Contribution to Price Discovery in the Forest Product Market: Futures, Forwards, and Spot Markets

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Abstract

Cash forward contracting is a common, and often preferred, means of managing commodity price risk in many industries. Despite this, little is known about the performance of cash forward markets, in particular the role they play in price discovery. The lumber market provides a unique case for examining this issue. The Bloch Lumber Company maintains an active cash forward market for many lumber products, and publishes benchmark forward prices on their website and disseminates these prices to data vendors. Focusing on 2x4 random lengths lumber and 7/16 oriented strand board, this research examines the lead-lag relationships between the three-month forward prices published by Bloch Lumber, representative spot prices, and lumber futures prices at the Chicago Mercantile Exchange. Results suggest that at least for 2x4 random lengths lumber, the forward prices published by Block Lumber lead both the spot price and futures price, suggesting that this private cash forward market provides some level of price discovery in the lumber markets.

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1. Introduction

Lumber mills, lumber wholesalers, home builders, and construction companies are all exposed to the volatility of lumber prices. While an active futures market exists for 2x4 random length lumber, hedging with futures contracts is only one way in which these businesses can manage their price risks.[1] Indeed, cash forward contracting provides a viable alternative to managing price volatility in the lumber markets, and may actually be a preferred method of risk management for many firms that are unfamiliar with the futures markets. In a cash forward contracting arrangement, a buyer of lumber agrees to pay a seller of lumber a fixed price for delivery of lumber at some time in the future. These cash forward contracting arrangements are almost always privately negotiated (Menkhaus et al.), and unlike futures prices, cash forward prices are not made public.[2] Given this, researchers have had limited opportunity to empirically examine the performance of cash forward markets. Because of the lack of data for these markets, researchers have often relied on theoretical, or more recently experimental economic methods, in analyzing cash forward market performance (Menkhaus et al.; Krogmeier et al.; Mahenc and Salaine; Mahenc and Meunier).

An existing private cash forward market for lumber, however, may provide some insight into the performance of forward markets. The Bloch Lumber Company (www.blochlumber.com), a large forest products distributor based in Chicago, Illinois offers cash forward contracts through their Guaranteed Forward Price (GFP) program. Through the

[1] See Leuthold, Junkus, and Cordier and for a discussion of the use of futures markets to hedge against price volatility.
[2] One exception is the forward market for foreign currencies. See Wang and Jones.

GFP program, Bloch provides customers cash forward contracts for a number of lumber and board products. Customers, such as homebuilders and lumberyards, can fix their lumber or wood products prices up to one year in advance. The company also posts cash forward prices on their web page which they refer to as "Bloch Benchmarks". These benchmark prices are more general than GFP prices, and they do not reflect specific transaction prices. Rather, they are designed to provide the lumber trading public with forward price information that can be used for planning purposes. The Bloch Benchmark prices are posted daily on the company's website, and can also be accessed through Bloomberg's subscription service, providing a rare source of publicly available cash forward price data.

The overall objective of this research is to determine the role, if any, the Bloch Benchmark program plays in discovering prices in lumber and wood product markets. In doing this, both the Bloch Benchmark prices and the Bloch GFP program are discussed. Focus is placed on two important lumber products: spruce, pine, or fur 2x4 random lengths lumber and oriented strand board. Following the methods of Oellermann and Farris and Koontz, Garcia, and Hudson, this research incorporates the use of Granger Causality tests to determine bivariate causality among the Bloch Benchmark forward prices, lumber spot prices, and the lumber futures market. Determining the lead-lag relationships between the forward, spot, and futures prices provides initial evidence into the price discovery role that cash forward markets play in the lumber industry. If the prices in one market (say the futures market) are found to lead the prices in the other two markets, then this suggests that the futures market is the center of price discovery. It is widely noted that futures markets are the primary center of price discovery for the underlying cash commodity (Yang and Leatham; Leuthold, Junkus, and Cordier, p. 4).

However, very little evidence has been amassed concerning the role of cash forward markets in discovering prices.

The research provides initial insight into how the Bloch forward pricing program contributes to price discovery in the lumber and board markets. Indeed, the market for lumber and wood products is large, with worldwide exports exceeding 169 billion U.S. dollars in 2004 (FAO). Moreover, lumber represents a major production cost in key industries such as housing. Therefore, it is important to understand price discovery in this specific market, and the results may provide important clues into the performance of cash forward markets in general. This is of particular interest since many important commodity markets do not have active futures markets. Regardless, given the paucity of cash forward price data in general, the forward price information published by Bloch Lumber provides an interesting case study. This research also broadens the academic literature examining the performance of futures and cash markets for lumber and wood products (He and Holt; Veld-Merkoulova and DeRoon; Sun and Zhang; McKenzie, Thomsen and Dixon; Rucker, Thurman, and Yoder).

The remainder of the paper is presented as follows. First, both the Bloch Benchmark and Bloch GFP programs are described. Second, the specific data used to analyze the lead-lag relationships between the forward, spot, and futures prices are discussed. Next, the Granger Causality tests used are presented, performed, and discussed. The final section summarizes the results and suggests directions for further research.

