . We now show that firms choice of contract type as a trade attribute is informative as a way to segment destination markets in terms of trade pricing. For Norwegian salmon exports, three contract types dominate and account for 93% of all transactions; these are CIP, DDP and FCA contracts[3]. Use of these contracts vary systematically over different types of markets. Table 3 shows mean trade attributes conditional on contract type used.

[3] CIP contracts are equivalent to CIF contracts bud adapted to other transportation methods than by sea. Exporter pays for freight and insurance. Ownership title is transferred to the importer at the destination market terminal. For DDP contracts, the exporter covers all transportation costs (including import/export fees), and takes the full risk until the good is fully delivered at the importers location. For FCA contracts, the seller delivers the good ready for export at the export country terminal loaded onto the buyers specified means of transportation. At this instance, the title of ownership is transferred to the importer.

As the table shows, CIP contracts characterize trades by plane to large (in terms of GDP) distant markets. Shipments are of relatively low weight, and trade relationships are relatively committed based on the average duration of these relationships. These markets are typically high paying markets in Asia such as Japan, Hong Kong and Singapore demanding high quality fresh salmon for sushi. Fresh salmon is a perishable good and timely delivery to the final market is of essence to ensure the deliverance of a high quality product. The attractiveness of air transport when time is an important trade barrier is emphasized by Hummels and Schaur (2013). Specialized long distance trade suggests higher arbitraging costs and more sluggish price adjustments. These trades are likely trades sorted to the tails of the cross-sectional distribution.

DDP contracts characterize trades using truck or boat to closer high-income markets. These can be considered as conventional trade relationships, consisting of the traditional Norwegian export markets, such as France, Spain, Sweden and Poland. With this contract, the exporter carries the largest risk, suggesting that for the less traditional destination markets, exporters push more of the transaction risk to the importers. Trade relationships using DDP contracts has an average duration of 14 months.

The FCA contracts are used for larger shipments to lower income close markets, such as Russia, Ukraine and Turkey. These relationships have the lowest commitment in terms of the average duration of trade relationship. In this sense, these trades are closest to spot trades, and have the lowest average trade price. Given the closeness of the market and the low relationship commitment, these trades are more likely to be price leaders.

The results on average price differences across the contract types are consistent with the findings of Görg et.al. (2017) for Hungarian exporters and Manova and Zhang (2012) for Chinese exporters, which show that prices increases with the geographical distance to the final destination market. For Salmon this can be a quality effect, where higher quality salmon (i.e. fresh sushi grade) travels longer. Figure 2 shows a scatterplot of transportation distance and transaction price along with the linear regression line fit. There is considerable variation in transaction prices conditional on distance, but a slight increase in price for as transportation distance increases. A simple linear regression provides the fit $p = 33.34 + 0.0005 distance$, with a conventional homoscedastic t-statistics of 60.72. The fitted regression line suggests that the average transaction price increases by 0.5 NOK/kg. per 1000 km from Oslo.

Table 6 shows estimation results conditional on contract types and the other trade attributes reported in table 5. Firstly, pricing efficiency is lowest for the trades associated with the longer distance CIP trades, and highest for the closer distance lower commitment FCA trades. These differences are statistically significant (the baseline estimate is CIP contracts). The FCA contracts are almost fully efficient, adjusting 95% of pricing errors within 1.3 months. For CIP contracts, the equivalent number is 3 months.

The remaining results in table 6 largely confirm the findings by contract type. Trades by plane are associated with more sluggish price updating. These are the CIP contract trades. For the non-factor attributes at the bottom of the table, we condition on the quartiles of the attributes. From these results, we can conclude that efficient trade relationships are non-committed trades to close markets of below average size, with large shipments using truck or boat. The H1, H2, and H3 columns test the hypothesis that β, α or both are equal across these attributes. The null of homogeneity is rejected for all attributes.

These results suggest that as the salmon market expands geographically, pricing heterogeneity increases. This again increases the variance of the cross-sectional distribution of trade prices. The more distant market trades will tend to sort to the tails of the cross-sectional distribution, and contributes to weakening the representativeness of a price index of the market. Since our measure of the common salmon price was the Fish Pool settlement price index, these results directly translate to the hedging efficiency using the Fish Pool futures. Hedging efficiency is weaker for transactions to the more distant Asian markets. This can also explain why these traders are normally more committed; committed contracts is a way to reduce transaction risk. The consequence is that these transaction prices will be less informative of the common salmon price. However, since these trades are fairly easily identified using contract type, they can be easily filtered out in the construction of a representative price index.

5. Conclusion

Norwegian salmon production has experienced considerable growth in the last 15 years. At the same time, concerted efforts by the Norwegian government and private industry has led to accompanied growth in markets for salmon. This has contributed to keeping the salmon price high and the industry profitable. However, the volatility of salmon prices has also increased in this period. Here, informative price indices remain a valuable tool to benchmark pricing of salmon, to plan investments, and to hedge price risk.

