Hedging Efficiency of Atlantic Salmon Futures

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Abstract

This paper examines the hedging properties of Atlantic salmon futures. Hedging is important since it allows for mitigation of the risk of adverse price changes in the spot market. We examine the hedging efficiency of three types of hedging strategies; unhedged, fully hedged and hedging using optimal hedging ratios. To find the optimal hedge ratio we use an estimated constant hedge ratio, optimal hedge ratios estimated with rolling 20-week and 52-week windows, and bivariate GARCH models. The results provide evidence that hedging using futures contracts listed on Fish Pool reduces risk for producers of farmed Atlantic salmon. The best hedging efficiency is achieved with a simple one-to-one hedge, closely followed by the bivariate GARCH approach.

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1. INTRODUCTION

For over 30 years, production of Atlantic salmon (*Salmo salar*) has been an important and rapidly growing industry globally. In 2013 production passed 2.5 million tonnes. This fast industry growth has led to an increase in the types of suppliers providing a variety of services contributing to productivity growth and competitiveness (Asche, 2008).[1] A key financial service increasingly becoming available to salmon producers and consumers is market places for trading of derivatives contracts such as forwards and futures.

It has long been argued that forward and futures contracts serve two key roles. The first is the transfer of risk from those who wish to reduce risk and hedge their price exposure to those agents with a risk appetite. The second role for futures prices is in providing an efficient price discovery mechanism, whereby the futures prices provide information about future spot prices. However, most new futures markets do not succeed and fail after a relatively short time (Brorsen & Fofana, 2001). The termination of shrimp futures contract trading at the Minneapolis Grain Exchange is an example of this as these futures contracts did not uncover an efficient price discovery role and provided a poor hedge (Martínez-Garmendia & Anderson, 1999; 2001). Moreover, a recent study has shown that salmon futures prices also do not provide a price discovery role (Asche et al., 2016). In fact, the spot price seems to lead the forward prices in the market for Atlantic salmon.

Although salmon seafood futures do not seem to serve a role as a price discovery mechanism in seafood markets, the contracts may still be relevant for hedging price risks as it can provide a mechanism for the transfer of risk from producers and buyers wanting to offload risk and speculators who have a risk appetite. Salmon prices are volatile (Oglend & Sikveland, 2008; Sollibakke, 2012; Oglend, 2013; Dahl & Oglend, 2014; Asche et al., 2015b), and can therefore represent a substantial risk factor for both salmon producers and buyers. Moreover, price is the main driver for salmon farming profitability (Asche & Sikveland, 2015). Hedging with futures contracts can potentially smooth revenues and substantially reduce risk management costs.

Whether the salmon future contract provides a good hedge is an empirical question which we address in this paper. We apply a set of hedging strategies to evaluate the hedging efficiency of salmon futures. The benchmark strategy is that of an unhedged producer, who is exposed to market risk in the spot market. The return variance of this strategy is then compared to the results for two types of hedging strategies, using the naïve one-to-one (fully hedged) approach, and four empirically estimated optimal hedging ratios; full-sample OLS (constant hedge ratio), 20-week and 52-week rolling OLS, and bivariate GARCH.

[1] Salmon is also a key contributor to the increasing trade with seafood (Anderson, 2003; Asche et al., 2015a).

The results suggest that the naïve one-to-one hedging strategy yields the highest hedging efficiency, closely followed by the bivariate GARCH method. While the constant OLS hedge ratio is quite close in hedging efficiency to the one-to-one hedge, it is, unlike the other strategies, a perfect foresight approach and therefore has its limitations for practical use. The rolling window OLS strategies performed the worst.

The rest of the paper is organized as follows. The next section presents the literature. This is followed by a description of the production process for Atlantic salmon. Section 4 presents the methodology, Section 5 describes the data. In Section 6 we present and discuss the results and section 7 concludes.