2. Bloch Benchmark Prices and Guaranteed Forward Price Program

The Bloch Lumber Company is a major wholesaler and distributor of lumber products in the U.S.A. Bloch Lumber is headquartered in Chicago, Illinois, and maintains six regional sales

offices and nine warehouses throughout the country. Bloch Lumber has been providing cash forward contracts to their customers for a number of years through their Guaranteed Forward Price (GFP) program. Through the GFP program, Bloch Lumber provides their customers with the opportunity to lock in prices for various lumber products for up to three, six, or twelve months in the future. Bloch Lumber's customers include major purchasers of lumber and board products including other wholesale and retail lumber yards, large home builders, and developers. As with any company that provides forward contracts to their customers, Bloch Lumber takes on the risk that prices for these products will be higher between the time the contract is entered and when they must source and deliver the product to their customers. To mitigate this risk, Bloch Lumber may hedge their exposure in the lumber futures markets, engage in cross-hedging activities, or implement various spot market strategies (personal communication). While exact volume and dollar numbers were not known or revealed by Bloch Lumber, they did suggest that the GFP program is very active with approximately $80 to $100 million worth of forward contracts written per year (personal communication).

In 2002, Bloch Lumber launched the publication and dissemination of Bloch Benchmark prices on their website and also through Bloomberg's subscription service. The Bloch Benchmark prices are essentially forward prices (three-, six-, and twelve-month forward prices) published by the company for a number of important lumber and wood products including 2x4 spruce-pine-fur (SPF) random lengths lumber and 7/16 oriented strand board (OSB). Forward prices for these products are reported for three general delivery locations including Midwest Markets (Chicago, IL and Detroit, MI), Southeast Markets (Atlanta, GA and Birmingham, AL),

and Southwest Markets (Dallas, TX and Houston, TX). Forward price quotes represent equal carload quantities (quoted in thousand board feet) shipped monthly during the time period.[3]

According to the Bloch Lumber website, as well as interviews conducted with Bloch Lumber personnel, Bloch Benchmark prices are developed using a proprietary model. While the model specification was not revealed by Bloch Lumber, the model is essentially a fundamental value model incorporating information from a number of sources. As stated on the Bloch Lumber website, the model uses "…information Bloch obtains from our agents, financial market data, quotes, news, analysts opinions, and research reports…" (www.blochlumber.com)[4].

According to Bloch Lumber, the motivation for publishing the Bloch Benchmark prices is to provide greater price transparency in the lumber market: "…the Bloch Benchmark prices are neither an offer to nor recommendation to buy or sell, but rather information designed to facilitate trading in an orderly market..." (www.blochlumber.com). Not only does the publication of Bloch Benchmark prices provide increased transparency in the lumber markets, they also help to differentiate Bloch Lumber themselves as a company (personal communication). As the disclaimer page for the Bloch Benchmark prices states "Bloch Lumber Company ("Bloch") makes a market in the products listed above, and we may or may not have a position in such products" (http://www.blochlumber.com/). While the Bloch Benchmark prices are not the exact forward prices offered to customers through the GFP program, they are quite similar. The GFP prices are quoted for a larger and more specific number of products and delivery markets, and ultimately actual transaction prices may reflect discounts for large orders

[3] See the Bloch Lumber website at www.blochlumber.com for more details.
[4] See further discussion on the Bloch Benchmark prices at http://www.blochlumber.com/Disclaimer.asp?page=public .

and quality premiums or discounts.[5] Indeed, as with any cash forward contract, the ultimate price and terms are negotiable. Ultimately, the GFP prices are "more refined" prices than that of the Bloch Benchmarks, but the Bloch Benchmark prices still provide customers with an important benchmark to aid in their cash forward pricing decisions (personal communication).

3. Data and Methods

Granger Causality tests have been used in the commodity marketing and futures market literature to examine how different markets contribute to the transmission and discovery of prices. Oellermann and Farris test the lead-lag relationships between live cattle spot prices and live cattle futures prices in order to determine if the spot or futures market is the center of price discovery. Similarly, Koontz, Garcia, and Hudson examined the spatial nature of price discovery for live cattle by examining lead-lag relationships between various spot markets for live cattle, and between the live cattle futures market and these spot markets. More recently, Zhou and Buongiorno examine price transmission in the softwood marketing channel using a causality framework. Given this, Granger Causality tests are used to determine if Bloch Lumber's private forward cash market contributes to price discovery in the lumber and wood product markets. To conduct the causality tests, time series of the Bloch Lumber forward prices and alternative market prices, namely spot and futures market prices, are collected.

[5] Guaranteed Forward Prices (GFP) are also published on the Bloch Lumber website. As with the Bloch Benchmarks, these prices are developed using a proprietary trading model. However, the GFP prices are not reported or disseminated through Bloomberg's subscription service. Therefore, a history of GFP prices was not available.

