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I. Introduction

The impacts of introducing an organized futures market on the spot market for the traded commodity have been studied from several perspectives. One emphasis has been the hedging role of futures markets. Much of this research has concentrated on markets for seasonally produced agricultural commodities, like the grains, which have a long history of trading on futures markets. For example, Working (1948, 1949) formulated the concept of the price of storage as the primary determinant of the basis for storable commodities, and he (1960) indicated that the influence of futures trading on the carrying of inventories could reduce the seasonal variability of cash prices.

A second emphasis is related to the role of futures prices as vehicles for aggregating the information held by the individual participants in the market. Futures markets may, provided certain assumptions are met, summarize all the relevant available information for forecasting the spot price (e.g. Fama, 1970; Tomek, 1981; Bray, 1981).

Both the hedging and forward pricing literature have laid a foundation for later research which investigates the impacts of futures trading on aggregate market relations. Several papers develop models of the behavioral relationships of producers and speculators from a basic optimization framework (Danthine, 1978; Holthausen, 1979; and Feder, Just, and Schmitz, 1980). The existence of a futures market can be shown to cause the risk-averse, competitive producer to produce a level of output which depends exclusively on the futures price and not on the firm's subjective distribution of the uncertain future cash price. Through development of the microeconomic foundations of the optimal behavior of the individual producer and speculator, the market supply relationship that results from aggregation can be shown to be fundamentally altered by the introduction of futures trading in a market.

But no empirical investigations exist of the aggregate supply impacts caused by the introduction of a futures contract. Yet, if these impacts do indeed exist, important implications follow. In particular, if supply becomes more price elastic, demand shifts will have smaller price effects, ceteris paribus.

The focus of this study is on the empirical examination of the influence of the introduction of a lumber futures contract on the supply of lumber. A lumber futures contract was introduced in October 1969 on the Chicago Mercantile Exchange, specifying the delivery of random lengths 2x4's--the most common dimension lumber used in construction. The volume of trading grew through 1971, then declined through mid-1972, before starting to grow again. Volume was about 85,000 contracts in 1970, and volume has ranged from 195 to 840 thousand contracts per year since 1972.

The remainder of this paper is organized in three sections. First, a portion of the basic theoretical model (based on Turnovsky (1983)) is presented. Comparative static results are derived which predict that the introduction of a new futures contract will (1) fundamentally alter the supply relationship in the underlying spot market, (2) cause the producer's supply decision to be based solely on the futures price and not on subjective price expectations, and (3) cause the supply relationship to become more price elastic. Next, the empirical model employed and the results are presented. The introduction of the lumber futures contract on the Chicago Mercantile Exchange is used as a basis for analyzing supply of domestic softwood. The empirical results provide evidence in support of the theoretical model. Finally, the importance of these results is discussed.

II. Theoretical Model

The basic model used in this paper had its origins in Holthausen (1979) and in Feder, Just, and Schmitz (1980). Later, Turnovsky (1983) rigorously developed the model for storable commodities, and a recent paper by Stein (1986) complements Turnovsky's work.[1]

The model used in this paper assumes a two-period world in which producers determine in time t-1 the level of output realized in time t. The output price in time t is uncertain due to random fluctuations in consumer demand. The market is competitive and all firms are privy to the same set of information.

A representative firm's objective is assumed to be to maximize a function of expected profit and the variance of profit in which the cost function is assumed to be quadratic. Without a futures market,

$$(1) \quad V_t = P^*{}_t Y_t - (1/2)CY_t{}^2 - (1/2)\alpha[\sigma_p{}^2](Y_t)^2$$

where $P^*{}_t$ = future spot price expected in t-1 to prevail in t, Y_t = planned output, C = parameter of production costs, α = the producer's coefficient of risk aversion, and $\sigma_p{}^2$ = variance of the expected spot price ($P^*{}_t$).

Optimal output is derived from the first-order condition for maximizing V_t with respect to Y_t, which gives

$$(2) \quad Y_t = \left[\frac{P^*{}_t}{C + \alpha\sigma_p{}^2}\right].$$

Turnovsky (1983), Meyer (1985), and Stein (1986) provide the underlying details. Market supply is obtained by aggregating equation (2) over all N firms in the industry. Consequently, total output is $S_t = \Sigma Y_t = NY_t$, and the right-hand side also should be multiplied by N. But this factor can be set to one, without any loss of generality for the purpose of this paper. Hence, we write aggregate supply as

$$(3) \quad S_t = \left[\frac{1}{C + \alpha\sigma_p{}^2}\right]P^*{}_t$$

$$= bP^*{}_t \qquad \text{where } b = 1/[C+\sigma_p{}^2].$$

Equation (3) states that the optimal planned output increases with an increase in the expected spot price and decreases with rises in the variance of the expected spot price, the producers' risk aversion, and in production costs.

When futures trading is introduced, it is assumed that hedgers and speculators establish positions in the futures market in t-1 in contracts maturing in t. For simplicity, participation in the futures market is assumed to be the speculators only activity.