2. BACKGROUND AND LITERATURE

The production cycle for farmed Atlantic salmon (*Salmo salar*) goes through several steps (see e.g. Asche & Bjørndal, 2011) for a detailed description of the production process). The first is the production of juvenile salmon (smolt) in fresh water (Sandvold & Tveteras, 2014). After completing the smoltification phase, the salmon can be transferred to seawater where they are reared in sea-based pens. Next, the salmon are raised until they reach marketable size at 3-8 kilos over 16 to 24 months. The key determinants of the growth rate for salmon in this phase are size, feed conversion rate, feed quantities, seawater temperature and season. That the production process utilizes such biophysical factors cause substantial production risk. For instance, Tyholdt (2014) show how production varies with as temperature. Torrissen et al. (2011) discuss the impact of disease. Several papers have documented that this cause substantial production risk (Asche & Tveteras, 1999; Tveteras, 1999), which contribute to price volatility.[2] Moreover, a fall in salmon prices will lead to lower profitability, which may ultimately lead to an increase in the default probability of salmon producers (Misund, 2017).

As noted above, the key factor in explaining the substantial production growth for salmon is rapid productivity growth (Nilsen, 2010; Vassdal & Holst, 2011; Asche & Roll, 2013; Roll, 2013; Kumar & Engle, 2016). The effect of the productivity growth has been augmented by a substantial demand growth (Asche et al., 2011; Brækkan & Tyholdt, 2014; Brækkan, 2014), but as demand growth is uneven, also this can contribute to price volatility. Moreover, while futures contracts are an important tool in mitigating risk, there are a number of other approaches that are also important. These include horizontal and vertical integration (Kvaløy & Tveteras, 2008; Olsson & Criddle, 2008; Oglend & Tveteras, 2009; Asche et al., 2013a) and use of bilateral contracts (Kvaløy & Tveteras, 2008; Larsen & Asche, 2011; Asche et al; 2014; Straume, 2014).

The literature on hedging efficiency in seafood markets is scarce. This might be a result of a limited number of financial contracts available to a hedger. Martínez-

[2] Input factor prices also contribute to production risk, and particularly the highly volatile fish meal price (Kristofersson and Anderson, 2006; Tveteras and Asche, 2008; Asche et al., 2013b).

Garmendia & Anderson (1999) investigate the hedging effectiveness for shrimp futures and find a modest hedging effectiveness. They attribute the limited usefulness of the shrimp contracts to an inherent feature of the shrimp futures. These contracts include embedded exchange options, whose value are influenced by price volatility. The lack of trader interest in the shrimp contracts may be caused by a complicating factor inherent in the shrimp futures contracts. The futures contracts included embedded delivery category exchange options, making the contracts more complicated to use as hedging instruments. Hence, the findings in the shrimp market may not serve as a benchmark for hedging effectiveness in other seafood markets.

Recent studies on the spot-forward relationship in the salmon market have uncovered some interesting features (Asche et al., 2015c, 2016). Asche et al. (2016) examine price discovery in the salmon market, and find that the spot prices tend to lead futures prices. Moreover, Asche et al. (2015c) show that the convenience yield in salmon forward prices depends on expected stock growth, the expected price and the impact of growth on the future price. It is plausible that a time-varying risk premium in salmon forward prices could be affected by the same factors as identified by Asche et al. (2015c). These issues can affect the hedging efficiency of futures contracts for salmon.

The existing literature on hedging efficiency and performance of futures contracts, on the other hand, is voluminous, in particular following the pioneering work of Figlewski (1984). Studying U.S. data in the 1980s, Figlewski (1984) found that the minimum variance hedge ratio provided the most effective hedge compared to other hedging strategies. Since Figlewski (1984), two key themes of relevance for this paper have emerged in the extant literature. The first strand addresses the topic of the best method for determining the optimal hedge ratio. The conclusions from these studies are mixed. For instance, Holmes (1996) found that the optimal hedge ratio for stock indices estimated using OLS was superior to other methods such as GARCH. Other studies have found that other models in the GARCH family, or alternative methods such as VAR or error-correction models (EC), are superior to OLS when estimating the optimal hedge ratios for financial securities (Koutmos & Pericli, 1998; Lien & Tse, 1999). More recently, Lien & Shrestha (2008) compares the hedging effectiveness of seven stock indices, twelve commodities and five exchange rates. They find that the minimum variance ratio estimated by OLS is superior to one estimated using EC, when there is no structural change in the samples.

