Production Risk and the Futures Price Risk Premium?

by

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Abstract

Typically, the risk premium in futures prices is examined by regressing the *ex post* risk premium on the *ex ante* spot-futures price basis. However, recent studies suggest that industry specific production factors as well as the basis can influence the relationship between spot and futures prices. The Atlantic salmon market is a market where risk associated with special production characteristics may affect the spot-forward relationship. Futures markets have recently been introduced for aquaculture products, and an understanding of the specific risk factors is important if these markets are to succeed. Using spot and futures prices as well as a set of industry specific variables, we seek to explain the variation in the risk premium in salmon futures by the variation in the basis. We find that shocks in key production variables help explain the variation in the risk premium along the forward curve.

Key words: Atlantic salmon markets, Forward prices, Risk premium

JEL codes: G13, G14, Q22

1. INTRODUCTION

Studies that investigate commodity price risk premiums typically follow the Fama-French (Fama and French, 1987; 1988) approach of regressing the *ex post* risk premium (i.e. the realized risk premium) on the *ex ante* basis, leaving out other latent explanatory variables. However, a growing literature suggests that in some markets additional industry specific variables help explain variation in the risk premium (Botterud, Kristiansen and Ilic, 2010), as industry specific production factors influence spot price as well as price for futures. This evidence in this literature is mostly from a highly perishable commodity, electricity, and there is limited evidence of this feature from other markets (Bessembinder, 1993). The production process in aquaculture implies a potential to be an industry with similar characteristics for the risk premium (Asche, Oglend and Zhang, 2015). A futures market has recently been established for Atlantic salmon market, and in this paper we test whether industry specific variable affect the spot-forward relationship.

A key characteristic of electricity generation is the lack of storability, effectively disqualifying the popular Theory of Storage (Working, 1933, 1934, 1948, 1949; Kaldor, 1939; Brennan, 1958; and Telser 1958) as a relevant theoretical framework for explaining the spot-forward relationship in this particular market. This defining feature has favoured empirical studies based in the alternative hedging pressure theory (Keynes, 1930) in power markets. The latter theory explains the difference between the expected spot and futures prices in terms of a risk premium. In fact, Bessembinder and

Lemmon (2002) demonstrate that the risk premium in electricity markets is related to the variance and skewness of the wholesale spot price and power demand risk.

Following Bessembinder and Lemmon's (2002) seminal equilibrium theory for the power risk premium, several authors have applied their model to examine the impact of power industry fundamentals to risk premium. Longstaff and Wang (2004) find risk premiums directly linked to economic risk factors such as the volatility of unexpected changes in demand, spot prices and total revenues. Botterud, Kristiansen and Ilic (2010) find that the relationship between spot and futures prices is clearly linked to the physical state of the system, such as hydro inflow, reservoir levels and demand. Several studies relate the risk premium to indirect storage, either in the form of water reservoir levels (Bühler and Müller-Mehrbach, 2009; Lucia and Torro; 2011) in hydropower generation or underground natural gas storages in gas fired power generation (Douglas and Popova, 2008). Van Treslong and Huisman (2010) also relate empirically forward risk premiums to indirect storability. Redl and Bunn (2011) find that the forward premium in electricity is a complex function of fundamental, dynamic, market conduct and shock components. In summary, several studies of the electricity markets suggest that risks associated with the production process can help explain the variation in risk premiums.

According to Botterud, Kristiansen and Ilic (2010), market participants follow an optimization model, which takes into account key variables in relevant for electricity generation, such as weather and temperature forecasts, reservoir levels, inflow forecast, fuel prices, imports and exports, and the supply/demand balance in the market etc. This resembles the production process for Atlantic salmon, where market participants model key variables relevant for Atlantic salmon production such as seasonality and water temperature, stock size (biomass), feed supplies, feed prices and exports, and the supply/demand balance in the market. Asche, Oglend and Zhang (2015) studied the convenience yield that emerges in markets with productive stocks, using Atlantic salmon as a case study. They show that convenience yield depends on expected stock growth, the expected price and the impact of growth on the future price. Furthermore, the price development depends on key elements in the production process, such as sea water temperature, biomass, etc. This implies that the spot-forward relationship is affected by industry-specific factors.