3.1 Forward, Spot, and Futures Data

Since the early inception of the Bloch Benchmark price program, Bloomberg has reported the three-month, six-month, and twelve-month forward prices on a daily basis for all products and market regions published by Bloch Lumber. Bloomberg also publishes spot price series for 2x4 SPF random lengths lumber and 7/16 OSB. These spot prices represent FOB mill prices, not delivered prices. For 2x4 SPF random length lumber, prices reflect mill prices per thousand board feet out of the Western U.S. and Canada, while the 7/16 OSB prices reflect mill prices in thousand board feet for shipments out of Wisconsin and Minnesota mills. These spot prices are provided to Bloomberg by Random Lengths, a market news service for the lumber industry. Random Lengths conducts weekly surveys of prices among mills, and publishes these prices each Friday in their Random Length's publication. [6] This newsletter is widely read by lumber industry participants, and is considered a leading source of market information for the industry.

A futures market also exists for 2x4 random lengths lumber. The random lengths lumber futures contract is traded on the Chicago Mercantile Exchange, and calls for delivery of 110,000 board feet of random lengths 2x4 SPF softwoods.[7] Futures contracts are listed and traded for the months of January, March, May, July, and September, and November, and are denominated in dollars per thousand board feet, the same as the Bloch Benchmark and Random Lengths reported spot prices.

Since the Random Lengths spot prices are reported on Friday, weekly (Friday) price series are constructed for the Random Lengths spot prices, Bloch Benchmark prices, and nearby futures prices. In the occasional cases when there was no price information reported on Friday

[6] When capitalized, "Random Lengths" refers to the publication where spot prices for both 2x4 SPF random lengths lumber and 7/16 OSB spot prices are reported.
[7] See Chapter 21 of the CME's Rulebook for exact delivery specifications for the random lengths lumber futures contract: http://rulebook.cme.com/rulebook10837.html#bm_1702_D.

(e.g., holidays) the corresponding Thursday price was used. Furthermore, to keep the analysis tractable and to minimize potential empirical issues arising from the use of overlapping data series, the Bloch Benchmark prices examined are the three-month forward prices for Chicago/Detroit delivery. In constructing the nearby futures price series, rollover from the expiring contract month into the existing contract month is designated as the first business day of the delivery month. When differencing the futures data, careful attention is paid to ensure that price differences are not calculated between different contract months when there is a rollover from the expiring contract to the nearby contract.

The sample data span from September 20, 2002 through March 11, 2005, for a total of 130 weekly observations. Figure 1 plots the 2x4 SPF random lengths spot price (SPF spot), the corresponding Bloch Benchmark three-month forward price (SPF forwards), and nearby futures (SPF futures) while Figure 2 shows the 7/16 OSB spot (OSB spot), Bloch Benchmark three-month forward prices (OSB forwards), and SPF futures over the sample period. In both Figures 1 and 2, it is clear that the spot and forward series track each other closely, with the three-month forward exhibiting a premium relative to the spot price. While this premium may be reflective of storage costs or risk premiums, the bulk of the difference likely reflects transportation costs between mill (spot) and the delivery price for the Chicago/Detroit markets (three-month forwards). According to Bloch Lumber, historically the transportation premium for 2x4 SPF random lengths lumber is approximately $58 above the mill price, and is approximately $20 above the mill price for 7/16 OSB for delivery into Chicago/Detroit markets (personal communication).

While the SPF spot, SPF forward, and SPF futures prices clearly exhibit similar price patterns over time (Figure 1), the same cannot be said about OSB (Figure 2). While there are

clearly similar movements in OSB spot and OSB forwards over time, SPF futures price does not always move in tandem with these price series. This observation is certainly not unexpected, as oriented strand board and 2x4 SPF random length lumber are different product forms. However, it still may be the case that SPF futures impound information regarding the OSB market as well, especially in the absence of an active and liquid futures market for OSB. Indeed, it may be that the SPF futures market is the center of price discovery for the overall lumber and wood products market in general; but, this notion needs statistical confirmation.

3.2 Summary Statistics

Summary statistics of the price series are reported in Table 1. The mean for the SPF spot price series is 321.8, and is 382.1 for SPF forwards, for a difference of 60.3. This is very close to the $58 average transportation cost quoted by Bloch. Nearby SPF futures average 318.5 over the sample period, for an approximately $3.00 discount to the SPF spot price. The mean OSB spot price over the sample period is 317.3 and the mean for OSB forwards is 342.0, for a difference of 24.70. Again, the difference between the spot and forward prices is generally in line with the transportation differential of $20 communicated by Bloch Lumber. However, the premiums are certainly not static, and they may contain a risk premium to compensate Bloch Lumber for providing customers the ability to lock in forward prices.

It is clear from Figures 1 and 2 that the price series may not be stationary in levels. The Augmented Dickey-Fuller test is used to test for unit roots in the data series. First, the price levels are converted to natural logarithms to reduce heteroskedasticity in the time series. The augmented Dickey-Fuller test fails to reject the unit root null hypothesis at the 10% level for all the series. Given the price series are non-stationary, it is necessary to test for cointegration

among the series. If the price series are cointegrated, then an error correction term will need to be specified in the causality tests.