A second theme addresses the degree of risk reduction that can be attained by applying the optimal hedge ratio. The success of using futures contracts in terms of risk reduction varies across studies. According to Laws & Thompson (2005), the reasons for this variation can be attributed to i) whether the hedge is a direct or a cross-hedge, ii) type of asset (e.g. commodity or financial), and iii) choice of sample (within or post-sample). Of relevance for our study are the results from a studies on agriculture and seafood commodities. Lien & Shresta (2008) examines 24 commodities and financial assets spanning 10-18 years. Among the agricultural commodities, their results, based on a within-sample, suggest a decrease in risk (variance) from 32% for cotton futures to 90% for soya bean meal. This suggests that the efficiency can vary substantially among different commodities. In fact, Martínez-Garmendia & Anderson (1999) find a lower hedging effectiveness from selecting an optimal hedge as compared to the naïve strategy for shrimp futures contracts. Their results demonstrate a 16-21 percentage reduction in the variance for black tiger shrimp and 6-21 percentage reduction for white shrimp futures. This is substantially lower than the results from the study on agricultural commodities.

In conclusion, the literature suggests that hedging efficiency can vary substantially across methods for calculating the optimal hedge ratio, and across type of commodity. Moreover, the hedging efficiency for shrimp futures seems to be lower than other agricultural commodities. An interesting question is whether this finding also extends to other seafood derivatives contracts such as salmon futures contracts.

3. METHOD

The objective of our analysis is to examine hedging properties of salmon futures. Hedging can be an important tool for producers and buyers of Atlantic salmon since it allows for mitigation of the risk of adverse price changes in the spot market. To assess hedging efficiency we evaluate the performance of a set of hedging strategies. A hedging strategy creates a hedging portfolio by combining simultaneous positions in both spot and futures contracts and holding these contracts for a certain time period. The size of the futures position is determined by the hedge ratio, which is a measure of the number of futures contracts one needs to buy or sell in order to hedge the price risk. The effectiveness of the hedging strategy is then evaluated by comparing the minimum variance of the return on the hedging portfolio to the variance of an unhedged position in the spot market. The deviation in variance from the unhedged position is a measure of the hedging efficiency of a particular hedging strategy. In the following we describe this approach more in detail.

Hedging strategies

The literature suggests three types of hedging strategies. The first is an unhedged position in the spot market only, and will serve as our benchmark for comparison of hedging efficiencies. The second approach is a fully hedged portfolio, a so-called one-to-one hedge, where one enters into a futures position that is equal to in magnitude, but opposite in sign (Butterworth & Holmes, 2001). The assumption is that there are proportionate price changes in both markets offsetting each other and thereby eliminating risk. The third approach is to estimate optimal hedge ratios. The aim is to find the minimum variance hedge that minimizes risk, and which takes in account imperfect correlation.

The overall principle to estimate an optimal hedge ratio is based on portfolio theory and derive hedge ratios that minimize the variance of price changes (Johnson, 1960; Stein, 1961; Ederington, 1979; Figlewski, 1984). The starting point is the relationship between the spot and futures price. Let p_t^s be the expected spot price of the commodity at time *t*, and p_t^f be the current price for future delivery at time *t*.

$$\ln p_t^s = a + b \ln p_t^f \qquad (1)$$

The constant or deterministic variable a allows the price levels to differ. This will typically be the case when there is a convenience yield. On first difference form this relationship can be described as

$$r_{S,t} = \alpha + \beta r_{f,t} \qquad (2)$$

where $r_{S,t}$ and $r_{f,t}$ are changes in the natural logarithm of spot and futures prices from time *t-1* to time *t*, respectively. The parameter β describes the relationship between changes in futures and spot prices. If $\beta = 1$, the price changes are proportional, while if $\beta = 0$, then no relationship exists between the prices. Consequently, the β parameter can be used to determine how to hedge the risk in the spot price changes. The standard approach is to estimate the optimal hedge ratio as the variance-minimizing hedge ratio, h^*, of the covariance between spot and futures price changes to the variance of futures price changes

$$h^* = \frac{cov(r_{S,t}, r_{f,t})}{var(r_{f,t})} \qquad (3)$$

The optimal hedge ratio can be estimated empirically using various econometric techniques. We will apply two different methodologies, namely ordinary least squares with varying sample windows and bivariate GARCH.