Futures markets have only recently been introduced for aquaculture products, and an understanding of the specific risk factors is important if these markets are to succeed. However, most new futures markets do not succeed and fail after a relatively short time (Brorsen and Fofana, 2001). The rise and decline of shrimp futures contract trading at the Minneapolis Grain Exchange is an example of this. It is plausible that the failure of the shrimp derivatives market can explained by the latter contracts lacking critical roles in terms of price discovery and hedging efficiency (see e.g. (Martínez-Garmendia and Anderson, 1999; 2001). In this paper, the price premium for salmon futures traded at

Fish Pool is investigated, augmenting the Fama-French model with biophysical factors important for salmon production.

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

Aquaculture has been the world´s fastest food production technology during the last three decades, and production of salmon has increased even faster, making it one of the most successful aquaculture species (Asche et al., 2015). The success of salmon aquaculture can be explained by a substantial productivity growth (Roll, 2013), which to a large extent is caused by more sophisticated input providers and supply chains (Asche et al., 2014; Sandvold and Tveteras, 2014; Straume, 2014). Several studies have showed that salmon prices are highly volatile (Sollibakke, 2012; Oglend, 2013; Dahl and Oglend, 2014), and a futures market was established in 2006 to help handling this risk.

Recent studies on the spot-forward relationship in the salmon market have uncovered some interesting features. Asche, Misund and Oglend (2015), examining price discovery in the salmon market, find that the spot prices tend to lead forward. Asche, Oglend and Zhang (2015) 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.[1] It is likely that a time-varying risk premium in salmon forward prices could be affected by the same factors as identified by Asche, Oglend and Zhang (2015). Moreover, insights into the effect of production related factors on the forward/futures price risk premium can be gained from studies in electricity markets.

Although salmon seafood futures do not seem to serve a role as a price discovery mechanism, the contracts may still be relevant for hedging price risks. There is very limited knowledge about the role of salmon forwards and futures as mechanisms for the transfer of risk. The latter role is important since derivatives serve an important role as a mechanism for the transfer of risk from producers and buyers wanting to offload risk and speculators who have a risk appetite. One would expect that this would also be the case for the salmon market. Salmon prices are volatile (Sollibakke, 2012; Oglend, 2013; Dahl and Oglend, 2014), 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 and Sikveland, 2015). Hedging with futures contracts can potentially smooth revenues and substantially reduce risk management costs. Nevertheless, studies on shrimp futures found that this contract did not constitute a relevant hedging tool (Martínez-Garmendia and Anderson, 1999). If this finding also

[1] This is not surprising as salmon aquaculture is an industry with substantial production risk (Asche and Tveteras, 1999; Torrissen et al., 2011).

extends to the salmon market is important to investigate. In this paper we indirectly examine the effects of hedging on the spot-forward relationship by studying the futures price risk premium. The existence of risk premium in Atlantic forward prices is indicative of the use of these contracts for hedging. The hedging pressure theory serves as the theoretical framework for the risk premium, and is explained in the next section.

3. METHODOLOGY

According to the hedging pressure theory, the difference between the futures price and the future spot price is the bias of the futures price (also referred to as the risk premium)

$$E_t[P_{t,T}] = F_{t,T} - E_t[S_T], \qquad (1)$$

where $E_t[.]$ is the expectations operator at time t, $P_{t,T}$ is the risk premium, $F_{t,T}$ is the futures price observed at time t for maturity at time T ($T>t$) and S_T is the spot price at time T. The difference between the futures price and the current spot price can be written as the sum of an expected premium and an expected change in the spot price

$$F_{t,T} - S_t = E_t[P_{t,T}] + E_t[S_T - S_t], \qquad (2)$$

where $E_t[S_T - S_t]$ is the expected change in the spot price. Fama and French (1987, 1988) develop an empirical methodology for testing the relationship in Eq. (2).

