Futures Market Hedging Efficiency in a New Futures Exchange: Effects of Trade Partner Diversification

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Abstract.

This paper uses transaction data to examine hedging efficiency in a new futures exchange; the Fish Pool salmon futures exchange in Norway. The paper utilizes data on firm level exporter/importer transaction prices to quantify firm level futures hedging efficiency. This allows us to address heterogeneity in firm level hedging efficiency. The main result of this paper is that larger firms with better trade partners diversification experience better hedging efficiency using the futures, which encourages them to participate in the futures market. Results are discussed in light of recent declines in participation in the salmon futures exchange.

Keywords: futures; hedging efficiency; trade; diversification

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Financial support from the Research Council of Norway (CT # 233836) is acknowledged.

1. Introduction

Well-designed futures contracts allow efficient hedging of price risk. This has been demonstrated for several futures contracts and exchanges (see for instance Lien, Lee, and Sheu (2018) for a recent overview). However, the success of any particular contract or exchange is not certain. Bernardo and Welch (2004) states that of the 250 contracts approved by the Commodity Futures Trading Commission from 1975 to the early 1990s, only about one third of contracts succeeded. In a detailed case study of the failure of the Minneapolis Grain Exchange black tiger and white shrimp future contracts, Martinez-Garmendia and Anderson (1999) point to weak hedging efficiency due to lack of commodity homogeneity relative to contract specifications. While the literature has provided many important characteristics of successful contracts and exchanges (Brorsen, Fofana, & Others, 2001; Gray, 1966; Pennings, Egelkraut, & others, 2003; Pennings & Meulenberg, 1997a, 1997b), there is relatively little empirical analysis of firm level determinants of hedging efficiency. To investigate hedging efficiency, much research relies on analyzing price aggregates such as spot price indices (see Lien et al. (2018) and references therein). While aggregates can inform on the hedging efficiency faced by some representative hedger, they cannot inform on how differences across firms in the markets translate to differences in hedging efficiency. This omission is important. It is fundamentally the decision of individual agents whether to participate in some futures market. A better understanding of how firm characteristics affects hedging efficiency can provide a more solid foundation to evaluate the successes and failures of futures markets.

In this paper, we utilize a unique data set of firm level exporter/importer transaction prices to investigate futures hedging efficiency at the firm level. The data covers the majority of first-hand exporter/importer transactions of farmed fresh salmon from Norway over the lifetime of the salmon futures exchange. It covers almost all individual first-hand transactions that would be relevant to hedge using the futures. This allows for a unique disaggregated analysis of determinants of hedging efficiency during the lifetime of a new futures exchange.

The start of a contract, or exchange, is a critical period. It is important that both buyers and sellers find the contract unbiased and representative of their transaction prices. This can be compromised if firm sizes differ systematically between buyers and sellers. With fixed costs of participating, larger firms are likely more willing to engage in futures hedging. In addition, with fixed transaction costs (i.e. costs of finding trade partners, negotiating contracts, etc.), larger firms experience scale benefits in diversifying transactions across multiple trade partners. This is important, as it allows firms to internally diversify the idiosyncratic price risk associated with single trade partners. By doing so, the diversified firm can better align its internal firm price to the futures price, or some other indexed price, that represents the common price in the market. In this paper, we hypothesize that larger firms that diversify transactions over multiple trade partners have better hedging efficiency using futures contracts, and that the more diversified firms will find participation in the futures market more valuable. The firm level transactions data is used to test this hypothesis. The presence of futures hedging benefits of trade partner diversification is relevant both as a suggestion for how firms can improve the benefit of participating in a futures market, and more generally to highlight a potentially important firm size factor to the success or failure of a futures contract or exchange. We discuss this in terms of the recent difficulties in the salmon futures exchange, and more generally on the value of participating in a futures market. The futures hedging benefit of diversifying across multiple trade partners is not restricted to the specific futures exchange examined in this paper. It requires that transaction specific risks can be diversified away by trading with multiple trade partners, and that the futures contracts hedge common market risk, which by construction is not hedged by partner diversification.

The empirical analysis investigates hedging efficiency in the exports of farmed salmon from Norway. Aquaculture is the world's fastest growing food production industry, providing a natural extension of the domain of control over seafood production, as agriculture did for land based production more than 10 000 years ago. Atlantic salmon is one of the most technologically advanced and successful aquaculture species, and Norway is the largest producer of Atlantic salmon. With growth in production and advances in technology comes a need for improved risk management tools. Here, futures markets can play an important role, as they have historically done for agricultural products. Futures contracts on salmon started trading in 2006. These are synthetic contracts with no physical delivery. Contracts are settled against an underlying price index, and marking to market and clearing operations are managed by NASDAQ.