Using ordinary least squares, the optimal hedge ratio can be found by estimating the following equation:

$$r_{S,t} = \gamma_0 + \gamma_1 r_{f,t} + u_t \qquad (4)$$

where u_t is the error term, γ_0 is the intercept and $\gamma_1$is the estimate of the optimal hedge ratio, h_{OLS}^*.

A limitation of the empirical model in Eq. (4) is that it makes the assumption that the risk in spot and futures markets is constant over time. However, if the joint distribution of spot and futures prices changes through time, this regression methodology will not correctly estimate the current risk-minimizing portfolio (Cecchetti et al., 1988). We therefore also estimate rolling OLS optimal hedge ratios using both 20 and 52 week rolling windows.

An alternative to rolling OLS is to apply the GARCH methodology of Bollerslev (1986), which allows volatility (risk) to change over time. In particular, the multivariate GARCH models of Engle & Kroner (1995) can be applied as it allows for the modeling of both variance and covariance. The following description of multivariate GARCH models relies heavily on Silvennionen & Teräsvirta (2009). First, we define the standard multivariate GARCH framework without a linear dependency structure in $\{\boldsymbol{r}_t\}$, where the latter is a stochastic vector process with dimension $N \times 1$ such that $E[\boldsymbol{r}_t] = 0$. Assuming that $\boldsymbol{r}_t$ is conditionally heteroskedastic, we can write

$$\boldsymbol{r}_t = \boldsymbol{H}_t^{1/2} \boldsymbol{\eta}_t \tag{5}$$

where the conditional covariance matrix of $\boldsymbol{r}_t$ is represented by the $N \times N$ matrix $\boldsymbol{H}_t = [h_{ijt}]$, and $\boldsymbol{\eta}_t$ is an iid vector error process such that $E[\boldsymbol{\eta}_t \boldsymbol{\eta}_t' = \boldsymbol{I}]$.

The next step is to specify the matrix process $\boldsymbol{H}_t$. Silvennionen & Teräsvirta (2009) describe four main classes. The first includes the VEC and BEKK models, while the second class includes factor models. The third class contains models where the conditional variances and correlations are modeled instead of the conditional covariance matrix. The last class includes semi- and nonparametric approaches. In our analysis we apply a model belonging to the third class, a dynamic conditional correlation (DCC) model. The DCC model is an extension of the constant conditional correlation (CCC) model of Bollerslev (1990). A limitation of the CCC model is that the restriction of constant conditional correlation may be unrealistic in practice. For this reason, Engle (2002) and Tse & Tsui (2002) introduced the dynamic conditional correlation (DCC) model which allows for the correlation matrix to be time varying with motion dynamics. Specifically, the conditional covariance matrix is specified as

$$\boldsymbol{H}_t = \boldsymbol{D}_t \boldsymbol{P}_t \boldsymbol{D}_t \tag{6}$$

where the $\boldsymbol{D}_t$ is the diagonal of the time-varying $h_{ijt}^{1/2}$ and $\boldsymbol{P}_t$ is the time varying correlation matrix

$$\boldsymbol{D}_t = \begin{bmatrix} h_{11,t}^{1/2} & 0 & \cdots & 0 \\ 0 & h_{22,t}^{1/2} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & h_{kk,t}^{1/2} \end{bmatrix}, \quad \boldsymbol{P}_t = \begin{bmatrix} 1 & \rho_{12,t} & \cdots & \rho_{1k,t} \\ \rho_{12,t} & 1 & \cdots & \rho_{2k,t} \\ \vdots & \vdots & \ddots & \vdots \\ \rho_{1k,t} & \rho_{2k,t} & \cdots & 1 \end{bmatrix}$$