The representative producer's objective function is modified, becoming:

$$(4) \quad V^f_t = P^*_t(Y_t - z_{t-1}) + P^f_{t-1} z_{t-1} - (1/2)C(Y_t)^2 - [(1/2)\alpha\sigma_p^2](Y_t - z_{t-1})^2$$

where z_{t-1} = the quantity of planned output sold, if positive, or purchased, if negative, via a futures contract and P^f_{t-1} = the futures price at t-1 for a contract maturing in t. The optimal level of output derived from the first-order conditions is:

$$(5) \quad Y_t = \frac{P^f_{t-1}}{C} \quad .$$

Equation (5) states that the optimal output is a function only of the futures price prevailing when the production decision is made and is not influenced by expectations or the degree of risk aversion.

The aggregate market supply relationship is expressed:

$$(6) \quad S_t = (1/C)P^f_{t-1}$$
$$= b'P^f_{t-1} \qquad \text{where } b' = 1/C.$$

The effect of the introduction of futures markets can now be directly traced. The most obvious impact of future trading is that the supply relationship is structurally different, changing from b to b'. The slope coefficient, defined as $\partial S/\partial P$, is higher in the presence of futures trading assuming that the market is dominated by risk averse participants. In addition, the price on which production decisions are based is P^f_{t-1} when futures trading exists as contrasted with P^*_t when there are no futures trading opportunities.

III. Empirical Analysis

A. Model

A single equation, short-run model of lumber supply forms the base for testing the theoretical results. The model is estimated using data running from the first quarter of 1961 to the fourth quarter of 1983. This covers a period prior to futures trading and a period with futures trading.[2]

Production generally is geared towards meeting expected demand since inventories of lumber are expensive to maintain, and a production lag of roughly three-months duration exists between the time the decision to produce is made and the finished lumber is ready for shipment. Prices serve as the primary adjustment mechanism in the market because inventories of lumber are not held as buffer stocks. As a result, lumber supply is specified as a function of the expected spot price, raw material (stumpage) costs, other input prices, and labor productivity, which has been improving. Also, while production is continuous, it clearly has a seasonal component, and seasonal dummies are included. After some exploratory analysis (see below), the model used is

$$(7) \quad Q_t = a_0 + a_1 P^*_t + a_2 SC_{t-3} + a_3 FC_{t-1} + a_4 LPI_{t-1} + a_5 T + a_6 D_1 + a_7 D_2 + a_8 D_3,$$

where Q_t = quantity of softwood lumber supplied in quarter t, P^*_t = spot price expected in quarter t-1 to prevail in quarter t, SC_{t-3} = stumpage costs lagged 3 quarters, FC_{t-1} = fuel costs in the previous quarter, LPI_{t-1} = labor productivity index in the previous quarter, T = trend, and D_i = quarterly dummy variables.

Two measures of price expectations are used: lagged cash prices and futures prices. Prior to the introduction of futures trading, producers are assumed to form their price expectations from past observations of cash prices. Prices for kiln-dried Spruce-Pine-Fir 2x4's produced on the West Coast are most commonly used as an indicator of general market conditions and were the principal measure for spot prices used in this study. After the introduction of futures trading, the theoretical model suggests that producers form expectations based on the futures price. Because lumber production is year round and there are no clear decision dates guiding timber harvests, producers most likely respond to a spectrum of futures prices rather than a single quote. Prices, therefore, were observed at closing on the fifteenth and thirtieth of each month of the t-1 quarter for futures contracts maturing in the t and t+1 quarters. A simple average of these prices is then used as the futures price in the model.[3]

A complete description of the data and their sources is given in Meyer (1985, pp. 133-166). Definitions of the variables and their units of measure are presented in Table 1.

The equations estimated with data over the entire period of observations, 1961-1983, and with data from the with-futures trading period, 1970-1983, are presented in Table 2. Two common econometric problems were encountered: collinearity and autocorrelated residuals in some equations. An initial specification included an hourly wage rate variable, which created collinearity. A second specification combined the labor productivity and wage variables; the coefficient of CP was 0.89 for 1961-1983 and 1.33 for 1970-1983. Then as reported in Table 2, only the labor productivity variable was used, and the coefficient of CP was 0.80 and 1.06 for the respective periods. Thus, the results in Table 2 can be viewed as those least favorable to the hypothesis of structural change. This is particularly true since, as subsequent results indicate, replacing cash with futures prices increases the slope coefficient of the price variable.

Table 1. Definition of Variables

Variable	Definition	Units
Q	Softwood Lumber Shipments	Million board feet (MMbf)
CP	Cash Price[a]	$/10 thousand board feet (Mbf)
FP	Futures Price[a]	$/10 Mbf
LPI	Labor Productivity Index	100 Mbf/worker
SC	Stumpage Costs[a]	$/100 Mbf
FC	Fuel Costs Index[a]	1967=100
T	Trend	1, 2, 3, ...
D1	=1 if first quarter =0 otherwise	
D2	=1 if second quarter =0 if otherwise	
D3	=1 if third quarter, =0 if otherwise	

[a] All prices are in real terms, deflated by producer price index, 1967=100.