The Johansen procedure is used to test for cointegration among all the series, as well as two subsets of the series. The first subset is the OSB spot, OSB forwards, and SPF futures. The second subset is the SPF spot, SPF forwards, and SPF futures. In none of the three tests does the trace statistic reject the null hypothesis of no cointegrating vectors. This result is not surprising given that the relationship between these prices is driven by economic variables such as interest rates and transportation costs, which themselves are typically non-stationary. Based on these results, the price series are non-stationary, but they are not cointegrated. Therefore, statistical analysis should be performed using first differences of the data to avoid spurious results.

3.3 Granger Causality Tests

Following the examples of Oellermann and Farris and Koontz, Garcia, and Hudson, we use Granger Causality tests to examine the lead-lag relationships between the Bloch Benchmark forward prices, spot prices, and futures prices for both SPF and OSB. In this framework, a market is said to provide price discovery if it leads competing markets in a Granger Causality sense. We are particularly interested in determining if the Bloch Benchmark prices are contributing to price discovery. While the Bloch Benchmark prices are not forward market transaction prices per se, they are intended to provide forward price information to lumber market participants; therefore, they can potentially be discovering prices in the lumber market.

Price discovery is commonly tested in a Granger causality framework, where a price is said to "cause" or lead another price if utilizing it in a forecasting model reduces the mean-squared forecast errors over a model that lacks its information (Koontz, Garcia, and Hudson).

Hamilton (p. 302) suggests the following direct or bivariate Granger test for causality between X and Y:

$$(1) \qquad Y_t = a + \sum_{i=1}^{m} l_i Y_{t-i} + \sum_{j=1}^{n} q_j X_{t-j} + w_t$$

where, *m* and *n* represent the lag lengths for Y_t and X_t respectively, and w_t is a random disturbance term (Pindyck and Rubinfeld; Granger). The null hypothesis that X_t does not lead Y_t, or more formally that X_t does not Granger cause Y_t, can be examined by testing the restriction that $q_j = 0$ for all j using a Wald chi-square statistic. That is, if the null hypothesis is rejected, then it can be said that *X* does indeed lead *Y*.

The Granger Causality test outlined above is conducted for both SPF and OSB markets—forwards, spot, and futures—using log-relative price changes. That is, $X_t = \ln(X_t / X_{t-1})$ and $Y_t = \ln(Y_t / Y_{t-1})$. The lead-lag relationships are estimated between all related markets in a pair-wise fashion. For example, we test if Bloch Benchmark forwards lead spot prices, and also test if spot prices lead Bloch Benchmark forwards. In each case, equation 1 is estimated using OLS. The optimal lag structure used is determined by estimating all models for lag values of *i* = 1 to 10 and *j* = 1 to 10. The model that minimizes Akaike's information criteria (AIC) is then used in the causality regression (Beveridge and Oickle). Serial correlation in the relationship is tested using a Lagrange multiplier test, and heteroskedasticity is tested for using White's test. For instances where heteroskedasticy is found, White's heteroskedastic consistent covariance estimator is used to correct the covariance matrix. For instances where both heteroskedasticity and serial correlation are found, the Newey-West estimator is employed (Hamilton, p. 281).

4. Results

Results from the Granger Causality tests for 2x4 SPF random lengths lumber prices are presented in Table 2, while the results for 7/16 oriented strand board (OSB) are reported in Table 3. In both tables, the first column describes the lead-lag null hypothesis, the second column reports the optimal lag length of the estimated model determined by the minimization of AIC, and the third column reports the p-value from the Wald chi-square statistic testing the null hypothesis that *X* does not lead *Y*.

4.1 2x4 SPF Random Lengths Lumber

Results from the causality tests performed for the 2x4 SPF random lengths lumber markets are reported in Table 2. The first pair of causality tests examines the price discovery role of SPF futures relative to SPF spot and SPF forward prices. There is a failure to reject the null hypothesis that SPF futures do not lead SPF forwards at the 5% level (p-value =0.263). Therefore, it can be said that SPF futures do not contribute more in terms of price discovery relative to SPF forwards. However, the null hypothesis that SPF futures do not cause SPF spot prices is rejected at the 5% level (p-value = 0.011), indicating a role for the SPF futures market in discovering spot lumber prices. These tests indicate that SPF futures do indeed play a role in discovering prices in the 2x4 SPF random lengths lumber market, but they do not lead or cause the SPF forward prices published through the Bloch Benchmark program.