Using a bivariate ($k = 2$) DCC-GARCH we can model the time-varying conditional correlations and variances, which allows us also to extract the time-varying conditional covariances for the spot and futures prices in our sample. We can then calculate the time-varying hedge ratio as

$$h^{*}_{bGARCH,t} = \frac{H_{12,t}}{H_{22,t}} \quad (7)$$

where H_{12} is the estimated conditional covariance between spot and futures price changes, and H_{22} is the estimated conditional variance of the futures price changes.

Hedge performance evaluation

Following Martínez-Garmendia & Anderson (1999), we evaluate the hedging performance by taking the variance of the revenues from the hedging portfolios. We define the revenues from the hedging portfolios as

$$r_{p,t} = r_{S,t} - h^{*} r_{f,t} \quad (8)$$

where $r_{p,t}$ is the revenues of the hedging portfolio, $r_{S,t}$ is the return on the spot position, $r_{f,t}$ is the return on the futures position and h^{*} is the hedge ratio applied. Eq. (8) implies that a long position is taken in the spot market, offset by a short position in the futures contract. The size of the position in futures is determined by the hedge ratio. For the unhedged portfolio, h^{*}=0 and for the fully hedged portfolio, h^{*}=1. In addition we apply three methods for estimating optimal hedge ratios. The first calculates a constant hedge ratio as the slope of a univariate ordinary least squares regression. The second approach aims to calculate a time-varying hedge ratio using ordinary least squares regressions over rolling periods of the previous 20 weeks following Martínez-Garmendia & Anderson (1999). We also apply a 52-week rolling window. Finally, we apply a bivariate GARCH model to estimate the optimal hedge ratios based on the estimates of conditional covariance between the future and spot price returns, and the conditional variance of the futures price returns.

We calculate the returns on the hedging portfolio for the last 4-5 weeks before maturity of the front month contract. The hedging efficiency is measured as the variance of the returns on the hedging portfolio.

4. DATA

For the spot price we use the Fish Pool Index, FPI™ (www.fishpool.eu) which is a reference price calculated in order to facilitate settlement of forward contracts. This FPI spot price is a weighted average selling price based on several inputs (see http://fishpool.eu/default.aspx?pageId=8 for more information). The FPI is calculated on a weekly basis.

The monthly contracts consist of 4 or 5 weeks as defined by Fish Pool. A week starts at Monday 00.01 hours and ends on Sunday 23.59 hours. All financial contracts at Fish Pool are settled monthly against the FPI™. Futures price are settled on a daily basis, and we use the price on the last business day in the week in order to make the price time-consistent with the spot prices.

The futures contracts are traded from date of listing until the second Friday after the delivery period. The trading of the contracts into the delivery period has the consequence that the prices in this period incorporate observations of the realized spot price in the same period. In order to avoid the problems with this, we only use the forward observations before the delivery period. That is, we define the maturity date of the futures contracts as the last business day before the start of the delivery period.

We collect weekly spot and futures price observations from June 2006 to June 2014. One observation of returns in December 2010 was eliminated since it was considered to be an outlier. The last week of December is often an odd week as there is strong seasonality in the demanded quantity (Asche, 1996), and very limited trading the last week due to the holidays (Asche & Bjørndal, 2011).

The descriptive statistics are presented in Table 1, and shows that the spot prices are more volatile than the front month contract, in line with the Samuelson effect (Samuelson, 1965).

Table 1: Descriptive statistics

	Mean	St.dev	25 percentile	Median	75 percentile
$r_{S,t}$	0.023	6.094	-4.211	-0.079	3.958
$r_{p,t}$	0.207	2.798	-1.105	<0.001	1.802

Note: $r_{S,t}$ are weekly returns on the spot price, and $r_{p,t}$ are the weekly returns on the front month futures contract. The numbers are in percent.