Specifically, this approach tests for time-varying expected premiums with the following regressions of the premium on the basis:

$$F_{t,T} - S_T = \alpha_1 + \beta_2 B_t + \varepsilon_T \tag{3}$$

where B_t is the basis, calculated as the difference between $F_{t,T}$ and S_t observed at time t, and ε_T is the error term. The hypothesis is that the predictable variation in realized premiums is evidence of time-varying expected premiums. Formally this is tested as a standard F-test test on coefficients. If β_2 is positive and statistically significant this is evidence of the existence of time varying risk premium. However, research results from studies using this approach have been mixed in terms of the existence of a time-varying risk premium. A plausible explanation could be that the empirical model in Eq. (3) is too simple, and suffers from model misspecification issues such as the omitted variables bias. We therefore find it appropriate to augment the Fama-French model with some industry-specific production factors.

In this section we propose to augment the standard Fama-French approach with the risk and industry-specific factors identified in the three preceding sections. To simplify the time notation, we will in the remainder of the paper refer to time t as both the maturity of the forward contracts, and the time (measured in months) of the observation of the variables. RP_t will represent the realized risk premium observed in month t and calculated as the difference between the forward price as observed at time *t-n* (where *n* is the number of time periods to maturity, e.g. *t-1* refers to the 1 month (or front month) contract), and the observed spot prices during month *t*. Equation (4) is modified as follows

$$RP_t = \alpha_1 + \beta_1 B_{t-n} + \sum_{i=1}^{i} \beta_i CV_{i,t} + \varepsilon_t^{rp} \qquad (4)$$

where RP_t is the realized risk premium in month *t*, B_{t-n} is the difference between the spot price at time *t-n* and the forward price for time *t* observed at time *t-n*. $\boldsymbol{CV_{i,t}}$ is a vector of supplementary variables observed for month *t*. The models in Eq. (4) is estimated for maturities *n* = {1, 2, 3} months. The additional variables $\boldsymbol{CV_{i,t}}$ are

1) ΔBIO_t: Growth in biomass, measured as the change in the logarithm of the quantity of live Atlantic salmon from time *t-n* to *t*.
2) *ΔPROt*: Growth in harvest, i.e. the logarithm of the change in quantity of salmon slaughtered and processed from time *t-n* to *t*.
3) $Temp_t$*: Temperature deviance (shock) measured as the difference between the observed temperature and a seasonal normal temperature: $Temp_t - \overline{Temp_t}$, where $Temp_t$ is the average temperature in month *t* and $\overline{Temp_t}$ is a set of 12 average monthly temperatures calculated across all observations.

We also estimated models including the variance and skewness of the spot price in line with Bessembinder and Lemmon (2002). However, the coefficients on these variables were not significant, and were omitted from the analysis.

We estimate the models using ordinary least squares. Since we use variables in the form of a time series, they can potentially be affected by autocorrelation. The residuals are therefore tested for the presence of both serial correlation and heteroskedasticity. We examine the presence of autocorrelation using autocorrelograms, Box-Ljung (Ljung and Box, 1978) and Breusch-Godfrey tests (Breusch, 1978; Godfrey, 1978). Heteroskedasticity is tested using the Breusch-Pagan test (Breusch and Pagan, 1979).

4. DATA

Our spot price is based on 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. As our spot price we use an average of 4 or 5 weekly FPIs according to Fish Pool's product specification for futures contracts. For instance, if the January 2011 forward contract consists of the weeks 1 through 5, we average the FPIs in weeks 1 through 5 to calculate the January 2011 Spot price.

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^{TM}. Futures price are settled on a daily basis, and we average the daily prices into a monthly futures price. For instance, we calculate the average monthly price for all contracts throughout the contract's lifetime. This gives us monthly observations of the contracts and allows us to sort the observations by time to maturity. For instance, we sort all the one month to maturity observations, the two months to maturity, etc.[2] We use monthly observations for 1 month to 12 months to maturity.