In its first years, the exchange experienced a substantial growth in trading volume. However, in 2012 the futures exchange experienced a major drop in participation and a subsequent stagnation in participation (Asche, Misund, & Oglend, 2016; Misund & Asche, 2016). Interestingly, this occurred despite salmon price volatility having increased over the lifetime of the exchange (Asche, Oglend, & Zhang, 2015; Oglend, 2013), which would suggest higher demand for risk mitigation tools (Brorsen et al., 2001). The findings of this paper largely rules out that the lack of interest in the exchange can be ascribed to poor hedging efficiency. While sellers of salmon are larger and more diversified, and have on average greater hedging efficiency than buyers, the overall hedging efficiency of salmon transactions are high.

As an alternative explanation to the reduced participation in the exchange, we briefly discuss the impact of non-stationary price movements. Specifically, we hypothesize that a persistent and large decline in the salmon price in 2011 played a part in dissuading participation. This is only a conjecture at this time, as the data in this paper is not suitable to address the claim empirically. The claim is supported by the 2012 annual report of the exchange itself, in which the exchange state that “in the fall of 2011 the market experienced a historically large fall in the spot price. This led to buyers being less willing to enter new contracts. Sellers also wanted spot exposure rather than contracting”. A balancing of losses and gains through stationary price movements will more quickly reinforce benefits of hedging to both sides of futures positions. A large persistent price shock can lead to large one-sided losses, and might convince potential participants that the market is not worth participating in. This is especially critical when the futures exchange is new with little prior history to draw from.

The paper is structured as follows. In the next section, we present a discussion on the relation between firm diversification of transactions across multiple trade partners and futures market hedging efficiency. We arrive at a useful correlation transform that can be used to test the hypothesis excctly in a linear regression framework. The subsequent sections present the data, carries out the empirical analysis of the hypothesis, and provides a discussion of results and consequences on the value of participating in futures markets.

2. Futures Hedging Efficiency and Trade Partner Diversification

An important aspect of futures market participation is to what degree contracts are perceived as relevant to both buyers and sellers in the market. Balance can be threatened if hedging efficiency systematically favors one side of the market. This is not necessarily due to contract design, but can arise from structural differences between buyers and sellers. One aspect relates to firm size and trade partner diversification. To our knowledge, this has not been investigated in the futures market literature previously. In this chapter, we approximate transaction prices as consisting of a common pricing factor and an idiosyncratic transaction specific pricing factor. We use this approximation to show precisely how partner diversification influences hedging efficiency. The approximation is also used to develop a correlation transform that allows us to test empirically the effect of partner diversification on hedging efficiency in a linear regression framework.

Firms that diversify transactions across multiple trade partners will internally diversify away idiosyncratic price risk associated with single transactions. Their internal price should then better reflect purely common market pricing factors, and subsequently display lower basis risk against a representative futures contract in the market. More diversified firms will then potentially find it more attractive to participate in futures markets for hedging purposes.

To make this argument more precise, let P_{ijt} be a transaction price between some firm i and j at time t. We assume there exists a futures market with contract settlement price C_t, such that a contract entered at time $t-n$ at a futures price $F_{t-n|t}$ will at time t credit $C_t - F_{t-n|t}$ to the long position, and $F_{t-n|t} - C_t$ to the short position. In an efficient futures market with physical delivery, C_t will be the spot price of the contracted commodity. This clearing mechanism refers specifically to forward contracting with no marking to market updating of position values. As is well known, it applies equally well to a futures contract under the normal conditions of uncorrelated interest rates (Black, 1976).

We assume transaction prices outside a possibly fixed pricing term are proportional to a common pricing factor X_t in the market, such that each transaction price can be written as,

$$P_{ijt} = X_t \epsilon_{ijt} + \mu_{ij}, \quad (1)$$

where ϵ_{ijt} represents a stochastic idiosyncratic pricing component associated with the given transaction, and the time-invariant term μ_{ij} represents a fixed relationship-specific pricing term, i.e. a quality premium. The idiosyncratic term ϵ_{ijt} has mean $\alpha_{ij} > 0$ and (finite) variance σ_{ij}^2. We make no distributional assumptions, except the existence of the first two moments of the probability distribution of ϵ_{ijt}. That the component is idiosyncratic implies that $E(X_t \epsilon_{ijt}) = 0$ for all i, j. In (1), X_t represents common market risk, while ϵ_{ijt} represents transaction specific risk.