Table 2. Estimates of Lumber Supply Model, Two Time Periods

1961 I - 1983 IV: Estimated with GLS

$$Q = \underset{(936.29)}{5{,}191.95} + \underset{(0.43)}{0.80}CP_{t-1} - \underset{(0.05)}{0.05}SC_{t-3} - \underset{(0.37)}{1.02}FC_{t-1}$$

$$+ \underset{(0.27)}{0.51}LPI_{t-1} + \underset{(7.50)}{10.94}T + \underset{(92.66)}{9.20}D1 + \underset{(95.09)}{697.14}D2 + \underset{(86.45)}{454.83}D3$$

SER = 347.21

1970 I - 1983 IV: Estimated with OLS

$$Q = \underset{(1028)}{960.86} + \underset{(0.43)}{1.06}CP_{t-1} - \underset{(0.03)}{0.002}SC_{t-3} - \underset{(0.48)}{1.74}FC_{t-1} + \underset{(0.29)}{1.23}LPI_{t-1}$$

$$+ \underset{(12.32)}{41.44}T + \underset{(147.13)}{118.01}D1 + \underset{(139.24)}{663.96}D2 + \underset{(140.43)}{383.90}D3$$

$R^2 = 0.86$ SER = 365.12 DW = 1.74

Figures in parentheses are the standard errors of the coefficients.

A feasible GLS estimator is used to accommodate first-order autocorrelation (the Prais-Winsten estimator as implemented by SAS). The GLS slope coefficients typically were little different than the OLS coefficients.

B. Structural Change

The theoretical model predicts that the lumber supply relationship will change with the introduction of futures trading. Within the context of an econometric model, this prediction implies that the estimated coefficients will differ between the two periods. Since the lumber futures contract was introduced for trading in late 1969, the supply relationship may be expected to have changed at this point as a first approximation. Trading volume, however, varied sporadically until late 1971 and, after this time, grew more steadily. There may have been an initial period after the introduction of the contract during which potential hedgers and speculators scrutinized the usefulness of the contract. As a result, the futures contract may not have influenced the market immediately after its introduction. Such a change, if it exists, likely would be evident after late 1971.

Two methods were used to test for structural change in the estimated relationship. The null hypothesis tested by each was that no structural change occurred. First, an F test was used with the before and with-futures results.[4] Because the exact split between pre- and with-futures periods is hazy, two cut-off periods were explored: between the fourth quarter of 1969 and the first quarter of 1970, and between the fourth quarter of 1971 and the first quarter of 1972. The computed F statistic for the 1969 cut-off date is 1.87 and for the 1971 cut-off is 2.04. There are 90 observations in the full sample, and the critical value of F at the five percent level of significance (9, 72 degrees of freedom) is 2.0. Thus, the null hypothesis is rejected when the fourth quarter of 1971 is defined as the pivotal point between the pre- and with-futures periods.

Because this test required a division of the data into two distinct periods, a second test was employed, which does not require such an arbitrary decision. Cusum and cusum-of-squares are generated from recursive residuals derived from the OLS estimation of the model. The recursive residuals are obtained by successively estimating the model beginning with k+1 observations (where k is the number of explanatory variables plus the intercept), then k+2 observations, and so on, ending with all T observations. This procedure, then, results in T-k residuals. If the null hypothesis is true (i.e., no structural change has occurred), then the recursive residuals should all be about the same. The cusum and cusum-of-squares test statistics combine the recursive residuals and can be used to compute confidence intervals (Brown, Durbin and Evans, 1975).

The cusum and cusum-of-squares statistics, however, can be computed by forward or backward procedures. With a forward procedure, the first statistic is computed with the first k+1 observations, the second statistic is computed with the first k+2 observations, and so on. In contrast, a backward procedure starts with the last k+1 observations and proceeds back to the initial observation. If a structural shift in the coefficients occurs in the middle of the sample period, either the forward or backward procedure should be equally likely to detect a shift. If, however, a structural shift takes place during the initial period of observation, the forward procedure is less likely to reflect the change than the backward procedure since the first k+1 observations are required to estimate the initial cusum statistic. Similar reasoning can be made when a structural change occurs in the last part of the sample period.

Studies examining the statistical power of the cusum and cusum-of-squares tests have found that the cusum techniques increased in power as the level of instability increased (Garbade, 1977). Also, the cusum-of-squares procedure is a more powerful test for instability than the cusum procedure, and apparently the cusum confidence levels overstate the actual probability of incorrectly rejecting the null hypothesis (Garbade, 1977 and McCabe and Harrison, 1980). Johnson and Bagshaw (1974) examined the influence of serial correlation on the performance of the cusum test and concluded that the test was not robust in the presence of an autocorrelated error term structure.