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. Following Asche, Misund and Oglend (2015), we define the maturity date of the futures contracts as the last business day before the start of the delivery period.

We collect use spot and futures price observations from June 2006 to June 2014, resulting in 89 monthly observations.

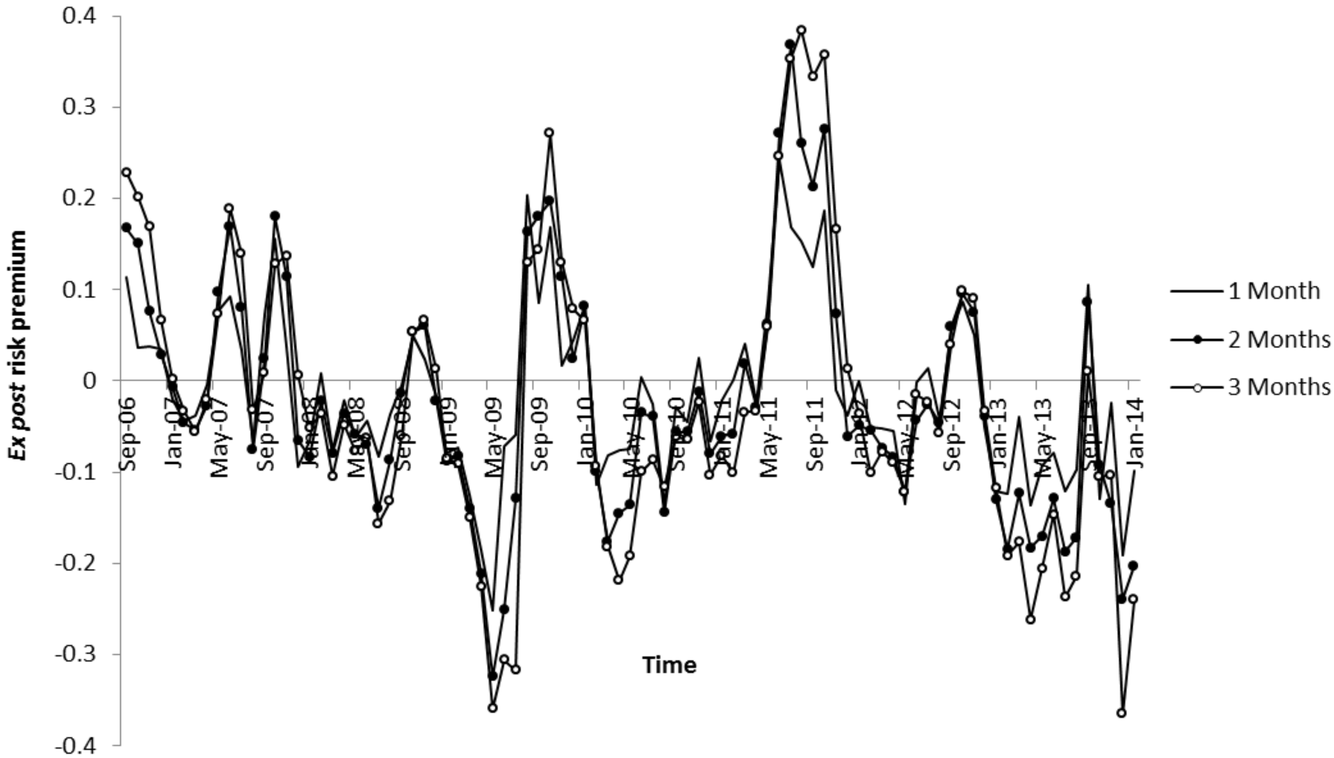
[2] Specifically, the "one month" to maturity is actually on average 0.5 months to maturity since it includes observations which range from 4 to weeks to maturity until 1 week to maturity.

We collect monthly observations of Atlantic salmon biomass and harvest in Norway from the Norwegian Fisheries Directorate (www.fiskdir.no). The biomass (ΔBIO) and production (harvest, ΔPRO) variables are calculated as log changes in monthly quantities.