The contract settlement price C_t is representative of individual transaction prices, a necessary requirement for a well-functioning exchange traded contract. Statistically, C_t is assumed proportional to the common pricing factor, $\beta C_t = X_t,\ \beta > 0$. It follows that all transaction prices are proportional to the contract price, but with possibly different loadings on C_t. This implies that all transactions can be hedged using the contract. From (1), we then have that $P_{ijt} = \beta C_t \epsilon_{ijt} + \mu_{ij}$, and the loading of the contract price is $\beta\alpha_{ij}$;. comprising a common loading β and an individual loading α_{ij}.

Firm i trades with N_i unique trading partners. The N_i different transaction prices are aggregated to determine the internal firm transaction price, P_{it}. Prices are aggregated according to transaction volumes. Let S_{ijt} be the transaction volume, such that $S_{it} = \sum_{j=1}^{N_i} S_{ijt}$ is the total transaction volume of the firm. The firm i price then becomes,

$$P_{it} = C_t\beta\left(\frac{S_{i1t}}{S_{it}}\epsilon_{i1t} + \frac{S_{i2t}}{S_{it}}\epsilon_{i2t} + \cdots + \frac{S_{iN_it}}{S_{it}}\epsilon_{iN_it}\right) + \mu_{ij} = C_t\epsilon_{it} + \mu_{ij}, \tag{2}$$

where ϵ_{it} represents the diversified idiosyncratic pricing component. Specifically, the diversified risk factor ϵ_{it} has mean $\alpha_i = \beta\sum_{j=1}^{N_i}\frac{S_{ij}}{S_i}\alpha_{ij}$ and variance $\sigma_i^2 = \beta^2\sum_{j=1}^{N_i}\left(\frac{S_{ij}}{S_i}\right)^2\sigma_{ij}^2$.

It is useful to discuss common and idiosyncratic pricing in terms of their respective coefficients of variation. Ket $CV_i(N_i) = \sqrt{\frac{\sigma_i^2}{\alpha_i^2}}$ and $CV_C = \sqrt{\frac{var(C_t)}{E(C_t)^2}}$ be the coefficients of variation of the *idiosyncratic component* and *common component,* respectively.

It is well known that the maximum variance reduction possible by hedging, defining the hedging efficiency of the contract, is given by the squared linear correlation coefficient between P_{it} and C_t. Using (2), hedging efficiency can be written as,

$$corr^2(P_{it}, C_t) = \left(1 + CV_i(N_i)^2\left(1 + \frac{1}{CV_c^2}\right)\right)^{-1}. \tag{3}$$

Form (3), hedging efficiency increases in partner diversification N_i as long as the coefficient of variation of the idiosyncratic risk factor, $CV_i(N_i)$, decreases in N_i. More specifically, as long as marginal idiosyncratic risk, $CV_i(N_i + 1) - CV_i(N_i)$, is negative. This is clearly the case when individual coefficients of variation, $\frac{\sigma_{ij}^2}{\alpha_{ij}^2}$, are constant, in which case $CV_i(N_i) \propto \frac{1}{N_i}$. In general, marginal idiosyncratic risk decreases as long as the coefficient of variation of any new idiosyncratic risk taken on increases at a rate lower than N_i. As such, it is not given that greater diversification reduces transaction risk. If new transactions are sufficiently more risk than the existing portfolio, total firm price risk might increase.

Hedging efficiency increases when the coefficient of variation of the common price CV_C increases relative to $CV_i(N_i)$. This is intuitive as it is the common price variation that the contract hedges. As we will see later, this is important in order to explain inter-year variations in hedging efficiency. We have not considered the possibility that idiosyncratic risk components are partially correlated. For example, adding a trading partner from the same country already trading with provide a lower diversification benefit than a trading partner from a new market. Any positive correlation of new transaction with existing idiosyncratic pricing components will necessarily increase marginal risk.

