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Research Article

Forecasting Performance of Lumber Futures Prices

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We test the forecasting power and information content of lumber futures prices traded on the Chicago Mercantile Exchange, from 1995 to 2013, at four forecast horizons. A Mincer-Zarnowitz regression finds evidence of statistically significant forecasting power at all forecast horizons. The results also support the presence of a time-varying risk premium for the shorter forecast horizons. A Granger causality test provides evidence that lumber futures prices lag spot prices in information assimilation over longer forecast horizons, while neither lagging nor leading over shorter forecast horizons.

1. Introduction

A futures contract is an instrument for trading commodity price risk. Like forward contracts, traders in a commodity that are concerned about unpredictable spot price movements can lock in a price for a future trade by buying (taking a long position) or selling (taking a short position) a futures contract of suitable maturity on the commodity. However, unlike forward contracts, futures contracts are marketable, allowing futures market participants to exit a contract before maturity by taking an offsetting position. The price hedging enabled by futures contracts reduces uncertainty for producers and consumers and promotes growth in economic activity. Futures contract markets also serve the function of price discovery by capturing information on future demand and supply conditions available to market participants, revealed by their buying and selling activities. Thus, futures contract prices may serve as market forecasts of the future spot price of a commodity.

Lumber futures have been traded on the Chicago Mercantile Exchange (CME) since 1969. At present, lumber is the only forest industry product for which domestic futures contracts are traded on the CME. Lumber futures contracts traded on the CME require on-tract mill delivery of 110,000 board feet of kiln dried two-by-fours of Random Lengths (8–20 feet, with percentage limits by length). The deliverable grades are number 1 and number 2 of the structural light framing category. Deliverable species are Western Spruce-Pine-Fir (SPF), Western Hemlock-True Firs (Hem-Fir), Engelmann Spruce, or Lodgepole pine. The producing mill must be located in the Canadian provinces of Alberta or British Columbia or in the states of California, Idaho, Montana, Nevada, Oregon, Washington, or Wyoming. Lumber for delivery must be grouped according to length, wrapped in paper, and loaded on one 73-foot flatcar. Futures contract buyers that wish to take delivery are charged the lowest published freight rate for 73-foot flatcars from Prince George, British Columbia, to the specified destination. The majority of lumber futures contracts tend to be offset, instead of ending in delivery. The contract delivery months are January, March, May, July, September, and November.

Studies of the forecasting performance of lumber futures prices have employed two approaches. A comparison approach has involved the testing of the relative forecasting performance of lumber futures prices vis-à-vis alternate mediums of lumber price forecasts or the establishment of lead-lag relationships in price discovery between lumber futures and spot prices. Buongiorno et al. [1] uses the relative root mean square error to compare the forecasting performance of prices of lumber futures contracts with a random walk model of spot prices and the FORSIM model (a computer-based forecasting tool). The study finds that the FORSIM model outperforms futures contracts for long-term forecasts, while both outperform the random walk model for near and long-term forecasts. Deckard [2] tests for a lead-lag relationship by establishing a cointegration relation between lumber futures and spot price series. The study finds that the spot price is marginally exogenous in the long-run equilibrium relationship. It concludes that the lumber spot market leads the futures market in price discovery. Similarly, Manfredo and Sanders [3] use a Granger causality test to find that a 3-month lumber forward price published by a private timber wholesaler leads lumber futures prices and spot prices in price discovery.

The second approach to studying the forecasting performance of lumber futures has involved tests for efficiency and bias. He and Holt [4] use an error correction model with generalized-quadratic ARCH-in-mean (to accommodate a time-varying risk premium) to find that the lumber spot price series is not cointegrated with the lumber futures price series. The study concludes that the lumber futures market is neither unbiased nor efficient in the short or long run. Similarly, Hasan [5] fails to find a cointegration relation between lumber spot price and futures price series and concludes that the lumber futures market behaves irrationally.