We test for ARCH effects in the data using the ARCH lagrange multiplier test of Engle (1982). We find significant ARCH effects for all lags, suggesting that the time series exhibits conditional heteroscedasticity (Table 2). We can therefore conclude that we can use the GARCH model in remaining analysis.

Table 2: ARCH effects tests

	1	5	10
$r_{S,t}$	2.870*	12.779**	18.649**
$r_{p,t}$	6.372**	36.265***	39.624***

Note: $r_{S,t}$ are weekly returns on the spot price, and $r_{p,t}$ are the weekly returns on the front month futures contract. Engle's (1982) lagrange multiplier test is used to test for ARCH effects in the spot and futures returns under the null hypothesis of no ARCH effects. The levels of significance is denoted by asterisk: *: p<0.10, **:p<0.05, and ***:p<0.01.

We test the variables for stationarity using the augmented Dickey-Fuller test, both with and without constant and drift and (Table 3).

Table 3: Unit root test (ADF)

	ADF no trend	ADF with trend
$r_{S,t}$	-18.018***	-18.061***
$r_{p,t}$	-11.738***	-12.002***

Note: the ADF test is the augmented Dickey Fuller test of Said & Fuller (1984). The null hypothesis that there is a unit root. The levels of significance is denoted by asterisk: *: p<0.10, **:p<0.05, and ***:p<0.01.

5. RESULTS AND DISCUSSION

The mean of the optimal hedge ratios with the different approaches is reported in Table 4. We find quite high hedge ratios, ranging from 0.94 to 1.06. The lowest optimal hedge ratios are found for pooled OLS across all observations and the 52 week rolling OLS approaches. The 20 week OLS method gives the highest average optimal hedge ratio at 1.06, closely followed by the bivariate GARCH approach at 1.05. However, the former approach also results in also the highest dispersion with a coefficient of variation of 67%, while that of the bivariate GARCH approach is 21%. The bivariate GARCH method clearly results in more stable hedge ratios compared to the rolling OLS estimates. Possible reasons are that the bivariate GARCH model optimizes the weights on recent compared to earlier observations, while the OLS approach allocates an equal weight to all observations in the estimation window. The choice of window length for the OLS approach is also arbitrary, while the bivariate GARCH approach optimizes based on all previous observations.

Table 4: Hedge ratios

	Constant	Rolling 20 week OLS	Rolling 52 week OLS	Bivariate GARCH
Mean	0.941	1.058	0.940	1.048
St.dev		0.706	0.279	0.220
Min		-0.509	0.201	0.384
Max		3.153	1.485	1.406