3. Empirical Methodology

In the paper, we are interested in testing empirically whether the hedging efficiency using futures increases for firm that are more diversified across trade partners To this end, consider the following correlation transform, which follows directly from manipulating (3),

$$\frac{corr(P_{it},C_t)}{\sqrt{(1-corr(P_{it},C_t)^2)}} = \frac{\theta}{CV_i} \approx \gamma_i\sqrt{N_i}, \qquad \theta = \left(1+\frac{1}{CV_C^2}\right)^{-0.5}. \qquad (4)$$

The approximation is exact if $\frac{\sigma_{ij}^2}{\alpha_{ij}^2}$ is a constant across all transactions j. By a first order approximation, positive hedging benefit from diversification implies the one sided hypothesis, $\gamma_i > 0$. The correlation transform in (4) is defined over all real numbers, and modifies the relationship between hedging efficiency and number of trading partners to an approximate linear form. This allows application of linear regression tools for testing the hypothesis.

Figure 1 shows the relationship between $corr(P_{it}, C_t)$ and the number of trading partners for three specifications of CV_x, σ_{ij}^2 and α_{ij}, all assumed constant. The figure highlights how hedging efficiency increases in the number of trading partners, and increases monotonically across all number of partners to higher is the common factor variation relative to the idiosyncratic factor variation. The bottom panel shows the correlation transforms, which becomes linear in the square root of the number of trading partners as in (4). With fixed parameters, the relationship is exactly linear.

Evaluating the proposed hypothesis requires observations across different number of trade partners, N_i. We infer the hedging benefit of partner diversification using a cross-section of observed N_i and correlations. For inference, we estimate the following cross-sectional linear regression,

$$y_i = \mu + \bar{\gamma} z_i + \boldsymbol{X}_i \boldsymbol{\beta} + \varepsilon_i \, , \qquad (5)$$

$$y_{it} = \frac{corr(P_{it}, C_t)}{\sqrt{1 - corr(P_{it}, C_t)^2}},$$

where $z_i = \sqrt{N_i}$ is the (square root) of the number of average trading partners for trader i across its active trading period. A positive hedging benefit implies $\bar{\gamma} > 0$, where $\bar{\gamma}$ now represents an average across heterogeneous firms, and ε_i represents empirical residuals.

Controlling for Hedging Efficiency Heterogeneity

The empirical analysis uses observations of different exporting and importing firm. Such firms necessarily differ in other dimensions than just number of trading partners. We attempt to control for heterogeneity using a set of control variables $\boldsymbol{X}_i$. Anticipating the empirical analysis in the next section, we now summarizes and discuss these control variables.

First, we consider common gravity model variables such as *average geographical distance to markets (km from Oslo to the biggest city in the destination country)*, *average GDP per capita of destination countries,* and *average size of trading countries* (GDP). Because many exporters trade with multiple countries, these measures must be averaged across destination markets. We use transaction volume weighted averages. For instance, the *average distance to market* for trades made by exporter i is measured as the average distance travelled by a kilogram of salmon from this exporter in the sample. In the gravity model of international trade (see Head and Mayer (2013)), trade volume increases proportionally to the size of the market, and inversely proportional to the distance between markets. The trade literature suggests large heterogeneity in export prices at the product level, that prices increases with the geographical distance to the final destination market, and that the correlation between prices decline with trade distance. This last observation suggests that hedging efficiency will decline with trade distance; i.e. an exporter that that trades with close partners will have prices that better reflect the contract price. Variations in income and/or wealth might translate to variations in pricing through direct demand effects or different preferences across product attributes. It is not immediately clear in what direction income would translate to idiosyncratic pricing and hedging efficiency.

The data does not contain exact information about pricing terms in the trade contracts. However, it contains information on incoterms used. Salmon transactions use different incoterms for different destination markets (Oglend & Straume, 2018). As such, incoterm provides a convenient variable to segment transaction types. Three contract types account for 93% of all transactions; these are CIP, DDP and FCA contracts[1]. CIP contracts, which are essentially CIF contracts adopted to other means of transportation than by sea, are associated with trades using planes to distant markets, typically high paying markets in Asia such as Japan, Hong Kong and Singapore. DDP contracts are used for transportation by truck to closer higher income markets. These are the traditional export markets for Norwegian salmon, such as France, Spain, and the United Kingdom. FCA contracts are used primarily with larger bulk trades to the lower income close markets, such as Russia, Ukraine and Turkey. Since preferences over pricing terms might vary substantially across these markets, we include incoterm as a control variable in the regression.

Control variables also include transportation method used for shipments, differentiated by road, maritime and airfreight. As discussed above, transportation method is highly correlated with contract type as well as distance to market. The average size of transactions (tonnes) is also considered. Traditional theories of trade suggest that trade is stable due to large fixed costs of exporting (Baldwin & Krugman, 1989; Melitz, 2003). In this sense, average size can proxy for fixed costs of transactions.