French [6] and Fama and French [7] study the factors influencing forecasting power (seasonality and shocks in demand/supply) of futures prices of a wide range of commodities, including lumber. These studies establish forecasting power by means of the Mincer-Zarnowitz regression (Mincer and Zarnowitz [8]). The regression tests the empirical relationship between the forecasted and realised change in spot prices. The studies report weak evidence of forecasting power for lumber futures.

This study differs from previous studies of the forecasting performance of lumber futures prices in two important respects. First, since the specific lumber commodity traded on the futures market is not traded in any spot market, most previous studies that employ lumber spot prices use an alternate lumber commodity spot price series. For example, Deckard [2] and Manfredo and Sanders [3] use a Western Spruce-Pine-Fir FOB mill spot price series reported by Random Lengths (a private price reporting and analysis service provider for solid wood products sections of the forest products industry sector), while He and Holt [4] as well as Hasan [5] use unspecified spot series reported by Random Lengths. The use of alternate spot price series can impact the results of the study. For example, Hasan [5] compares the means of lumber spot and futures price series for equality. With an alternate spot price series, the failure to find equality may reflect the differences in the commodities being valued by the spot and futures markets, instead of providing evidence of nonconvergence. The lumber commodities being valued may differ on account of species composition, lumber quality, markets covered, and delivery cost. Furthermore, the lumber spot price series used in earlier studies are reported as market and temporal (monthly, quarterly, etc.) averages, with consequent distortion of statistical properties. Temporal averaging of prices impacts tests for cointegration relations unless all series under investigation have been similarly transformed (Kirchgassner and Wolters [9]).

For this study, following Fama and French [7], we use futures prices on contract maturation as spot prices. This utilizes the fact that since, at maturation, some futures contracts result in physical delivery of the commodity, it is expected that the futures price on maturation will converge to its spot market price to eliminate arbitrage opportunities. To quote CME [10], "...if cash prices remain below futures prices *(at maturity date of futures contract)*, a market participant could buy in the cash market and sell in the futures market, and make a risk-free profit. Similarly, if the cash price is above the futures price, a market participant could buy in the futures market, take delivery and sell in the cash market, again earning a risk free-profit." Empirically, it is observed that convergence depends on the terms for physical delivery in the futures contract of a commodity. CME [10] establishes two reasons for the failure of wheat futures prices to converge to wheat spot prices on contract expiration for 9 straight contract expirations following March 2008. One reason was that the prices for the highly liquid CBOT (Chicago Board of Trade) wheat futures serve as a benchmark for world wheat prices and nonconvergence results when world wheat shortages are accompanied by US abundance. This problem was solved by expanding the list of permitted delivery territories. The second reason was that the oversupply of wheat relative to storage capacity during the period resulted in a cash discount to futures, reflecting the higher market cost of storage relative to the fixed storage charge specified in the futures contract. For some commodities like wheat, physical delivery against a futures contract is settled by means of a delivery instrument (warehouse receipt or a shipping certificate). The delivery instruments provide the holder transferable access to the commodity without requiring load-out in a specified time frame. While a storage fee is charged for the delay in taking physical delivery, the fixed fee rate established for wheat was found to be low relative to the prevailing market storage cost during the period. To fix this problem, the CME is exploring the possibility of variable storage fees. A similar finding is reported by Adjemian et al. [11] which concludes that the nonconvergence was attributable to the option value created by the storage fee-to-market storage cost mismatch. In contrast to wheat, the relatively illiquid lumber futures do not serve as global benchmarks. Furthermore, the lumber futures contract requires load-out in a fixed, short time frame (approximately one month from the contract maturation date) and may therefore be expected to ensure convergence of its futures price to the spot price on maturation (see Chapter 7: Delivery Facilities and Procedures and Chapter 201: Random Length Lumber Futures, Rule 20103: Settlement Procedures, CME Rulebook). In the absence of any cause to expect nonconvergence of lumber futures prices, it is reasonable to believe that the lumber futures maturation price serves as a better estimate of its spot price than the reported prices of alternate lumber commodities, for reasons discussed above. We use the final settlement prices (six per year) of the lumber commodity traded by the futures market to create a bimonthly spot price series.