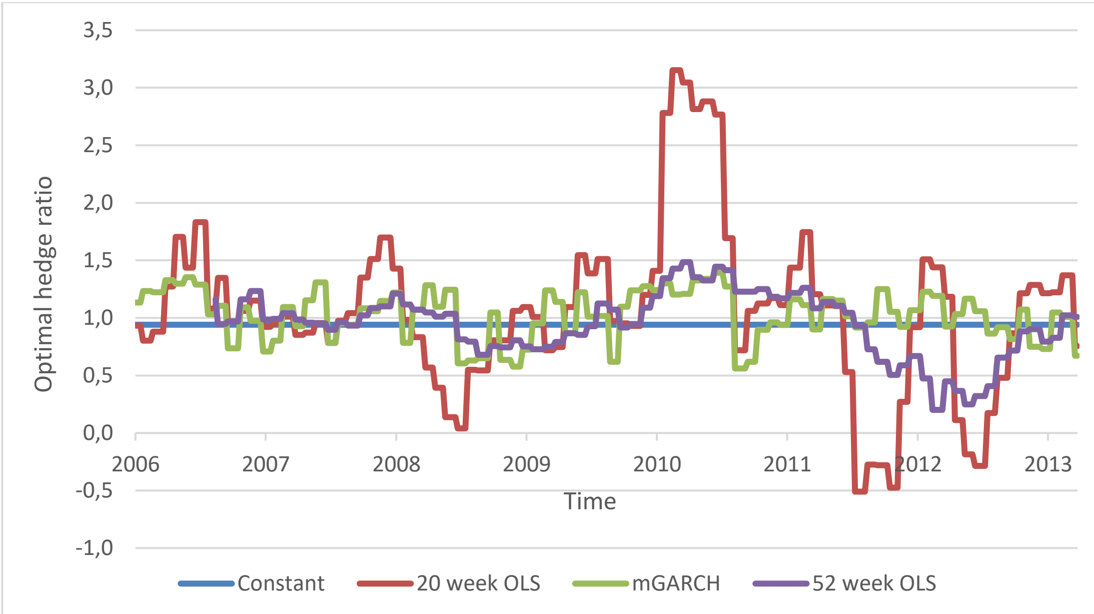

Figure 1: Constant and optimal hedge ratios

The efficiency of the hedging strategies is presented in Table 5. The average holding period return for the strategies ranges from -0.7% to +0.6%, with the 20 week rolling OLS hedge yielding an average holding period return closest to 0. The return variance for the unhedged portfolio (Table 5, column 2) is 0.01356 and will serve as our benchmark to evaluate hedging efficiency. The one-to-one hedging strategy (Table 5, column 3) results in a hedging efficiency of 38.5%, closely followed by the constant hedge ratio at 38.3%. The similarities of these values are a result of the constant hedge ratio being close to 1. The one-to-one strategy is a naïve strategy, and a reasonable approach for making hedging decisions if there is a lack of other information. On the other hand, the constant hedge ratio is estimated over all the observations and is in reality an *ex post* estimate, and is therefore unreliable for making hedging decisions. For this reason it is more appropriate to examine the hedging efficiencies of the three other strategies, the 20-week and 52-week rolling OLS, and the bivariate GARCH methods. The time-varying hedge ratio estimated using a 20-week and 52-week rolling OLS resulted in a hedging efficiency gain of 27.1% and 29.0%, respectively. Interestingly, the bivariate GARCH approach yielded a better hedging efficiency (36.1%), slightly below the fully hedged strategy. This suggests that the hedging efficiency of the bivariate GARCH method can potentially be improved by optimizing the bivariate GARCH model. This is a topic for further research.

Table 5: Hedging efficiency

	Simple hedges		Optimal hedges			
	Unhedged (h*=0)	Fully hedged (h*=1)	Constant h*	20 week rolling h*	52 week rolling h*	bivariate GARCH h*
Mean	0.00653	-0.00614	-0.00539	0.00044	0.00143	-0.00684
Variance	0.01356	0.00835	0.00840	0.00991	0.00965	0.00868
Effectiveness		-38.5%	-38.3%	-27.1%	-29.0%	-36.1%
N	92	92	92	88	80	92

Note: h* denotes the optimal hedge ratio.

6. CONCLUSIONS

The production of farmed Atlantic salmon has been rapidly growing since the 1980s. Consequently, there are an increasing number of suppliers identifying the salmon industry as a potential market for providing a variety of services. These suppliers contribute to continued productivity growth and competitiveness (Asche, 2008; Roll, 2013). An example of such a service is a well-functioning derivatives market. This is important since salmon prices have been found to be volatile, and derivatives such as futures contracts allow Atlantic salmon producers to hedge their market risk exposure.

The objective of this paper is to investigate the hedging effectiveness of Atlantic salmon futures. We find evidence that hedging salmon market risk using futures contracts results in a reduction in risk of approximately 30-40%. This is higher than for other seafood markets such as black tiger shrimp and white shrimp, but lower than for agricultural commodities. This can suggest that the salmon futures market has not reached the same level of maturity as other, more established, commodity markets.

Moreover, comparing various methods for estimating optimal hedge ratios we find that the two best methods are a simple one-to-one hedge and a more advanced bivariate GARCH methodology. The relatively good hedging performance of the salmon futures is in stark contrast to the results of for shrimp futures. Hence, the fact that the salmon futures contract provides a hedge can be an important factor in ensuring that the salmon contract does not suffer the same fate and gets terminated.

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