Salmon price volatility varies systematically within the year due to variations in natural growth conditions for fish and demand seasonality (Asche, Oglend, & Selland Kleppe, 2017). To measure seasonal as well as inter-year variations in hedging efficiency, we utilize the fact that different traders are active in different months and years in the sample. Specifically, let $\boldsymbol{Z}_i$ be trader i's distribution of trading activity across each month of the season such that all elements of $\boldsymbol{Z}_i$ sum to one. Variation in this distribution between firms then allows us to identify seasonality in hedging efficiency. A similar distribution of differences in trading activity across years allows us to control for annual variation in hedging efficiency.

Finally, since number of trading partners do not necessarily capture all purely independent sources of price risk we also investigate the effect of trade partner concentration, measured as $conc_i = \sum_{j=1}^{N_i}\left(\frac{\#trans_{ij}}{\#trans_i}\right)^2$, where $\#trans_{ij}$ is the number of transactions between i and j, and $\#trans_i$ is the total number of transactions made by firm i. A purely specialized firm will have $conc_i = 1$. while $conc_i \rightarrow 0$ as the firm diversifies its transactions across more partners. For this variable, we use the the fisher transform of the correlation coefficient instead of the correlation transform as dependent variable. This alternative measure of hedging efficiency allows a robustness check for the results derived from regression (5), which is based on the statistical approximation of transaction prices discussed in chapter 2.

4. Data

The data used in the empirical analysis 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, covering a large share of the first hand market for Norwegian salmon. Data is from custom declarations provided by Statistics Norway, and gives anonymous id's for the exporting and importing firm, the date of the transaction, the statistical value (in NOK), the weight of the shipment (in kg), the incoterm used and the country of destination. Exporter/importer ids allow identification of number of unique trading partners for each exporter and importer, as well as exporter/importer specific transaction prices (FOB unit values).

There is a total of 784,813 transaction prices in the data over the sample period. To focus on active trade relationships for price inference, exporters and importers with less than 100 transactions over the whole sample period are removed. This leaves at total 86 exporters and 1152 importers. Each exporter made on average 9097 transactions, while each importer made on average 607 transactions in the sample period. Exporters are fewer and larger than importers. The Herfindhal concentration index over the sample is 0.13 for exporters, and 0.0044 for importers.

Figure 2 shows the empirical distribution of the number of different trading partners. The frequency is monotonically declining in number of partners, with a few exporters having a large number of importing partners. The concentration distribution shows a peak at full concentration, due to many importers trading with only a few or one exporter.

Table I shows some descriptive statistics of the data used in the estimation of hedging efficiency. The average correlation between transaction prices and the contract settlement price is 0.9 (S.E. 0.15) for exporters and 0.89 (S.E. 0.14) for importers. The median number of trading partners for exporters is 186, with 5% having 6 or fewer partners, and 5% having 158 or more partners. For importers, the median number of exporting partners is 5, and only 5% have 16 or more trading partners. This also reflects in the partner concentration measure. The median concentration for exporters is 0.13, and 0.75 for importers.

The contract price used to measure hedging efficiency is the salmon futures markets settlement price. The contracts have no physical delivery; instead, all contracts are settled against a synthetic salmon price (the Fish Pool Index, http://fishpool.eu/price-information/spot-prices/fish-pool-index/). The FPI is constructed by the exchange, and consists of weighted average of various salmon price measures[2], with a primary weighting towards exporter prices. The stated aim of the index according to the exchange is to give a correct reflection of the market price of salmon, and to remain transparent and neutral to all parties. Weights in the index have 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 clearinghouse for the contracts. Nasdaq settles all futures contracts daily against the synthetic settlement price. Hedging efficiency is determined by the correlation of transaction prices with the synthetic settlement price.

5. Empirical Results

This section explores empirically the relation between trade partner diversification and hedging efficiency, as well as providing some results on other determinants of hedging efficiency at the firm level.

5.1 Testing for a Representative Contract Price

We start out by investigating to what degree the salmon contract price is representative of average transaction prices in the market. In chapter 2, we defined a representative contract price as being proportional to the common pricing factor in the market. The representative contract price then satisfies $C_t = \beta E(\bar{P}_t)$, where $\bar{P}_t$ is the cross-sectional average transaction price.