Second, we study the forecasting performance of lumber futures prices by testing for forecasting power as well as information content. To test for forecasting power, like French [6] and Fama and French [7], we apply the Mincer-Zarnowitz regression, with an extended interpretation used in more recent studies (e.g., Chernenko et al. [12], Reeve and Vigfusson [13], and Chinn and Coibion [14]). To test for information content, we use the Granger causality test, comparing information assimilation in lumber futures and spot prices. We apply these tests at four forecast horizons (2, 4, 6, and 8 months) to test the impact of forecast horizon on forecasting performance.

The principal findings of this study are evidence of statistically significant forecasting power of lumber futures prices for the period analyzed and the presence of a time-varying risk premium at shorter forecast horizons. The test for information content finds evidence that, at longer forecast horizons (6 and 8 months), lumber spot prices Granger-cause futures prices, indicating that the spot prices lead futures prices in information assimilation. However, at shorter horizons (2 and 4 months), the null hypothesis of either price Granger causing the other is not supported by the data, indicating that they share the same information.

Section 2 briefly discusses the theory of storable commodity futures markets pricing. Section 3 describes the methodology adopted in this study and the data used. Section 4 presents the results of the analysis. Section 5 discusses the results and concludes the study.

2. The Theory of Storable Commodity Futures Pricing

There are two convergent theories of storable commodity futures market pricing (Fama and French [7]). The *carrying cost theory* argues that the difference between contemporaneous spot and futures prices of a commodity (called the basis) reflects the cost of carrying the commodity in inventory till the maturity of the futures contract. The cost of carrying includes the warehousing cost, the cost of capital invested (interest rate), and the convenience yield from holding stocks of the commodity. Let F_{T-t} represent the time $T-t$ futures price for a contract that matures at time T with t ($t \geq 0$) representing the time to maturity and let S_{T-t} represent the spot price. Then, the storage cost theory argues that

$$F_{T-t} - S_{T-t} = S_{T-t} r_{T-t} + I_{T-t} - C_{T-t}. \tag{1}$$

Here, r_{T-t} denotes the relevant capital cost for the time to maturity, I_{T-t} is the marginal inventory carrying cost, and C_{T-t} is the marginal convenience yield that accrues to the inventory holder (and therefore reduces the carrying cost).

In contrast, the *expected price theory* explains the basis as a rational expected change in spot price plus a risk premium. That is,

$$f_{T-t} - s_{T-t} = \rho_{T-t} + \left[E_{T-t}(s_T) - s_{T-t}\right]. \tag{2}$$

The lower case letters denote logarithms of respective variables. E represents the expectation operator, ρ_{T-t} represents the risk premium for the period, and $E_{T-t}(s_T)$ represents the market expectation at time $T-t$ of the spot price at time T (Jensen's inequality correction factor ($(1/2)\,\mathrm{var}\,(s_T)$) is ignored or assumed to be included in the risk premium variable).

In an efficient market for a storable commodity, expected changes in the future spot price will be transmitted to both the futures and the spot markets, where inventories facilitate intertemporal arbitrage. For example, an expected rise in the future spot price of a storable commodity will increase current demand for building inventories of the commodity. An increase in current demand will increase the current spot price of the commodity till the basis equals the carrying cost. Conversely, if the future spot price is expected to fall, inventories will be sold off, lowering the current spot price till the basis equals the carrying cost. The temporal relation between the responses of spot and futures prices to market information is the subject of empirical testing.