We collect daily sea water temperatures from the Norwegian Institute of Marine Research (www.imr.no). These temperatures are averaged to monthly temperatures. The temperature shock variable is calculated as the difference between the observed monthly temperature (between 2006 and 2014) and a seasonal normal monthly temperature. To calculate the seasonal normal sea water temperature we use the entire time series of temperatures collected from 1971 to 2014.

Table 1 shows the descriptive statistics for the natural logarithm of salmon forward and spot prices, while Table 2 describes the basis, the realized risk premium, spot price change, biomass and production changes, and temperature shocks, respectively. The historical development for the realized risk premium is shown in Figure 1.

Figure 1: Risk premium



Note: The risk premium is calculated difference in log monthly spot prices observed at time t and futures prices observed at time *t-1*.

Table 1: Descriptive statistics: log prices

Maturity	Average	SD	Min	25%	Median	75%	Max
Spot	3.43	0.21	3.03	3.26	3.36	3.62	3.90
1 Month	3.42	0.19	3.14	3.26	3.39	3.58	3.84
2 Months	3.41	0.18	3.16	3.25	3.40	3.55	3.81
3 Months	3.41	0.18	3.17	3.26	3.42	3.53	3.78

Note: Monthly averages of log spot and different maturities for forward prices (M=Month). Spot based on weekly spot observations. Month contracts based on daily observations.

Table 1 shows that the spot price is on average higher than the futures prices. A declining average price with increasing time to maturity indicates the presence of a positive convenience yield and/or a negative risk premium consistent with a backwardated forward curve. Also, there is positive skewness, which is an indication of the presence of upward price spikes. Moreover, the standard deviation is declining with time to maturity which is consistent with the Samuelson effect (Samuelson, 1965), that is a falling term structure of volatility.

Table 2 shows that the *ex post* risk premium is negative and its magnitude increases with time to maturity. Moreover, the negative bases (forward price less spot prices) in Table 2 support the indication that the forward curves are mostly in backwardation.

Table 2: Descriptive statistics: Explanatory variables

	Average	SD	Min	25%	Median	75%	Max
Risk premium							
1M	-0.013	0.092	-0.252	-0.075	-0.025	0.038	0.242
2M	-0.022	0.130	-0.324	-0.098	-0.046	0.063	0.368
3M	-0.026	0.158	-0.365	-0.105	-0.048	0.067	0.384
Spot price change							
1M	0.004	0.090	-0.267	-0.048	0.009	0.059	0.256
2M	0.006	0.139	-0.320	-0.084	0.034	0.101	0.301
3M	0.005	0.180	-0.399	-0.093	0.027	0.123	0.438
Basis							

1M	-0.010	0.061	-0.157	-0.045	-0.008	0.038	0.121
2M	-0.016	0.081	-0.233	-0.065	-0.007	0.043	0.170
3M	-0.021	0.095	-0.288	-0.075	-0.010	0.043	0.219
Production variables							
ΔBIO 1M	0.006	0.050	-0.075	-0.035	-0.006	0.054	0.104
ΔBIO 2M	0.014	0.094	-0.128	-0.060	-0.012	0.097	0.198
ΔBIO 3M	0.023	0.134	-0.171	-0.094	0.002	0.129	0.315
ΔPRO 1M	0.009	0.129	-0.247	-0.107	0.015	0.116	0.282
ΔPRO 2M	0.019	0.172	-0.331	-0.104	0.033	0.138	0.397
ΔPRO 3M	0.031	0.197	-0.439	-0.103	0.036	0.192	0.520
Temp* 1M	0.722	1.355	-2.728	-0.124	0.592	1.649	4.098
Temp* 2M	0.720	1.187	-1.420	-0.041	0.715	1.483	3.361
Temp* 3M	0.725	1.108	-1.276	-0.168	0.648	1.593	3.239