The second set of tests in Table 2 show the results for the hypothesis that the SPF forwards do not lead either the SPF spot and SPF futures. In both cases, the null hypothesis is rejected at the 5% level. The SPF forward prices lead both the SPF futures and SPF spot prices. This suggests that the Bloch Benchmark prices play a key role in price discovery. Note,

however, in the third set of tests, we find that SPF spot prices do not lead SPF futures prices (p-value = 0.175). However, we reject the null hypothesis that SPF spot prices do not lead the SPF forwards (p-value = 0.032). So, the spot lumber market does not contribute to price discovery relative to the futures market, but the spot lumber market does add information relative to the Bloch Benchmark forward prices.

Collectively, these results suggest that the futures market is not the seat of price discovery for the 2x4 SPF random lengths lumber market. Instead, the Bloch Benchmark forward price program appears to dominate that role. While there is simultaneity between the SPF spot and SPF forward prices (forward prices cause spot prices and vice versa) indicating that they are each contributing to price discovery, the SPF forwards appear to provide the most information, as they are found to Granger cause both the SPF spot and SPF futures.

These results provide evidence to the price discovery role that the Bloch Lumber company is providing through their forward pricing program and reporting of their Bloch Benchmark prices. Indeed, at least for the product (2x4 SPF random lengths lumber) and market location (Chicago/Detroit) evaluated here, the private cash forward market is contributing to price discovery. These results suggest that Bloch Lumber is indeed providing valuable price information to the lumber market through their Bloch Benchmark program. As Bloch Lumber attests on its website, they are providing "…information designed to facilitate trading in an orderly market…" (www.blochlumber.com). While these results confirm that Bloch Lumber is providing valuable information to the marketplace, they also raise concerns about the efficiency of the 2x4 lumber futures market.

The above results seem at odds with the notion of futures market efficiency. That is, an efficient futures market should quickly and efficiently incorporate all available information

pertinent to the underlying market. However, it is important to note that the Granger causality tests are *ex post* in nature, and they are not meant to provide a strict test for futures market efficiency. Still, it is important to consider possible reasons for the finding that the Bloch forward market (SPF forwards) leads the futures market (SPF futures). First, Bloch Lumber may indeed have more complete information than the futures market. Bloch is a major player in the U.S. cash lumber markets, and may have a comparative advantage with regards to information, prices, research, and general market knowledge.

It may also be the case that the futures market is not quickly incorporating the information publicized through the Bloch Benchmark forward price program. While this seems unlikely, the relatively low volume of trade and open interest in the 2x4 lumber futures market may drive this result. For instance, on October 11, 2005 the total volume of trade for all futures contract months was 394, and open interest, the number of contracts that remain open at the end of the trading day, was 3,851 contracts (www.cme.com). While the volume of trade in lumber futures is respectable, it is very small compared with other commodity contracts traded on the Chicago Mercantile Exchange. For example, on the same day (October 11, 2005), the volume of trade for all contract months in the Live Cattle futures market was 18,644 and open interest was 167,718. Markets that exhibit small volume of trade, such as the 2x4 lumber futures market, are likely not as efficient as larger, more liquid futures markets. Indeed, the cost of transacting in this market may be high enough to prevent some of the Bloch Benchmark forward price information from being readily incorporated into the futures price.

4.2 7/16 Oriented Strand Board

Results from the causality tests examining the lead-lag relationships for 7/16 oriented strand board (OSB) are reported in Table 3. As with the 2x4 SPF random lengths lumber results, causality relationships are tested between the OSB forward, OSB spot, and also the SPF futures prices. While the SPF futures prices are clearly not OSB prices, there is not an active futures market for OSB.[8] However, it may be the case that the SPF futures market assimilates fundamental supply and demand information related to OSB as well.

The first causality tests determine if SPF futures lead OSB forward and OSB spot prices. The null hypothesis that SPF futures prices do not cause OSB forward prices is rejected at the 5% level (p-value = 0.003). That is, SPF futures prices lead OSB forward prices. Likewise, we reject that SPF futures prices do not lead OSB spot prices (p-value = 0.000). This suggests that SPF futures contribute more in terms of price discovery relative to the OSB spot and OSB forward markets. However, as shown in Table 3, we cannot reject that OSB forwards do not lead SPF futures, or that OSB spot prices do not lead SPF futures. Therefore, in the OSB market, the evidence strongly suggests that the futures market is the primary source of price discovery.

Again, however, there appears to be simultaneity between SPF forwards and OSB spot prices as the tests indicate that OSB spot prices lead SPF forward prices, or more formally, that the null hypothesis that OSB spot prices do not lead SPF forwards is rejected at the 5% level (p-value = 0.000). Likewise, the null hypothesis that the OSB forward prices do not lead OSB spot prices is rejected with a p-value of 0.017. So, as found with the 2x4 SPF random lengths lumber market, both the OSB forward and OSB spot prices appear to share information simultaneously regarding the OSB market. Importantly, the results in Table 3 indicate no information flow from

[8] In 2000, the Chicago Mercantile Exchange received approval for, and listed, futures contracts on oriented strand board. However, the contract is currently not listed by the exchange due to lack of trading volume.

either the OSB forward market or OSB spot market to the SPF futures market, providing strong evidence as to the futures market's important role in price discovery for OSB. Considering these results as a whole, the 2x4 random lengths lumber futures market is clearly the center of price discovery for 7/16 oriented strand board.