The existence of the expected risk premium in (2) has been controversial. Starting with Keynes [15], to which the concept is attributed, there is a large body of literature on the subject with little agreement. Commodity futures market participants can be divided into three groups. Producers of a commodity form the first group that seeks to avoid the risk of a decline in prices by shorting (selling) the futures contract. Users of the commodity form the second group, which seeks to avoid price increases by going long (buying) in the futures market. Speculators form the third group that takes positions in the futures market for earning speculative profits. Keynes [15] argues that commodity producers seeking to reduce their risk by selling the futures contract are willing to pay a price for doing so, which means that they are willing to pay a premium over the expected futures price. This premium is required to induce speculators to take long positions in the futures market. Reeve and Vigfusson [13] use CME data to show that, for many commodities, the typical combined position of producers and users is net short. Thus, speculators would be required in these markets to balance the excess demand for short positions by taking long positions. Telser [16] and others have argued that competition amongst speculators to invest in futures should eliminate the risk premium payment and more generally there is no reason why there should not be equal or more interest in long positions in the futures contract. Berck and Bible [17] conclude that the existence of a risk premium is not certain for futures on every commodity and that the question can only be settled empirically.

The following section describes the methodology and data used in this study for testing the forecasting power and information content of CME lumber futures prices.

3. Methodology and Data

An OLS regression based on (2) forms a statistical test of futures price forecasting power (Mincer and Zarnowitz [8]). Let the price change implied by the basis be denoted by $FC_{T-t} = f_{T-t} - s_{T-t}$, the expected change in spot price by $EC_{T-t} = E_{T-t}(s_T) - s_{T-t}$, and the ex post realised spot price change by $RC_{T-t} = s_T - s_{T-t}$. In empirical analysis, the unobservable expected price change (EC_{T-t}) is replaced with the observed realised price change (RC_{T-t}). Then rearranging (2), a regression of RC_{T-t} on FC_{T-t} has the following representation:

$$RC_{T-t} = \alpha + \beta * FC_{T-t} + \varepsilon_{T-t}. \tag{3}$$

Here, $\varepsilon_{T-t} = RC_{T-t} - EC_{T-t}$, the difference between realised and expected price change, represents the forecast error. For an efficient market where current prices reflect all available information and price changes are random, ε_{T-t} is distributed $IIDN(0, \sigma_{\varepsilon}^2)$. In (3), α and β are coefficients to be estimated with $\alpha = -\rho_{T-t}$ estimating (the negative of) a constant risk premium. Estimates of the coefficients from the regression are the basis for four tests (Reeve and Vigfusson [13]): the three individual tests of whether $\alpha = 0$, $\beta = 0$, $\beta = 1$ and the joint test of $\alpha = 0$ and $\beta = 1$. A statistically significant difference between α and zero is evidence of a constant risk premium. A β value significantly different from zero is evidence of the forecasting power of futures prices. If β is statistically different from 1, it is evidence of a time-varying risk premium. Finally, if there is statistical evidence to support the hypothesis of the joint test of $\alpha = 0$ and $\beta = 1$, the basis is an efficient predictor of the spot price change.

To test for the information content of futures prices relative to the spot price, we apply the Granger causality test. A Granger causality test involves regressing the dependent variable on lagged values of the dependent and independent variables as depicted in

$$y_t = \alpha + \sum_{i=1}^{p} \delta_i y_{t-i} + \sum_{j=1}^{m} \lambda_j x_{t-j} + \omega_t. \quad (4)$$

Here, α, δ_i, and λ_j are regression coefficients to be estimated and ω represents the residual error. Variable y is Granger-caused by variable x, if, given the past values of y, past values of x are useful for predicting y. The null hypothesis is that the estimated coefficients on the lagged values of x are jointly zero; that is, x does not Granger-cause y. For example, if the null hypothesis that lumber spot prices are not Granger-caused by lumber futures prices is not supported by the data, it would be evidence in support of additional information content of lumber futures prices.