With growth in production and markets, it is somewhat surprising that the growth in futures trading has stagnated in a period of increasing volatility. Our results suggest that the stagnation of futures trading is not because the contract settlement price used is not representative of salmon transaction prices. We find that on average 85% of the change in the settlement price is reflected in transaction prices within one month, and that the majority of export price variation (around ¾) is due to changes in the cross-sectional mean price.

Even so, there is significant heterogeneity in how individual prices relate to the common price, and this is related to the geographical expansion of the Norwegian salmon market. Transactions to the newer high value markets in Asia are significantly less responsive to common market information than the traditional

European markets. One possible explanation for this is that it takes time for established networks in distant markets to mature. The high volume trades to closer low income markets are almost perfectly efficient (at a monthly frequency). For these trades, 95% of a price difference from the common price is corrected within one month. The latter efficient trades are associated with the use of FCA, while the less efficient trades are associated with CIP contracts. As such, contract type is a useful variable to segment destination markets in terms of pricing efficiency and to ensure an informative salmon price index as the market expands.

If practically feasible, excluding the CIP trades would improve the representativeness of the salmon price index further. However, given the already high baseline commonality in salmon pricing, sacrificing this coverage might not be worth possible accusations of bias in coverage. In addition, this is not likely to fix the participation problem in the futures market. The growth in the futures market was killed by the large salmon price drop in 2011, related to the recovery of Chilean production. Large speculative losses on long positions might have dissuaded investors from the market. In addition, the salmon price over the period that the exchange has been active has been trending upwards. Given this trend has not been predictable, the price trend has consistently favored the long side of contract, dissuading exporters from taking short positions in futures to hedge future sales of salmon. The results in this paper provides justification for a publically available salmon price index. Given its availability, a salmon price index can be a useful instrument to settle forward contracts, even if not facilitated by an organized exchange.

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TABLE 1. Descriptive price statistics, full sample, all prices in logs.

	Mean	Std.	Q05	Q50	Q95	Skewness	Kurtosis
p_{it}	3.53	0.23	3.19	3.51	3.90	0.13	2.17
$\Delta\ p_{it}$	0.006	0.115	-0.184	0.007	0.190	-0.17	4.98
$\Delta\ c_t$	0.005	0.094	-0.160	0.010	0.139	-0.34	3.38
$p_{it} - c_t$	0.06	0.12	-0.11	0.05	0.26	0.70	7.41
N_t	885	143	665	864	1130	0.31	2.27

Note: All prices in logs. N_t is the monthly number of trade relationships. The full information price is approximated by the salmon futures clearing price index.

TABLE 2. Estimation Results Individual Trade Price Adjustments

Unconditional Model

	Est.	S.E.	t-val.	p-val.
Beta	0.85	0.005	175.12	0.000
Alpha	0.52	0.010	52.51	0.000

Model conditional on price quantiles

	<10%	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	>90%
Beta	0.77	0.90	0.94	0.95	0.96	0.92	0.90	0.87	0.78	0.59
p-val.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.830	0.000
Alpha	0.58	0.73	0.77	0.59	0.60	0.60	0.58	0.58	0.54	0.46
p-val.	0.000	0.000	0.031	0.886	0.635	0.470	0.801	0.982	0.094	0.000

Note: p-values are significant difference from <10% baseline.

TABLE 3. Salmon trade attributes by contract type

	Contract type		
Trade attributes	CIP	DDP	FCA
Transport mode	Plane	Truck/boat	Truck/boat
Travel distance (km.)	7169	1306	1393
Market Size (GDP, Bill. USD)	1670	1272	722
Income (GDP/cap., USD)	26726	32765	17793
Shipment weight (kg.)	2278	8970	14818
Length of relationship (months)	17	14	11
Average price (NOK/kg.)	37.2	33.9	32.7

TABLE 4. Heterogeneity in efficiency conditional on trade attributes

	CIP		DDP		FCA		Other	
Contract type	Est.	p-val.	Est.	p-val.	Est.	p-val.	Est.	p-val.
β	0.82	~0.00	0.87	~0.00	0.93	~0.00	0.82	0.63
α	0.48	~0.00	0.53	0.023	0.61	0.001	0.53	0.04
Adjustment time (5%)	3.0		2.3		1.3		2.65	

	Plane		Boat		Truck	
Transport Type	Est.	p-val.	Est.	p-val.	Est.	p-val.
β	0.80	~0.00	0.87	0.93	0.87	0.00
α	0.52	~0.00	0.53	~0.00	0.47	~0.00
Adjustment time (5%)	2.9		2.3		2.5	