Hence, the cusum procedures should not be interpreted as exact statistical tests for structural change, particularly since the cusum and cusum-of-squares in this study are obtained, because of computational convenience, from OLS residuals which in some cases exhibit first-order autocorrelation. As Brown, Durbin and Evans (1975, p. 150) state, these procedures "...should be regarded as yardsticks for the interpretation of data rather than leading to hard and fast decisions."

The results of the backward cusum plot and forward cusum-of-squares plot lend support to the hypothesis that a structural change occurred in the lumber supply relationship in late 1971 or early 1972 (Figures 1 and 2). The fact that two of the plots show a structural shift in the regression relationship while two do not is puzzling. It is reasonable to expect that both forward and backward plots should be able to detect a shift if it occurs in the middle of the period of observation. Yet, other empirical studies also report cases in which a forward cusum-of-squares plot indicates a structural change, while a backward plot does not and vice versa (see, for example, Hassan and Johnson, 1979).

In sum, the results of the statistical tests are not as clear-cut as one might like, but that a structural shift occurred around the end of 1971 is consistent with the comparative static results of the theoretical model. It must be stressed, however, that the Chow and cusum results cannot establish that the structural shift was caused by the introduction of futures trading but only that a shift coincided with the establishment of the futures contract.[5] But, whatever the cause, the point