Data on daily lumber futures contract prices was acquired from the CME historical data division. Of the four daily historical futures prices reported, namely, the "Open" or first price of the day, the "High" price for the day, the "Low" price for the day, and the "Settle" or final price of the day, the settle price is considered the most informative (CME [18]). While the spot price for the specific lumber commodity traded by the futures contract is not available from any source, the settle price on the date of maturity of a commodity futures contracts is expected to converge to the spot price of the commodity as some futures contracts result in physical delivery. Since lumber futures contracts are listed for 6 months a year (January, March, May, July, September, and November), a bimonthly spot price series was constructed for the lumber commodity traded on the futures market from the settle prices of the futures contracts on their maturation dates. This spot price series extended from January, 1995, to July, 2013, and contained 112 total data points. Four bimonthly futures price series (F_{T-t}) were constructed by selecting futures price data at 2-, 4-, 6-, and 8-month (calendar) intervals before the maturity date of each futures prices series contributing to the spot price series. Summary statistics for the data is reported in Table 1. Hereafter, the time to maturity t is expressed in months. The next section presents the results of the analysis.

Table 1: Summary statistics for lumber futures and spot price data.

	Mean (\$ per MBF)	Standard deviation
Spot price (S_T)	285.27	69.23
Futures price		
2 months (F_{T-2})	290.95	57.43
4 months (F_{T-4})	295.88	48.50
6 months (F_{T-6})	299.55	43.30
8 months (F_{T-8})	301.88	40.57

Table 2: Augmented Dickey-Fuller test results.

Variable	Augmented Dickey-Fuller test statistic	MacKinnon's p value*
S_T	−3.033	0.0319
F_{T-2}	−3.189	0.0206
F_{T-4}	−2.770	0.0626
F_{T-6}	−3.158	0.0226
F_{T-8}	−3.279	0.0159
FC_{T-2}	−6.143	0.0000
FC_{T-4}	−4.650	0.0001
FC_{T-6}	−4.258	0.0005
FC_{T-8}	−4.170	0.0007
RC_{T-2}	−10.216	0.0000
RC_{T-4}	−6.509	0.0000
RC_{T-6}	−5.265	0.0000
RC_{T-8}	−4.340	0.0004

*Alternate hypothesis: series are stationary.

4. Results

The realised change ($RC_{T-t} = \log(S_T) - \log(S_{T-t})$) and basis ($FC_{T-t} = \log(F_{T-t}) - \log(S_{T-t})$) data series were tested for nonstationarity (presence of unit root) using the Augmented Dickey-Fuller (ADF) test. ADF test results did not support the null hypothesis of nonstationarity for any of the data series at 5% level of significance (Table 2).

Table 3 lists the results of the Mincer-Zarnowitz regression. Durbin-Watson and Bruesch-Godfrey tests on residuals from a simple OLS regression for (3) rejected the null hypothesis of absence of serial correlation. To account for first-order positive serial correlation, Newey-West standard errors (heteroscedasticity and autocorrelation consistent) were used. The t-test results support the null hypothesis $\alpha = 0$ at 10% level of significance for the 2- and 4-month forecast horizons. However, the hypothesis is rejected for the 6- and 8-month forecast horizons at 10% level of significance. Thus, there is weak statistical evidence of a constant risk premium at longer forecast horizons but not for the shorter forecast horizons.

The null hypothesis $\beta = 0$ is not supported by the t-test results for all four forecast horizons at 5% level of significance.

Table 3: Mincer-Zarnowitz regression results.

Dependent variable	Independent variable	α		β		$\beta = 1$	$\alpha = 0$ and $\beta = 1$	R^2
		Value	t-statistics p value*	Value	t -statistic p value*	p-values Wald Test (F-statistic)		
RC_{T-2}	FC_{T-2}	−0.02	0.234	0.55	0.003	0.015	0.006	0.09
RC_{T-4}	FC_{T-4}	−0.04	0.109	0.67	0.000	0.046	0.015	0.12
RC_{T-6}	FC_{T-6}	−0.05	0.072	0.71	0.000	0.060	0.011	0.14
RC_{T-8}	FC_{T-8}	−0.06	0.051	0.77	0.000	0.173	0.015	0.17

*Alternate hypothesis: value(s) significantly different from zero.

Table 4: Granger causality test results.