Note: The variables are as follows: *Risk premium* = difference in log monthly spot prices observed at time t and futures prices observed at time *t-1*, *Basis* = the difference in log monthly spot and futures prices, *Spot price change* = change in log monthly spot prices from time *t-1* to time *t*, ΔBIO = monthly changes in log biomass from time *t-1* to *t* (i.e. the time to maturity of the futures contract), ΔPRO = monthly changes in log quantity of harvested salmon from time *t-1* to *t*, and Temp* is the monthly difference between the observed temperature from time *t-1* to *t* and a seasonal normal temperature over the same period. Each variable is denoted by maturity, 1M = front month, 2M = two months, and 3M = three months. The number of observations is 89.

Table 3 shows the correlations between the explanatory variables. The lowest correlations are found for the front month contract model, while the 3 month variables exhibit the highest correlations. However, the correlations are not high enough to be worrysome.[3]

Table 3: Correlations

Maturity 1M

	B1M	ΔBIO 1M	ΔPROD 1M	Temp* 1M
B1M	1.000	-0.053	-0.198	-0.064
ΔBIO 1M		1.000	0.204	0.273
ΔPROD 1M			1.000	0.109
Temp* 1M				1.000

Maturity 2M

	B 2M	ΔBIO 2M	ΔPROD 2M	Temp* 2M
B2M	1.000	-0.231	-0.383	-0.156
ΔBIO 2M		1.000	0.387	0.301
ΔPROD 2M			1.000	0.136
Temp* 2M				1.000

Maturity 3M

	B3M	ΔBIO 3M	ΔPROD 3M	Temp* 3M
B 3M	1.000	-0.375	-0.563	-0.224
ΔBIO 3M		1.000	0.528	0.324
ΔPROD 3M			1.000	0.235
Temp* 3M				1.000

Table 4: Augmented Dickey-Fuller tests.

	Risk premium	Spot price change	Basis	ΔBIO	ΔPRO	Temp*
1M	-3.741***	-5.643***	-4.304***	-5.174***	-8.065***	-3.208***
2M	-4.204***	-6.336***	-4.316***	-8.041***	-8.153***	-3.313***
3M	-3.570***	-4.926***	-4.228***	-10.384***	-6.499***	-2.691***

Augmented Dickey-Fuller tests with maximum lag =10 and no constant or drift. The number of lags used are calculated according to the Akaike information criterion (Akaike, 1979).

[3] Typically, a rule-of-thumb of 0.60 correlation is used. Too high correlations can lead to negative effects caused by multicollinearity.

5. RESULTS AND DISCUSSION

The diagnostics tests as well as ACF plots (not tabulated) do not reveal the presence of autocorrelation or heteroskedasticity (Table 5), and we therefore present the results from the empirical models estimated with ordinary least squares regressions.

The results in Table 5 provide evidence that variation in the basis explains the variance in the risk premium for all maturities, in line with Fama and French' (1987) findings. Furthermore, the coefficient on the basis increases with time to maturity. Moreover, the results show that two of the risk factors from the production process are important explanatory factors. An increase in production (harvest) is significantly associated with increased risk premium for all the maturities examined. In fact, the results suggest that the impact increases with time to maturity (1 month: 0.21, 2 months: 0.32 and 3 months: 0.72).[4] Likewise, the realized risk premium is positively associated with increases in biomass for maturities of 1 and 2 months. We only find a significant impact of changes in biomass on the risk premium for one of the three non-overlapping subsamples for the 3 month to maturity model. This could potentially be an effect of low number of observations (29).

We do not find a significant relationship between shocks in sea water temperature and the ex post risk premium. This is somewhat surprising given the results of Asche,

[4] Calculated as average coefficients across the subsamples (2 subsamples for 2 months, 3 subsamples for 3 months).

Oglend and Zhang (2015). However, they do not include production or biomass in their model. Hence, our results suggest that the market find that production and biomass are variables that contain more information than seawater temperatures.