For non-stationary prices, this can be tested consistently within the well-known framework of cointegration. Let $\bar{p}_t$ be the log of the cross-sectional average transaction, price and c_t the log contract price. The condition of representativeness implies $\gamma_1 = 1$ in the linear regression equation,

$$\bar{p}_t = \gamma_0 + \gamma_1 c_t + \varepsilon_t$$

where ε_t is a weakly stationary mean zero stochastic process. For non-stationary prices, representativeness means $\bar{p}_t$ is cointegrated with c_t with a cointegrating vector of $[1, -1]'$. This can be tested using the Johansen (1988) cointegration framework.

Table II shows some price descriptive statistics in addition to the test for representativeness. The mean transaction price and contract price have similar time series characteristics, however with the mean transaction price being on average slightly higher than the contract price. The relative price $\bar{P}_t/C_t$ is stationary, implying cointegration (we cannot reject that the price measure are I(1) as tested by the ADF unit-root test statistics). This result confirmed by the cointegration trace test results. A Likelihood ratio test for $\gamma_1 = 1$ fails to reject proportionality and the law of one price (p-value 0.2170), suggesting that the contract clearing price is representative of average transaction prices.

5.2 Hedging Efficiency and Partner Diversification

Before turning to regression results, we present some initial descriptive relationships between hedging efficiency and partner diversification. The top left panel of Figure 3 shows a scatter plot of the correlation transform and the square root of number of trading partners in the data. As the figure shows, the relationship is positive, indicating that firms with more partners have better hedging efficiency using the salmon futures. The top right panels shows the relationship between the price correlation and partner concentration. On average, more diversified firms better higher hedging efficiency.

The bottom left panel plots the relationship between the standard deviation of idiosyncratic price variation, defined as the standard deviation of the ratio, $\frac{P_{it}}{C_t} - 1$. The diversification benefit discussed in chapter 2 suggests that this volatility measure should be decreasing in the number of trading partners. The figure suggests that this is indeed the case. The bottom right panels provide a scatter plot of the (log) firm size (total transaction volume over the sample) and the (log) number of trading partners. On average, larger firms have more trading partners.

Table III shows the estimation results from the estimation of model (5). The dependent variable is the correlation transform. Independent variables include the square root of the number of trading partners, as well as control variables discussed above. Given the high correlations between transportation distance, transportation method, and incoterm used, table III reports result for each of these controls separately. The seasonal and inter-year control variables are not reported, we analyze these patterns separately below.

There is statistical significant increase in hedging efficiency (correlation between company price and contract price) as the number of trading partners increase. The coefficients refer to marginal effects at zero correlation (when efficiency is linear in trading partners). Since correlation are bounded, the marginal effect decreases as the correlation increases in magnitude. At a mean correlation level of 0.89, the estimated marginal effect of one additional trade partner is approximately 0.013. We will turn to a more detailed presentation of the diversification benefit below when we discuss results for exporters and importers separately.[3]

Trades over long distances, use of transportation by air, and use of CIP incoterms display lower hedging efficiency. This result is consistent with Shiue (2002) that shows that price correlations decrease in distance between regions. In general, larger transaction size is associated with lower hedging efficiency. In addition, trades to larger markets (in terms of GDP) is also associated with lower hedging efficiency. In total, the results suggest that the most efficiently hedged trades are associated with lower bulk trades over short distances to smaller markets, while large bulk trades over long distances to larger markets are less efficiently hedged. This can possibly be explained by differences in transaction pricing related to transaction risk. Large bulk trades over longer distances is reasonably associated with a higher risk and so would likely be carried out with a stronger degree of fixed pricing. Conversely, close and smaller shipments are more flexible and less risky, with potentially more spot trading contracts.

Figure 4 shows the relationship between price correlations and market size, average transaction size, average transportation distance and the share of transactions using airfreight. Results are predictions from the middle column model in table III, which has the highest R^2. In each panel, all other variables than the variable shown are fixed at their mean levels. This summarizes the findings discussed above.

Table IV builds on the results from table I and presents estimation results broken down by exporters and importers, as well as the alternative diversification measure - the rate of trade partner concentration. Here we use transport type as the distance measure as it provides highest explanatory power (the other measures, distance and contract type gives similar results).

The diversification benefit is present for both exporters and importers, with higher significance level for exporters, likely due to the larger variation rate of diversification for exporters (most importers are undiversified). We also see that exporters have higher hedging efficiency effect associated with large bulk shipments, interestingly this effect is opposite for importers. One possibility is that the less diversified importers prefer more fixed pricing when shipping large quantities.

The market size effect is not significant for exporters. Exporters a more diversified than the smaller importers, which makes identification of market specific effects more difficult, as cross-market variation is averaged across destination markets. Importers are located in a specific country, and so variation between importers can better explain variations due to destination market differences. Income is in general not significant, consistent with table 3, which suggest no clear association between income of destination market and hedging efficiency.