These results seem counterintuitive, but given the absence of a futures market for OSB, a considerable amount of cross-hedging may be conducted by OSB cash market participants in the 2x4 lumber futures contract. Furthermore, given that the 2x4 lumber futures contract is the only futures contract available for the entire lumber industry, news and information which would effect overall lumber prices, including that of OSB, would likely be considered by futures market participants and ultimately reflected in 2x4 lumber futures prices. While not confirmed through our discussions with Bloch Lumber, it may also be the case that Bloch Benchmark prices for OSB are generated from a proprietary trading model which uses 2x4 lumber futures prices as an input. In this case, the result that futures lead the Bloch Benchmark forward prices would not be unexpected. While Bloch Lumber is undoubtedly providing an important service to its customers and the lumber trading public through the publication of their Bloch Benchmark prices for OSB, the center of price discovery for this market still appears to be the 2x4 random lengths futures market.

5. Summary, Conclusions, and Future Research

While cash forward contracts are routinely used by various businesses to manage commodity price risk, little is known about the performance of cash forward markets and their role in the price discovery process. Indeed, the paucity of price data for cash forward market transactions makes empirical research into these markets limited. The Bloch Lumber Company, through their

Bloch Benchmark forward market price program, provides a publicly available source of forward market price data that may provide some insight into the performance of this important cash forward market for the lumber industry, as well as the performance of cash forward markets in general.

After describing the Bloch Benchmark and Guaranteed Forward Price (GFP) programs and data, we ask the question of whether the Bloch Lumber forward market is playing a role in discovering prices for two important lumber products—2x4 SPF random lengths lumber and oriented strand board (OSB). We do this by examining the lead-lag relationships between weekly Bloch Benchmark forward prices, spot prices, and 2x4 lumber futures prices. If one market is found to lead the other two, then it can be said that this market is the center of price discovery. The lead-lag relationships are tested using the standard Granger Causality framework.

In our results, we find that for the 2x4 SPF random lengths lumber market, that the three-month Bloch Benchmark prices lead both spot prices and futures prices. These results suggest that Bloch Lumber, a major player in the cash lumber market, is indeed contributing to price discovery in the 2x4 lumber market through the publication of their Bloch Benchmark prices. However, there is also evidence that spot lumber market prices leads the Bloch Benchmark forward prices. That is, there is simultaneity between the spot lumber market and the Bloch Benchmark program. So, the Bloch Benchmark forward market program is not the sole source of price discovery. Still, Bloch lumber clearly aids and contributes to the price discovery process for SPF 2x4 lumber.

While the Bloch Benchmark prices are found to be the center of price discovery for the 2x4 SPF random lengths lumber market, the same cannot be said about the market for oriented

strand board. Interestingly, it is the 2x4 lumber futures market that is found to be the center of price discovery for OSB. That is, 2x4 SPF random lengths futures prices lead both the three-month Bloch Benchmark forwards and the OSB spot price. On the surface, this result seems implausible given that 2x4 lumber and oriented strand board are very different product forms. However, given the 2x4 lumber futures market is the only active futures market for lumber products, this market likely responds to broad-based, general lumber market information that may also affect OSB prices—such as demand shocks. Alternatively, it may be the case that Bloch Lumber uses 2x4 lumber futures prices as a component of their OSB pricing model.

While this research sheds considerable light on the role that private cash forward markets play in price discovery in the lumber markets, it is important to note that the methodology and results are limited by the time span of the study and by the markets selected. It is possible that there exists an unexamined market which may be the true seat of price discovery, so the results and conclusions should be interpreted within the context of the data examined. Furthermore, this research also provides motivation for additional research. In particular, the SPF 2x4 lumber results provide some question as to the efficiency of the 2x4 lumber futures market. While the causality tests conducted in this research do not constitute an exhaustive test for market efficiency, they do suggest that the futures market may not be fully incorporating all available information—in particular some of the information contained in the Bloch Benchmark prices. Likewise, a next step would be to examine how the Bloch Benchmark forward prices perform as forecasts of eventual, realized, lumber prices (Wang and Jones). Indeed, Bloch Lumber's forward Benchmark pricing provides a unique opportunity to examine the performance of a private cash forward market for an important commodity group—lumber and wood products.