Dependent variable	Independent variable	Independent variable lags included	Chi-square $\chi^2(1)^*$ Value	p value
S_{T-2}	F_{T-2}	1	2.306	0.129
S_{T-4}	F_{T-4}	1	1.979	0.160
S_{T-6}	F_{T-6}	1	0.603	0.437
S_{T-8}	F_{T-8}	1	0.861	0.354
F_{T-2}	S_{T-2}	1	2.339	0.126
F_{T-4}	S_{T-4}	1	1.859	0.173
F_{T-6}	S_{T-6}	1	4.662	0.031
F_{T-8}	S_{T-8}	1	4.954	0.026

*Alternate hypothesis: independent variable Granger causes dependent variable.

This result supports the presence of forecasting power of futures prices for all forecast horizons. The result contrasts with Fama and French [7] which reports large t-statistic values at multiple horizons. The Wald test for hypothesis $\beta = 1$ is not supported for the 2-month and 4-month forecast horizon at 5% level of significance. However, the hypothesis is supported for the 6- and 8-month forecast horizons at the 5% level of significance. These results support the presence of a time-varying risk premium at the 2- and 4-month forecast horizons.

The Wald test for the joint hypothesis of $\alpha = 0$ and $\beta = 1$ is rejected at the 5% level of significance for all four forecast horizons. Thus, the hypothesis of efficient forecasts is rejected at all four forecast horizons. This result confirms the findings of some earlier studies (He and Holt [4], Hasan [5]) regarding inefficiency of lumber futures prices while contrasting with Deckard [2]. The low R^2 values listed in the last column of Table 3 provide an estimate of the high random component of realised price change (greater than 80%), which the market does not anticipate and thus fails to predict. This result is comparable to Buongiorno et al. [1] where decomposition of the mean square error reveals a disturbance component that ranges from 74% (for the current quarter forecast horizon) to over 90% (for 1 to 3 quarters ahead forecast horizons).

Table 4 presents the results of the Granger causality test. ADF tests performed on the levels of log transformed futures and spot price series rejected the null hypothesis of nonstationarity for all series at 10% level of significance (Table 2). The number of lags to be included in the Granger causality test regression was selected on the basis of the Akaike Information Criterion and Schwarz-Bayesian Information Criterion for the unrestricted Vector Autoregression.

The null hypothesis of lumber futures prices not Granger-causing spot prices is supported for all four forecast horizons at the 5% level of significance. The null hypothesis of lumber spot prices not Granger-causing futures prices is supported at 5% level of significance for the 2- and 4-month forecast horizons but rejected for the 6- and 8-month forecast horizons at the 5% level of significance. These results indicate that the information content of lumber futures prices lags that of spot prices at higher forecast horizons (6 and 8 months) but neither lags nor leads spot prices at shorter forecast horizons (2 and 4 months). These results are consistent with a wide body of previous results for storable commodities, which find that forecasts of spot price change based on the current spot prices are usually as good as futures price based forecasts (French [6]).

Earlier studies provide contrasting results on the lead-lag relation between lumber futures and spot prices. Based on the root mean square errors reported in Buongiorno et al. [1], lumber futures prices (1974–1980) are informationally more efficient than spot prices through 3 quarters ahead forecast horizons (at varying levels of significance), implying that the spot prices lag the futures prices. Deckard [2] finds lumber spot prices marginally exogenous to (hence leading) lumber futures for the 1983–1998 period for a one-month forecast horizon. Manfredo and Sanders [3] finds that lumber futures prices lead spot prices using data from 2002 to 2005 for a

Table 5: Sign test results.

Forecast horizon	Sign test frequency	Binomial distribution* p value
2 months	70/112	0.005
4 months	67/112	0.024
6 months	67/112	0.024
8 months	66/112	0.036

*Alternative hypothesis: probability of same sign is greater than 0.5.