To better highlight the hedging benefit of partner diversification, figure 5 shows model predicted hedging efficiency for exporters and importers as a function of the number of trading partners (top), and (log) partner concentration (bottom). Predictions are from the model in table IV. For exporters, the effect is stronger. The correlation and hedging efficiency increases in number of trading partners, a similar pattern but to lesser degree is present for importers. We see that in terms of (log) partner concentration, the correlation declines in concentration for exporters, and to a weaker degree for importers.

5.3. Changes in Hedging Efficiency over Time

Figure 6 shows the average correlations across the season (top) and year (bottom) for both exporters and importers. The panels also show the coefficient of variation of the contract price. Part of the seasonal variation in hedging efficiency can be explained by the volatility of the common price (contract price). The correlation between exporter (importer) hedging efficiency and the contract price variation is 0.08 (0.43), R^2 of regression line fit is 0.01 (0.18). In general, hedging efficiency is lowest in the major production period of salmon; the fall when sea temperature during the summer has increased fish biomass. This is the period associated with lowest common price volatility. This points to one potential weakness of the contract, as this period is likely a period where producer hedging is attractive.

The role of common price variation is stronger when looking at inter year variations in hedging efficiency. The correlation between exporter (importer) hedging efficiency and contract price volatility is 0.80 (0.81), the R^2 of regression line fit is 0.64 (0.66). We can also see a weak increase in exporter hedging efficiency relative to importers over time. This is consistent with the consolidation of exporters into fewer and larger units over the sample period.

The coefficient of variation in the salmon price is at a maximum in 2011. The salmon price experienced a large persistent drop in 2011 associated with the unexpected recovery of Chilean salmon production following a period of large disease issues. In a six month period from April to September of 2011, the price of salmon declined by more than 50%. The price remained at this lower level well into 2013. Figure 5 and the results above suggests that this price drop was well hedged in the futures market.

Figure 7 shows the reported number of traded contracts for the exchange over the sample period. The exchange shows a consistent growth in trade up to 2011. In 2012, the number of traded contracts dropped substantially. Our results show that this decline in participation is unlikely to be due to weak hedging efficiency using the futures. It is tempting to ascribe the decline in interest in 2012 to the large price drop in 2011. Unfortunately, our data is not suitable to address this hypothesis directly. Intuitively, a large and persistent price shock can lead to large one-sided losses in the futures market. Such losses might convince participants that the market is not worth participating in. As noted in the introduction, the role of the price decline for the lack of interest is supported by the exchange in its 2012 annual report.

6. Hedging Efficiency and the Value of Futures Market Participation

We have demonstrated empirically that firms that diversify trade across multiple trading partners have improved hedging efficiency using futures. A natural question is then how such differences in hedging efficiency might affect the perceived value of participating in a futures market.

When discussing participation, we need to distinguish between intensive and extensive margin contract demand. Specifically, the intensive margin refers to demand for contracts from participants already participating the market. The extensive margin relates to the decision of entering the market or not. Much research on futures markets focus on the intensive margin, i.e. the optimal hedge ratio. However, for a futures exchange, the extensive margin is important in order attract participation.

Consider an anticipatory hedge where some exporter i uses the futures contract to hedge an uncertain next period firm price. Normalizing the transaction size to unity, the return from the anticipatory hedge is

$$R_{t+1} = P_{t+1} - X_i\left(C_{t+1} - F_{t|t+1} + \tau_{fut}\right),$$

where P_{t+1} represents the next period firm transaction price, X is the number of (short) contracts demanded (hedge ratio), C_{t+1} is the contract settlement price, $F_{t|t+1}$ the futures price at the time the hedge is initiated, and, τ_{fut} is the transaction cost per contract.

With mean/variance preferences, the exporter chooses contracts to maximize the risk adjusted valuation $V_{i,fut} = E(R_{t+1}) - \frac{\lambda_i}{2} var(R_{t+1})$, where λ represents the risk/return trade-off preference. The demand for contracts is then,

$$X_i = \alpha_i - \eta_t,$$

$$\alpha_i = \beta \sum_{j=1}^{N_i} \frac{s_{ij}}{S_i} \alpha_{ij}\ , \qquad \eta_t = \frac{E\left(C_{t+1} - F_{t|t+1} + \tau_{fut}\right)}{\lambda_i var(C_{t+1})},$$

where α_i is the loading of the contract price in the firms transaction price, and the second term on the right hand side is the expected unit hedging cost. The demand for contracts does not depend on the partner diversification benefit achieved by dispersing trade across multiple trade partners; demand depends on the loading of the futures price in the firm transaction price, not hedging efficiency level. Specifically, hedging efficiency determines the level of $V_{i,fut}$, but not the maximizing number of contracts. As such, when the decision is purely how many contracts to acquire (short or long) *once in the market*, the *level* of efficiency does not matter.