FIGURE 1

Backward Cusum Plot
Five Percent Significance Level

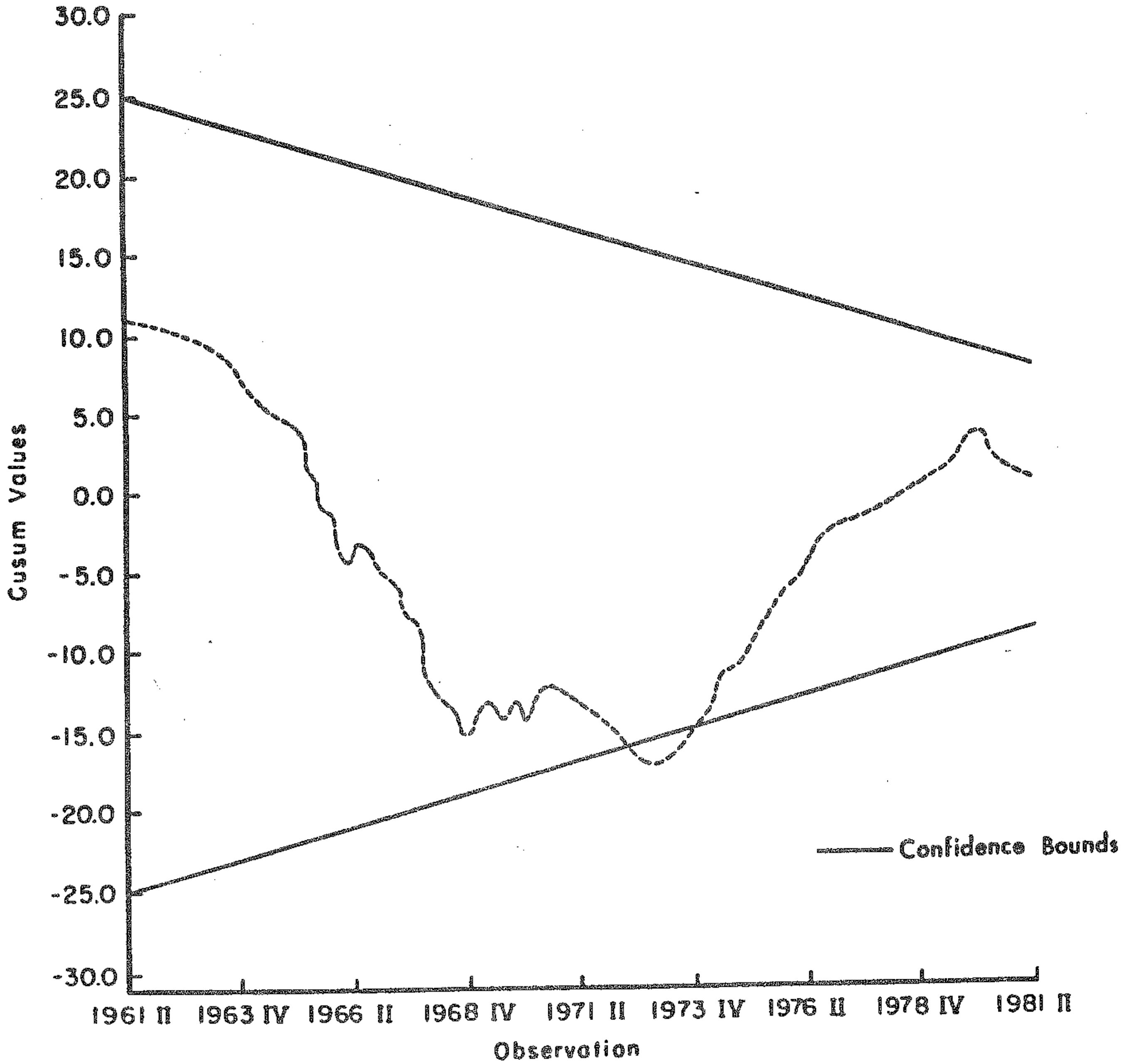
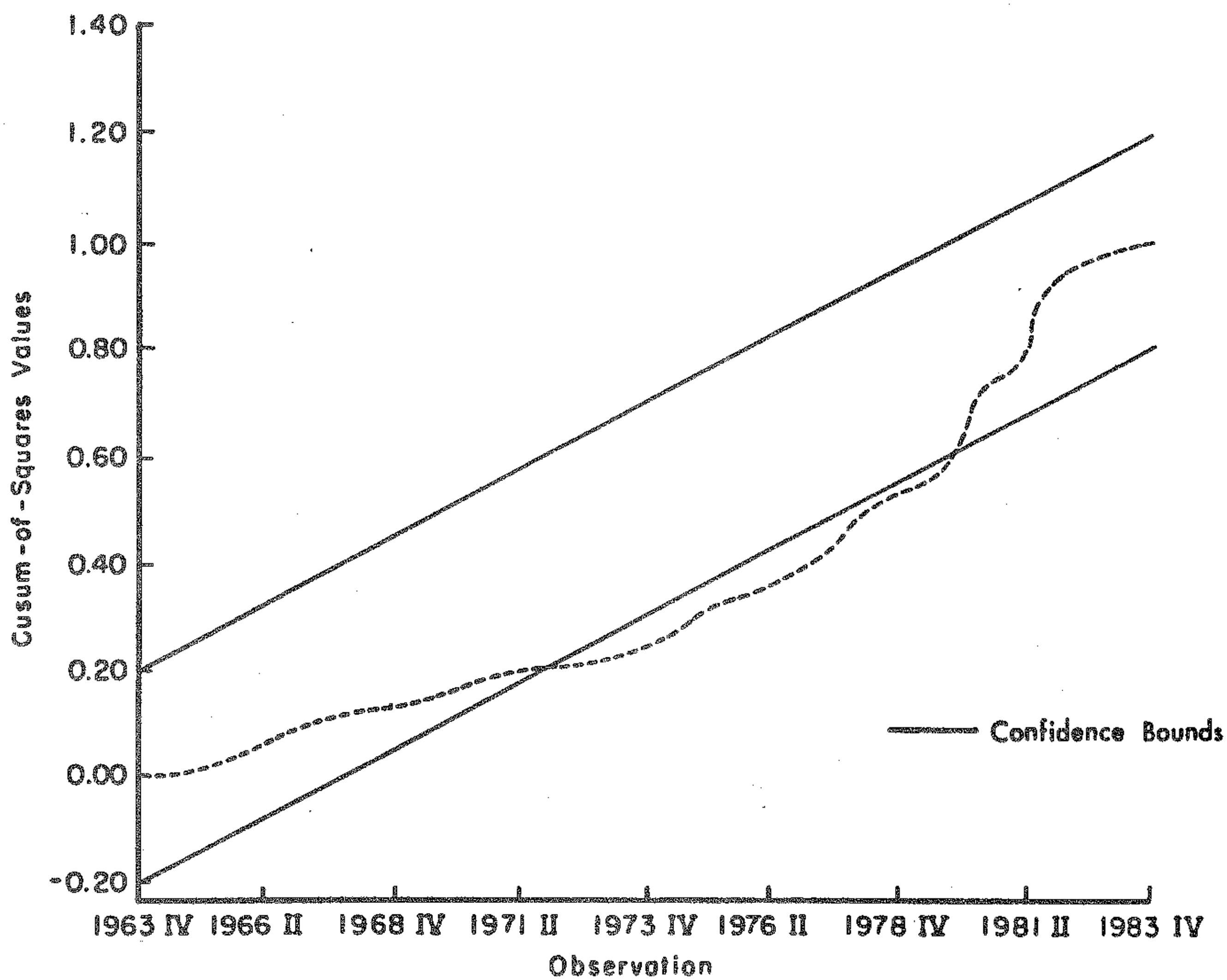


FIGURE 2

Forward Cusum-of-Squares Plot
Five Percent Significance Level



estimates of the slope coefficients suggest that the slope coefficient of the price variable has become larger.

C. Futures Price vs. Lagged Cash Price

If the advent of futures trading did indeed cause a structural shift, then according to the theoretical model, the supply relationship should be based on the futures price after this point in time. That is, the use of the lagged cash price presumably creates an errors in variable problem relative to the use of the futures price. The coefficient estimate associated with price should change, if errors in a variable are reduced.

In order to test this proposition, equation (7) was estimated with both the futures price and lagged cash price as explanatory variables. To avoid obtaining results influenced by a structural shift, the regressions reported here are estimated with data from the first quarter 1972 to the fourth quarter 1983. If one serves as the dominant price signal in the supply relationship, then that variable should have a larger t-ratio. Or R^2 should improve if the cash price is replaced by the futures price and the futures price is the dominant signal. Moreover, while an analysis of the bias associated with an errors in variables depends on values of unknown parameters, given that the true price parameter is positive, it is plausible that the bias is negative (Johnston, 1984, p. 429). If so, reducing the error should increase the coefficient.