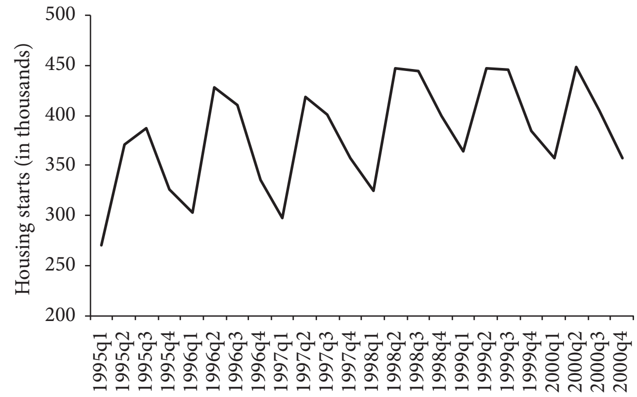

Figure 1: Strong seasonality in US housing starts 1995 Q1–2000 Q4 (source: US Census Bureau [21]).

one-week forecast horizon. The contrasting findings could be the result of differences in data (quality, period, etc.), forecast horizon, or methodology.

5. Discussion and Summary

The primary function of a futures contract is to serve as a mechanism for trading in price risk. Producers and users of a commodity use futures contracts to hedge against adverse movements in the spot price of the commodity. The contracted futures price reflects available information on expected price change to market participants. At any point in time, it reflects the market's collective best estimate of the future spot price of the commodity, evolving as new information arrives.

In this study, we test the forecasting power of lumber futures traded on the CME from 1995 to 2013 at four forecast horizons. Regression of the ex post, realised spot price change on the basis reveals that lumber futures prices carry statistically significant forecasting power at all four forecast horizons. This result is further illustrated by the results from a sign test (Pesaran and Timmermann [19]). The sign test measures the frequency with which the sign (positive or negative) of the basis correctly predicts the sign of realised spot price change. The sign test frequencies as well as p values of an upper-tailed binomial test are reported in Table 5. At 5% level of significance, the reported p values for all forecast horizons fail to support the null hypothesis that the probability of similar signs is less than or equal to 0.5. The results establish that the frequency of successful prediction of the direction of spot price change by the sign of the basis is significantly higher than a random outcome.

The significant forecasting power of lumber futures prices could be the result of strong seasonality in demand for lumber (Figure 1), derived from the residential construction, repair, and remodeling market that contributes over 60% of lumber demand (Howard and McKeever [20]). The expected change in spot price implied by the futures price is a function of demand and supply conditions expected to prevail at the maturation of the futures contract. These expectations are based on information available to the market. Predictable seasonality in demand is strong information to the lumber futures market. Together with available information on the expected supply (production and inventory) condition changes, this information should enable better estimation of the direction and magnitude of spot price change. French [6] and Fama and French [7] discuss and test the explanatory power of seasonality on forecasting power of futures prices. The studies argue that the high cost (relative to lumber value) of holding lumber in inventory reduces the ability to utilize inventories to smooth the impact of seasonality in demand on prices (thereby enhancing the forecasting performance of lumber futures). While the studies find that the lumber basis has a high standard deviation, consistent with seasonality in a high-storage-cost commodity, they fail to find reliable evidence of seasonal variation in the lumber basis using regression analysis with seasonal dummies. They speculate that this finding could be the result of ease in adaption of lumber production to seasonality in demand. In light of these results, it may be concluded that the forecasting power of lumber futures could be impacted by other factors also, the discovery of which could be the subject of future research.

A significant result of this study is the evidence of impact of forecast horizon on forecasting performance of lumber futures prices. Evidence from the Granger causality tests indicates that, for forecast horizons higher than 4 months, the lumber spot market prices Granger-cause the lumber futures market prices, implying that the futures market lags the spot market in information assimilation. One explanation for this phenomena is provided by the typical pattern of activity in a lumber futures contract, as measured by "open interest," over its term. The open interest is a measure of the total number of outstanding futures contracts. An increase in open interest indicates greater activity in and liquidity for the futures contract. Figure 2 presents the average open interest in lumber futures contracts between 1995 and 2013. It can be observed that the open interest is extremely low (less than 500) till nearly 4 months (average 21 trading days per month) before the contract maturation, when it begins to rise steeply. This increase in activity and participants brings informational benefits to the market which is reflected in the results of the analysis presented in this study.