If the rate of partner diversification does not affect the net supply (or demand) for contracts once in the futures market, it will not affect any risk premium. Of course, this assumes risk preferences are independent of company size, as is implied by the mean-variance preferences. With decreasing absolute risk aversion, larger companies would have lower demand for contracts, which might induce a risk premium. However, such an effect is not due to the internal diversification benefit, but the size of the company.

While the level of efficiency does not affect the intensive margin demand for contracts, it can affect the decision to participate in the market or not. The net value of participating will depend on the best outside option. If the best outside option is spot trading, internal diversification has no effect on the net benefit of futures participation. This is because the benefit of diversification accrues equally to spot trading as to the futures market participation. However, this is not necessarily the case for all relevant outside options, such as bilateral forward contracting with fixed future transaction prices.

Finally, the futures price itself can potentially compensate for any unbalanced value of participation. In this case, a biased futures price, a “risk premium”, can compensate for unequal benefit transfers of participating. For instance, if short-sellers have greater net valuation of the futures market, they can attract buyers by offering futures prices at a discount. Strictly speaking, this would be an efficiency premium, not a risk premium, that works to balance initial inequities in the perceived value of the market. The presence of any such efficiency premium would be an interesting venture of future research. Of course, the necessity of balanced buyer/seller participation or benefit transfers through efficiency premiums will also depend on the risk aversion and/or capital constraint of speculators in the market.

7. Concluding Remarks

The results in this paper should be of general interest to futures markets. The paper has highlighted and documented a novel source of futures market hedging efficiency resulting from trade partner diversification, a source of hedging efficiency that comes in addition to other benefits to larger firms, i.e. fixed costs of participating. In this sense, as long as there exists systematic differences between the size of buyers and sellers in the market, this is likely to favor the larger firms in the value of participating in futures markets. This is not due to imperfect contract design; the benefit of partner diversification is due to better aligning the firm price with any common market risk factors, the factors that future markets are in general designed to hedge against.

Hedging is a long game. Stationary market conditions with balanced positive and negative price changes is more likely to reinforce the benefits of using the futures market for both sides of the market. A large and persistent one sided price change in the market is likely negative in terms of how futures market participants perceive the benefit of participating. The persistent and abrupt price decline for salmon in 2011, which was due to the largely unexpected recovery of Chilean salmon production, benefitted massively short hedgers, but necessarily led to large unrecovered losses for long speculators (unrealized gains for long hedgers). Given the exchange was relatively new and untested when the price shock occurred, it is likely to have dissuaded participation. Futures markets compete with other measures to hedge price risk. High hedging efficiency and low barriers to entry are important to secure participation. Partner diversification of idiosyncratic risk can reduce basis risk using futures, making the exchange more valuable to hedge the residual risk that partner diversification does not achieve. However, market volatility is likely to play a role as well. For a new exchange with no prior history to draw from, large and persistent price shocks leading to large one-sided losses, can possibly convince interested parties that participation in the exchange is not worth the risk.

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List of Figure Captions

FIGURE 1. Example relationship between correlation towards contract price and number of trading partners.

FIGURE 2. The distribution of number of trade partners and trade partner concentration. The blue line is and exponential function fit, $freq = \exp(-0.174 * \#parnters + 5.32)$.

FIGURE 3. Hedging efficiency and trade partner diversification.

FIGURE 4. Relationship between hedging efficiency and destination market size, average transaction size, average transportation distance and the share of transportation by air.

FIGURE 5. Model correlation predictions as function of trade partner diversification measures. Table 4 estimate used.

FIGURE 6. Seasonal and annual variation in mean hedging efficiency (blue) and mean price coefficient of variation (red).

FIGURE 7. Number of traded futures contracts on the Fish Pool Salmon exchange.

[1] 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.

[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).

[3] As a robustness check of the estimation results we re-estimated all models after first deseasonalizing all prices using monthly dummy variables. We also re-estimated the models on sub-samples before and after 2011. Results remain robust to these alternatives. Results are available on request.