The results, as presented in Table 3, clearly show that the futures price is the dominant price variable in the estimated supply relationship. When estimated with GLS, the estimated coefficient associated with the futures price is more than forty-five times greater than its cash price counterpart. These coefficients imply that a $0.10 per thousand board feet (Mbf) increase in the futures price will generate a 2.76 million board feet (MMbf) increase in softwood lumber shipments, ceteris paribus, as compared with only a 60 Mbf increase in shipments from a $0.10 per Mbf increase in the real cash price of lumber. The ratio of the futures price coefficient to its standard error also indicates that the futures price is an important explanatory variable for lumber shipments. In contrast, the t-ratio associated with the cash price is small and the null hypothesis that the true coefficient is zero cannot be rejected. This is consistent with the conceptual model which requires that only the futures price appears in the equation.

The empirical model was estimated with the futures price variable only (and with the lagged cash price variable only). The model estimated with the futures price has a slightly better fit (R^2) than the model estimated with the lagged cash price (Table 4). The standard error of the regression is about eight percent lower when the futures price is employed. Both models display the anticipated signs on the coefficients. The t-ratios of the coefficients in the model fitted with the futures price all exceed or are close to two, indicating that the true values

Table 3. Lumber Supply With Futures and Lagged Cash Prices, as Explanatory Variables, 1972 I - 1983 IV

Estimated with OLS

$$Q = \underset{(1,181.90)}{1,485.71} + \underset{(1.02)}{2.64}FP + \underset{(0.60)}{0.07}CP_{t-1} - \underset{(0.03)}{0.05}SC_{t-3} - \underset{(0.56)}{1.42}FC_{t-1}$$

$$+ \underset{(0.36)}{0.72}LPI_{t-1} + \underset{(15.39)}{38.55}T - \underset{(173.38)}{96.31}D1 + \underset{(181.53)}{364.28}D2 + \underset{(157.31)}{257.93}D3$$

$R^2 = 0.884$ SER = 366.54 DW = 1.55

Estimated with GLS

$$Q = \underset{(1,264.49)}{2,494.64} + \underset{(1.07)}{2.76}FP + \underset{(0.65)}{0.06}CP_{t-1} - \underset{(0.04)}{0.06}SC_{t-3} - \underset{(0.63)}{1.51}FC_{t-1}$$

$$+ \underset{(0.36)}{0.46}LPI_{t-1} + \underset{(17.42)}{39.57}T - \underset{(162.46)}{163.92}D1 + \underset{(181.03)}{326.31}D2 + \underset{(145.41)}{253.63}D3$$

SER = 360.77

Figures in parentheses are the standard errors of the coefficients.

Table 4. Lumber Supply with Alternative Measures of Expected Prices, 1972 I - 1983 IV

Explanatory variables[a]	Lagged cash price OLS	Lagged cash price GLS	Futures price OLS	Futures price GLS
Intercept	1209.7 (1260.8)[b]	2336.8 (1345.8)	1484.6 (1166.8)	2493.4 (1247. 3)
Price	1.06 (0.50)	1.09 (0.55)	2.72 (0.78)	2.83 (0.83)
SC(t-3)	-0.0004 (0.03)	-0.02 (0.04)	-0.05 (0.03)	-0.06 (0.04)
FC(t-1)	-1.71 (0.59)	-1.85 (0.65)	-1.44 (0.53)	-1.53 (0.60)
LPI(t-1)	1.20 (0.33)	0.92 (0.34)	0.72 (0.35)	0.46 (0.35)
T	39.67 (16.48)	41.80 (18.37)	39.05 (14.67)	39.94 (16.79)
D1	78.90 (171.1)	20.42 (160.2)	99.93 (168.7)	167.1 (157.5)
D2	622.3 (162.7)	600.7 (159.4)	356.5 (168.0)	319.6 (166.1)
D3	362.6 (162.9)	370.3 (150.1)	253.4 (151.1)	249.6 (137.6)
R^2	.863	-	.884	-
SER	392.6	388.1	361.9	356.0
DW	1.66	-	1.54	-

[a] Dependent variable is Q (Table 1).

[b] Standard errors in parentheses.

of the coefficients are not zero. When the model is estimated with lagged cash price, the t-ratio associated with the lagged raw material cost variable, stumpage costs, is close to zero. The price coefficient more than doubles when futures prices are substituted for cash prices.

Comparing the model estimated with both the futures and lagged cash price (Table 3) and the model estimated with the futures price only (Table 4), the estimated coefficients are virtually identical. The addition of the lagged cash price neither augments the explanatory power of the model nor alters the estimated coefficients through collinearity with the futures price. This evidence also suggests that the lagged cash price is an irrelevant variable in the softwood lumber supply relationship.