Table 5: Results from the regression of risk premium on the basis, industry-specific variables and risk variables.

$$\textit{Risk premium regression: } RP_t = \alpha_1 + \beta_1 B_{t-n} + \sum_{i=1}^{i} \beta_i CV_{i,t} + \varepsilon_t^{rp}$$

	Maturity of forward contract (n)					
	1 Month	2 Months (1)	2 Months (2)	3 Months (1)	3 Months (2)	3 Months (3)
Intercept	-0.001	-0.026	-0.024	-0.041	-0.028	-0.031
	(0.292)	(0.173)	(0.194)	(0.150)	(0.258)	(0.232)
B	0.664***	0.677***	0.810***	1.042***	1.060***	0.863**
	(<0.001)	(0.003)	(<0.001)	(<0.001)	(<0.001)	(0.014)
ΔBIO	0.533***	0.629***	0.403**	0.103	0.741***	0.124
	(<0.001)	(0.003)	(0.029)	(0.721)	(<0.001)	(0.513)
ΔPRO	0.210***	0.226*	0.410***	0.729***	0.285***	1.146***
	(0.002)	(0.052)	(<0.001)	(0.003)	(0.007)	(<0.001)
Temp*	-0.003	0.003	<0.001	0.014	0.005	-0.018
	(0.665)	(0.840)	(0.978)	(0.532)	(0.784)	(0.418)
Goodness-of-fit						
R^2-adj	0.297	0.342	0.408	0.486	0.473	0.437
F-test	10.280***	6.717***	8.417***	7.855***	7.287***	6.622***
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
N	89	44	44	29	29	29
Serial correlation and heteroskedasticity tests						
Ljung-Box	0.074	0.999	0.070	1.280	0.165	0.888
	(0.786)	(0.318)	(0.792)	(0.258)	(0.685)	(0.346)

Breusch-	0.106	1.246	0.111	1.724	0.203	1.254
Godfrey	(0.744)	(0.264)	(0.739)	(0.189)	(0.652)	(0.263)
Breusch-Pagan	3.936	3.068	1.467	3.173	0.322	0.344
	(0.415)	(0.547)	(0.832)	(0.529)	(0.988)	(0.987)

Note: The statistical significance of the coefficients from the regression is denoted by both asterisks and p-values (in parentheses). *: $p<0.10$, **:$p<0.05$, and ***:$p<0.01$. The variables are as follows: *RP* = difference in log monthly spot prices observed at time t and futures prices observed at time *t-1*, B = the difference in log monthly spot and futures prices, ΔBIO = monthly changes in log biomass from time *t-1* to *t* (i.e. the time to maturity of the futures contract), ΔPRO = monthly changes in log quantity of harvested salmon from time *t-1* to *t*, and Temp* is the monthly difference between the observed temperature from time *t-1* to *t* and a seasonal normal temperature over the same period. The samples for the maturities above 1 month are split into subsamples and estimated separately to avoid issues related to overlapping observations. For the 2 month sample, (1) denotes observations in the two months preceeding and including the months 1, 3, 5, 7, 9, and 11, while subsample (2) includes the remaining months. Similarly, the 3 month sample is split into 3 non-overlapping subsamples, denoted by (1) for observations for the three months preceeding and including the months 1, 4, 7 and 10, (2) denoting the subsample for months 2, 5, 8, and 11, and (3) for the remaining observations. The number of observations in the sample and subsamples is denoted by *N*. The null hypotheses for the tests for serial correlation (Ljung-Box and Breusch-Godfrey) is that of no serial correlation. Both tests use 1 lag. The null hypothesis for heteroskedasticity test (Breusch-Pagan) is that the error term is homoskedastic.

6. CONCLUSIONS

This paper examines the risk premium in Atlantic salmon futures markets. Specifically, we study the impact of the basis as well as industry-specific risk factors. Using a data sample for the Fish Pool market we use an augmented Fama-French approach to examine the risk premium in salmon forward prices of varying maturities from 1 month to 3 months. We find evidence of time varying risk premium. Furthermore, it seems that changes in production-related variables help explain the variation in the risk premium along the forward curve.

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