Attributes	Quantiles of attributes						
Adjustment times (5%)	<25%	25%-50%	50%-75%	>75%	H1	H2	H3
Travel distance (1000 km.)	1.6	3.2	1.9	3.1	~0.00	~0.00	~0.00
Market Size (GDP, Bill. USD)	2.3	1.7	2.6	3.6	~0.00	~0.00	~0.00
Income (GDP/cap., USD)	2.2	2.5	3.4	2.1	0.001	~0.00	~0.00
Shipment weight (kg.)	3.3	2.4	2.0	2.3	~0.00	~0.00	~0.00
Length of relationship	2.0	2.3	2.8	3.2	0.003	~0.00	~0.00

Note: H1: β homogenous, H2: α homogenous, H3: both homogenous.

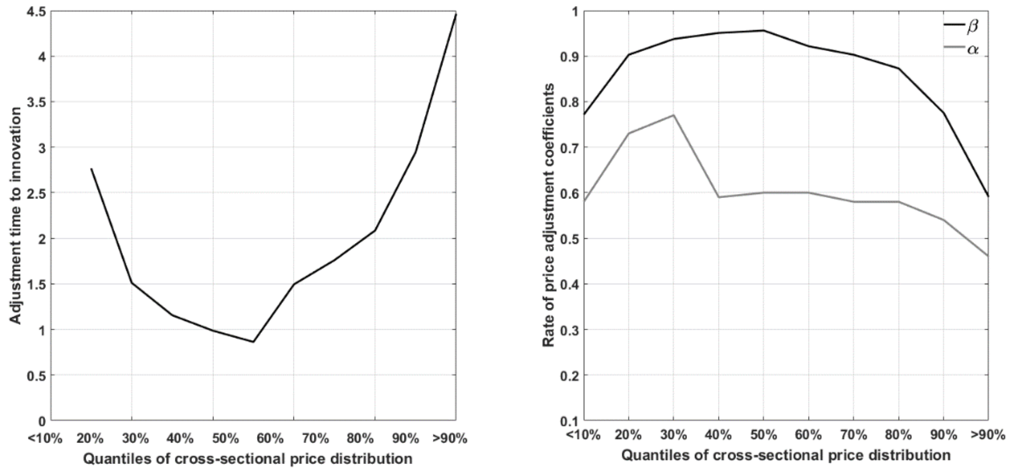

FIGURE 1. Sorting to the tails of inefficient trade prices. Left: time to correct 95% of a pricing error. Right: β and α estimates.

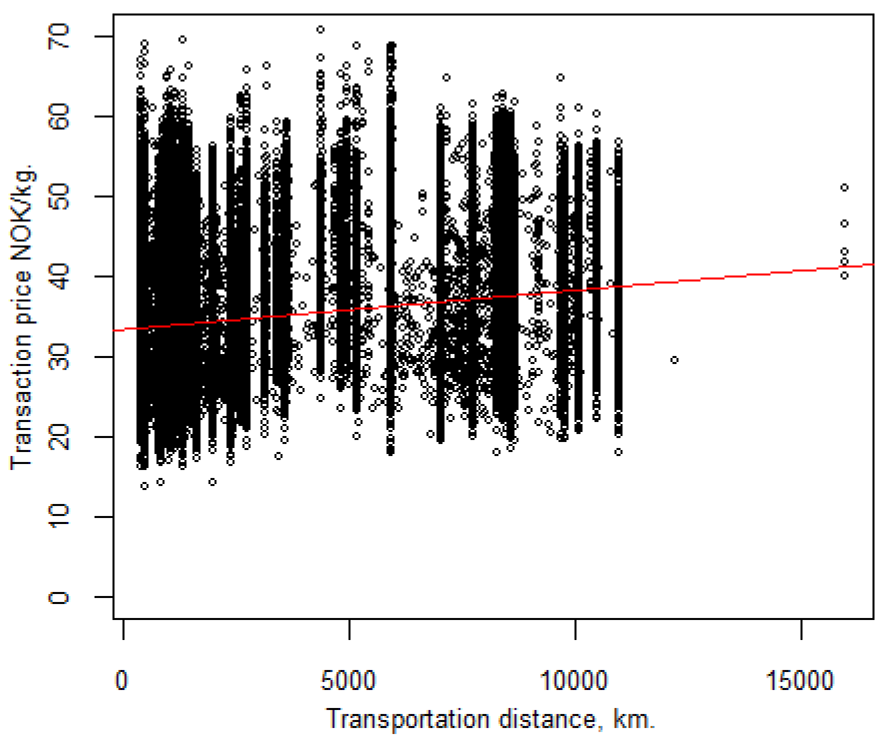

FIGURE 2. Scatterplot of transportation distance (km) and transaction price (NOK/kg). Red line is the regression line implied by the linear regression of price on distance.