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Figure 1. 2x4 SPF Random Lengths Spot (SPF Spot), Bloch Benchmark Three-Month Forward (SPF Forwards), and Nearby 2x4 Futures Prices (SPF Futures) in $/thousand board feet: September 2002 – March 2005

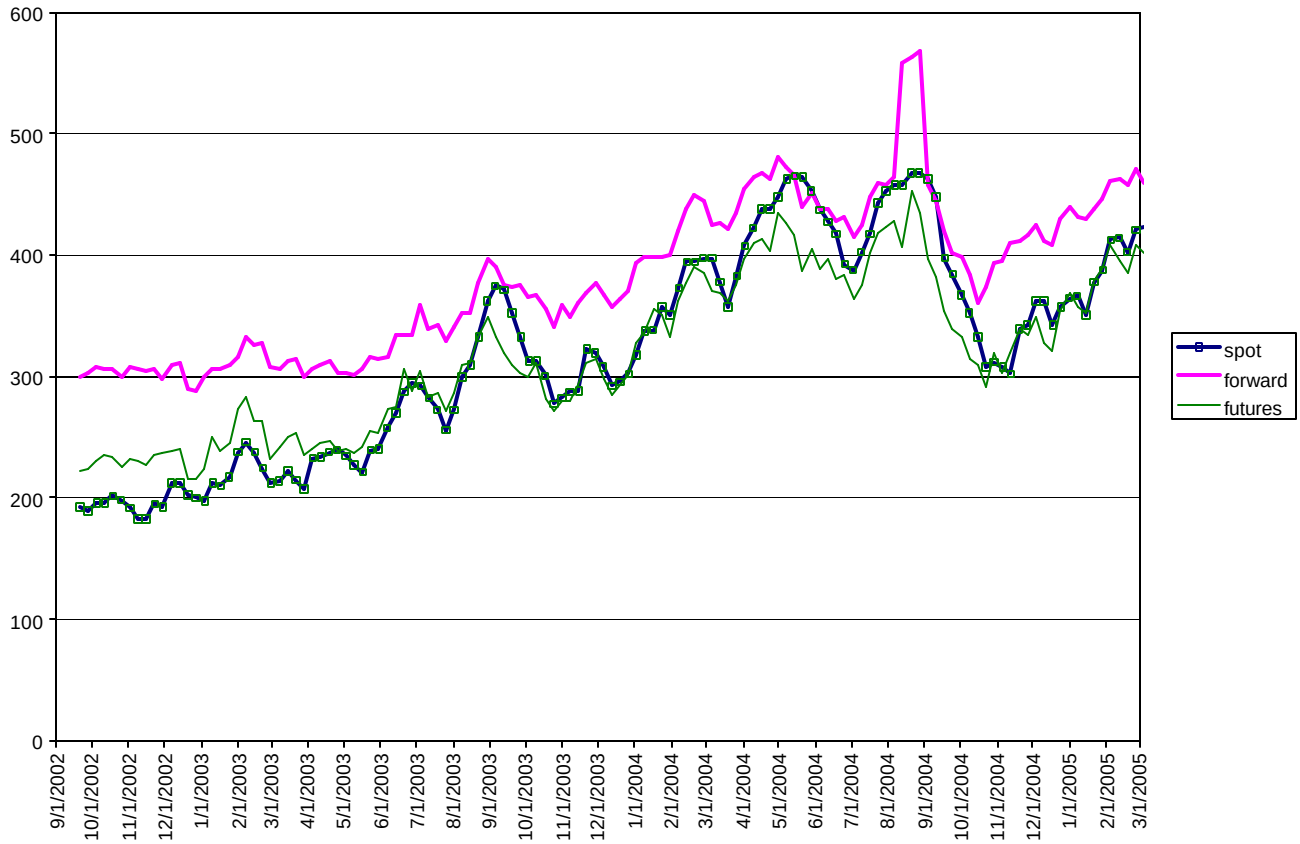

Figure 2. 7/16 OSB Spot Price (OSB Spot), Bloch Benchmark OSB Three-Month Forward (OSB Forwards), and Nearby 2x4 SPF Futures (SPF Futures) in $/thousand board feet: September 2002 – March 2005