The evidence supporting presence of a risk premium in lumber futures markets is another significant result of the analysis. As discussed earlier, it has been argued that the risk premium is required to attract speculators to compensate for the net short (or long) position of producers and users groups combined. From 2009 to 2013, the average daily long

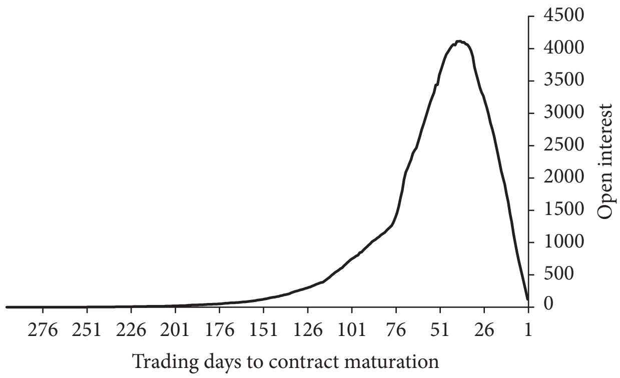

Figure 2: Average open interest in CME lumber futures contracts (1995–2013).

positions in lumber futures held by producers and users groups combined was 647, while the average short position held was 3678, resulting in an average net short position of 3031. The persistence of a substantial net short position in lumber futures market could account for the presence of risk premiums. The presence of a time-varying risk premium for the 2- and 4-month forecast horizon could be attributed to an improvement in ability to capture/reflect the prevailing interest rates as investor activity grows with shrinking time to maturity (Anderson [22] and Engle et al. [23]).

A question arising from the forecasting performance of lumber futures prices is whether they can be used to forecast timber market spot price changes? Since timber is the principal input for lumber, their prices can be expected to be strongly related. A research note prepared by the Forest Research Group [24] reports (using data from 1993 to 2012) relatively strong correlation (approximately 60%) between lumber futures and Pacific Northwestern Whitewood (Lodgepole Pine, Sitka Spruce, and Engelmann Spruce) log prices as well as with Pacific Northwestern Douglas-Fir log prices (approximately 70%). However, low correlation (approximately 5%) is reported with southern pine log prices. Whitewood species are included in the lumber futures commodity. However, Douglas-Fir, a major commercial species in northwestern USA, and southern pine are excluded. Therefore, the correlation results seem to imply that CME lumber futures prices could be useful for forecasting spot price changes for major Pacific Northwestern US timber species, even if they are not included in the lumber futures commodity. However, the futures price forecasts may not be useful for other US markets. Future research could look at developing and testing forecast models for timber markets based on their correlation with the lumber futures market.

In this study, we ignore the possibility of feedback from futures prices to spot prices. Often, periods of high volatility in commodity spot prices are blamed on high levels of speculative activity in the futures market. The possibility of feedback from the futures market to commodity spot price has been examined with mixed results. For example, Bohl and Stephan [25] explores the impact of the volume of speculative activity in futures market on the volatility of commodity spot prices. The study fails to find evidence to support the hypothesis for six agricultural and energy commodities. Earlier, Chatrath and Song [26] finds a negative relationship between spot price volatility and the number of speculative futures contracts as well as the number of speculators, for five agricultural commodities. Moreover, the relatively low level of speculative interest in lumber futures does not support the possibility of this feedback.

In summary, the results of this study show that lumber futures prices do serve as an effective hedging mechanism by virtue of a statistically significant forecasting performance and by efficiently incorporating available information regarding expected change in future spot prices, at shorter forecast horizons. With respect to the presence of bias implied by the risk premium, it is argued that futures prices are inherently biased on account of investor risk aversion and that they can provide unbiased estimates of future spot prices only when investors are risk neutral or the systematic risk of the underlying asset is zero (Kaminsky and Kumar [27], Chen and Zheng [28]). Thus, the finding of a risk premium in lumber futures market prices likely represents a rational market response of risk averse market participants rather than an irrational market bias.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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