Although the results indicate that the futures price dominates the cash price for Spruce-Pine-Fir 2x4's in the supply relationship after the introduction of the contract, this does not exclude the possibility that an alternative measure of cash prices might be a superior measure of the market's expectations. In order to explore this possibility, the model was re-estimated with two other measures of the spot price for softwood lumber: the producer price index for softwood lumber and the framing composite price developed by a private lumber market newsletter (Random Lengths). But these measures of the spot price for softwood lumber did not alter the original conclusion. The futures price coefficient is still much larger than the coefficients association with any of the cash price variables and the t-ratios on the cash price variables are relatively small.

D. The Supply Elasticity

The theoretical model also predicts that the price elasticity of supply will increase with the introduction of futures trading. Price elasticities are derived from the empirical model when estimated with data from the before and with-futures trading periods. Both because tests indicate that a structural shift occurred in late 1971 and because the volume of futures trading was erratic until early 1972, the pre-futures trading period is defined over the first quarter of 1961 through the fourth quarter of 1971. The with-futures trading period is defined over the first quarter of 1972 through the fourth quarter of 1983.

The price elasticity of supply is defined as $(\partial Q/\partial P)(P/Q)$, where Q = quantity of lumber shipments and P = the relevant price variable (i.e., cash price in the pre-futures period and futures price in the futures trading period). But comparison of elasticities before and with-futures trading is complicated by shifts in demand and supply which mean that elasticities are being computed at two different points in the quantity-price space and because the price variables employed differ between the two regressions.

Initial results (Table 5) show that the price elasticity is higher in the futures trading period than in the pre-futures trading period when calculated at the mean values of the relevant price and quantity values for the respective periods. The point estimate of the price elasticity in the pre-futures period is 35 percent smaller than its with-futures counterpart.

To adjust for potential differences between the price elasticities from the two periods due to the different levels of mean price and quantity, the price elasticities were first recalculated at the mean price level observed in the with-futures period. Thus, the quantities for the two periods were calculated using the same mean prices but the means of the other explanatory variables were for each respective period. Naturally, the price elasticity for the with-futures period remained the same. The pre-futures price elasticity was 0.21--62 percent lower than the with-futures elasticity.

A further step compares the price elasticities calculated at the same price and shipments levels. Thus, in addition to the mean price level observed during the with-futures period, the mean values of all of the other explanatory variables recorded during the with-futures period were employed to calculate the corresponding levels of shipments. The adjusted price elasticity for the pre-futures trading period is 0.22. This is nearly 55 percent lower than the elasticity calculated after the introduction of futures trading.[6]

Table 5. Price Elasticities of Supply from the Before and With Futures Trading Periods

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With Futures Period, 1972 I - 1983 IV: Estimated with GLS

$$Q = \underset{(1{,}247.34)}{2{,}493.37} + \underset{(0.83)}{2.83FP} - \underset{(0.04)}{0.06SC_{t-3}} - \underset{(0.60)}{1.53FC_{t-1}} + \underset{(0.35)}{0.46LPI_{t-1}}$$

$$+ \underset{(16.79)}{39.94T} + \underset{(157.54)}{167.08D1} + \underset{(166.07)}{319.65D2} + \underset{(137.57)}{249.56D3}$$

SER = 356.02 Price Elasticity = 0.34

Before Futures Period, 1961 I - 1971 IV: Estimated with GLS

$$Q = \underset{(3{,}188.43)}{2{,}727.02} + \underset{(1.02)}{1.81CP_{t-1}} - \underset{(0.06)}{0.09SC_{t-3}} + \underset{(2.86)}{0.33FC_{t-1}}$$

$$+ \underset{(0.56)}{0.69LPI_{t-1}} - \underset{(10.94)}{3.71T} + \underset{(132.56)}{199.82D1} + \underset{(131.55)}{924.75D2} + \underset{(115.22)}{577.95D3}$$

SER = 231.75 Price Elasticity = 0.25

Figures in parentheses are the standard errors of the coefficients.

In summary, the price elasticity of supply when calculated from the futures trading period is consistently higher than when it is calculated from the pre-futures trading period. Hence, although an exact comparison between price elasticities calculated from the two periods cannot be made since the two models are different, the comparative static conclusion tends to be supported by the empirical findings.

IV. Conclusions

The empirical results support the theoretical model. First, a structural change in the supply relation seems to have occurred, which coincided with the establishment of a new futures market. Although a causal relationship cannot be proven, the existence of a shift is important. Second, after the introduction of the contract, the futures price was the dominant price signal in the supply relationship. Third, a comparison of the price elasticities of supply before and with futures trading shows that the supply relationship became less price inelastic with the introduction of the futures contract.

For all of its simplicity, the theoretical model appears to describe the effect of futures trading on the market supply relationship. Perhaps the most important result is that the supply relationship appears to become less price inelastic. Many of the price changes in lumber occur because of changes in demand. Hence, if the introduction of a futures contract has made supply more price elastic, it has had a stabilizing influence on the underlying spot market.