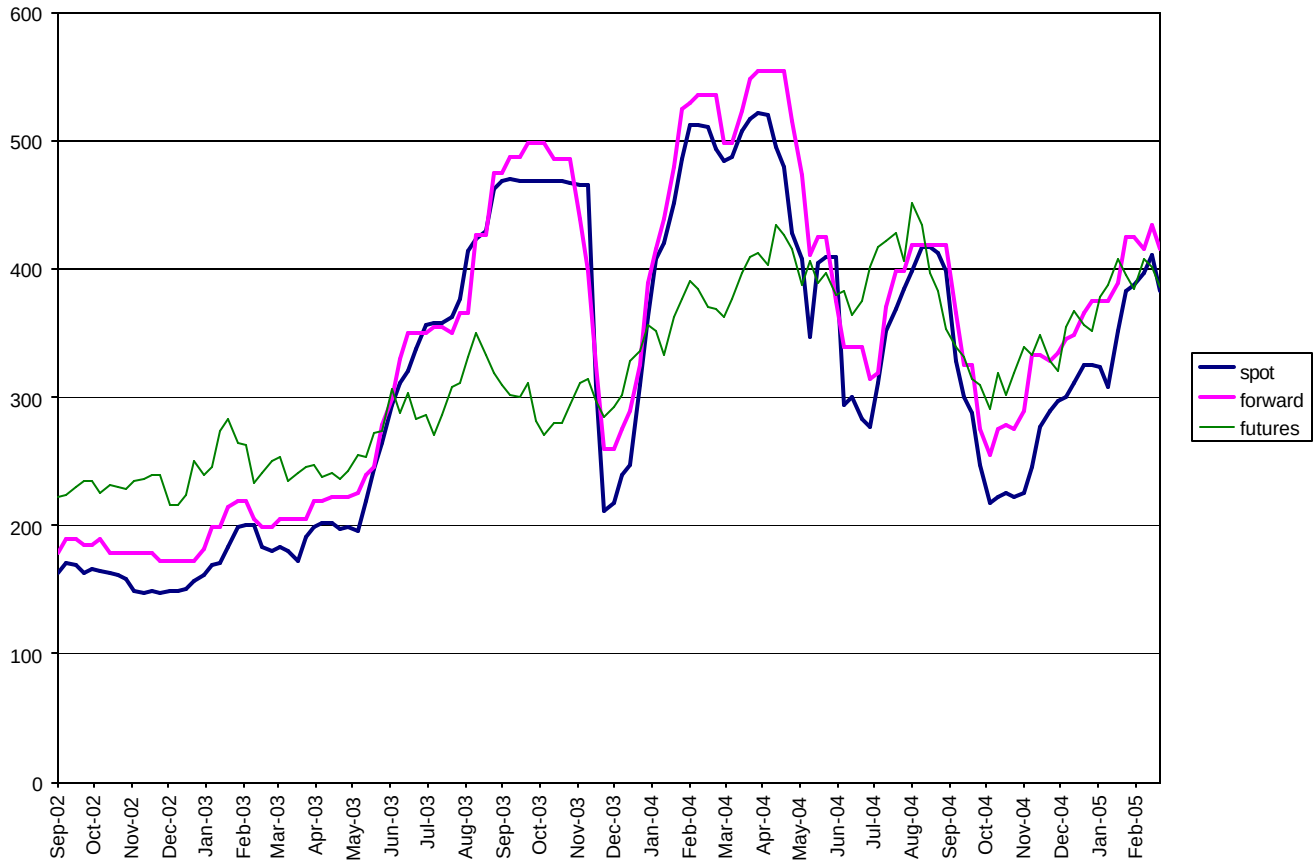

Table 1. Summary Statistics – 2x4 SPF Random Lengths Lumber (Spot, Forwards, and Futures) and Oriented Strand Board (Spot and Forwards) September 2002 – March 2005

NAME	MEAN	ST. DEV	MIN	MAX
SPF Spot	321.8	85.5	182.5	467.5
SPF Forwards	382.1	63.9	288.0	568.0
SPF Futures	318.5	64.3	216.2	452.0
OSB Spot	317.3	118.1	147.0	522.0
OSB Forwards	342.0	117.1	172.0	554.0

Table 2. Granger Causality Tests for SPF 2x4 Random Length Lumber.

Null Hypothesis (X does not lead Y)[1]	Lag Structure (m,n)	P-value
Futures do not lead Forwards	1,1	0.263
Futures do not lead Spot *	1,1	0.011
Forwards do not lead Futures	1,1	0.003
Forwards do not lead Spot *	1,1	0.005
Spot does not lead Futures	1,1	0.175
Spot does not lead Forwards *	3,1	0.032

[1] Causality test is of the form $Y_t = a + \sum_{i=1}^{m} l_i Y_{t-i} + \sum_{j=1}^{n} q_j X_{t-j} + w_t$ where the lag structure specified for each OLS regression is m,n. Y_t and X_t are defined as log price relatives of the respective data series [$\ln(p_t/p_{t-1})$]. The p-value is from a Wald chi-squared test of the null hypothesis that *X* does not cause *Y* ($q_j = 0 \; \forall \; j$). Rejection of the null hypothesis suggests that *X* does indeed lead *Y*.

* Estimated using White's heteroskedasticity consistent estimator.

Table 3. Granger Causality Tests for 7/16 Oriented Strand Board (OSB).

Null Hypothesis (X does not lead Y)[1]	Lag Structure (m,n)	P-value
Futures do not lead Forwards *	5,1	0.003
Futures do not lead Spot	1,1	0.000
Forwards do not lead Futures	1,1	0.171
Forwards do not lead Spot *	5,4	0.017
Spot does not lead Futures	1,2	0.160
Spot does not lead Forwards *	2,5	0.000

[1] Causality test is of the form $Y_t = a + \sum_{i=1}^{m} l_i Y_{t-i} + \sum_{j=1}^{n} q_j X_{t-j} + w_t$ where the lag structure specified for each OLS regression is m,n. Y_t and X_t are defined as log price relatives of the respective data series [$\ln(p_t/p_{t-1})$]. The p-value is from a Wald chi-squared test of the null hypothesis that X does not cause Y ($q_j = 0 \; \forall \; j$). Rejection of the null hypothesis suggests that X does indeed lead Y.

* Estimated using White's heteroskedasticity consistent estimator.