Footnotes

1 The supply function in our paper follows directly from Turnovsky; a similar supply function appears in Stein. Turnovsky's model includes speculators who hold inventories in the absence of futures markets; Stein's does not. Stein, however, permits two types of speculators in futures: amateurs and professionals. Meyer's (1985) model is a variant of Turnovsky's, but these nuances do not influence the supply equation. Lumber is technically storable, but can be produced continuously. Hence, since storage is costly, inventories at the mill level are small--on average, less than one week's production (U. S. Department of Commerce). Thus, from an economic viewpoint, lumber is not analogous to the grains. But, as emphasized in this note, several variants of the theoretical model give a qualitatively similar result for the supply function.

2 Data prior to 1961 were not used because cash prices were unavailable, and although futures trading started in late 1969, volume of trading in futures was small at the start of trading. The issue of testing for a point of structural change is discussed in the text.

3 For example, the futures price for the first quarter is derived from the closing futures prices recorded on the fifteenth and thirtieth (or the closest trading day closest

to these dates) of October, November, and December for the lumber contracts due to expire in January, March, and May.

4 The regressions estimated with data over the entire period of observation and the pre-futures periods exhibited significant first-order autocorrelation. The models were re-estimated, as explained in the text, with generalized least squares to correct for autocorrelation.

5 Other notable factors which may have contributed to a structural shift around 1971-1972 include the imposition of Phase II price controls in the U.S. economy during the last three quarters of 1972, which also froze the spot prices of lumber, and a record housing boom in 1972.

6 The range of values in the price elasticities of supply is somewhat smaller than those derived by other authors, who used annual observations from earlier periods (see McKillop, 1967, McKillop, Stuart, and Geissler 1980, and Robinson 1974).

References

Bray, Margaret, "Futures Trading, Rational Expectations, and the Efficient Markets Hypothesis," Econometrica 49 (May 1981), 575-596.

Brown, R. L., J. Durbin, and J. M. Evans, "Techniques for Testing the Constancy of Regression Relationships Over Time," Journal of the Royal Statistical Society, Series B, 37 (1975), 149-163.

Danthine, J. P., "Information, Futures Prices, and Stabilizing Speculation," Journal of Economic Theory 17 (February 1978), 79-98.

Fama, E. F., "Efficient Capital Markets: A Review of Theory and Empirical Work," Journal of Finance 25 (May 1970), 383-417.

Feder, Hershon, Richard E. Just, and Andrew Schmitz, "Futures Markets and the Theory of the Firm Under Price Uncertainty," Quarterly Journal of Economics XCIV (March 1980), 317-328.

Garbade, K., "Two Methods for Examining Stability of Regression Coefficients," Journal of the American Statistical Association 72 (March 1977), 54-67.

Hassan, Zuhair A., and S. R. Johnson, "Structural Stability and Recursive Residuals: Quarterly Demand for Meat," Agricultural Economics Research 31 (October 1979), 20-29.

Holthausen, Duncan M., "Hedging and the Competitive Firm Under Price Uncertainty," American Economic Review 69 (December 1979), 989-995.

Johnson, R. A., and M. Bagshaw, "The Effect of Serial Correlation on the Performance of CUSUM Tests," Technometrics 16 (February 1974), 103-112.

Johnston, J., Econometric Methods, third edition (McGraw-Hill Book Co., 1984).

McCabe, B. P. M., and M. J. Harrison, "Testing the Constancy of Regression Relationships Over Time Using Least Squares Residuals," Applied Statistics 29 (1980), 142-148.

McKillop, William, Thomas W. Stuart, and Peter J. Geissler, "Competition Between Wood Products and Substitute Structural Products: An Econometric Analysis," Forest Science 26 (March 1980), 134-148.

Meyer, John K., "the Effect of Futures Trading on the Supply of Lumber." Unpublished Ph.D. dissertation, Cornell University, 1985.

Robinson, Vernon L., "An Econometric Model of Softwood Lumber and Stumpage Markets, 1949-1967," Forest Science 20 (June 1974), 171-179.

Stein, Jerome L., "Real Effects of Futures Speculation: Asymptotically Rational Expectations," Economica 53 (1986), 159-180.

Tomek, William G., "Speculation and Price Behavior on Commodity Markets: A Survey," Research on Speculation Seminar Report (Chicago Board of Trade, 1981), pp. 8-23.

Turnovsky, Stephen J., "The Determination of Spot and Futures Price with Storable Commodities," Econometrica 51 (September 1983), 1363-1387.

U. S. Department of Commerce, Bureau of Census. Lumber Production and Mill Stocks. Current Industrial Reports, Serial MA-24T. Washington, D.C., annual.

Working, Holbrook, "Price Effects of Futures Trading," Food Research Institute Studies 1 (February 1960), 3-31.

Working, Holbrook, "Theory of the Inverse Carrying Charge in Futures Markets," Journal of Farm Economics 30 (February 1948), 1-28.

Working, Holbrook, "The Theory of the Price of Storage," American Economic Review 39 (December 1949), 1254-1262.