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The Relationship between Volume and Price Variability in Futures Markets

Bradford Cornell

When the future prices of commodities are known with certainty there is no reason to establish a futures market. Agents can construct a futures position in any commodity by borrowing or lending, since the future value of both the loan and the commodity are known.

Uncertainty introduces two motives for futures trading. First, as Keynes (1930) and Hicks (1946) originally noted, uncertainty may produce a desire to transfer risk. Those with large endowments will want to hedge by taking short positions in the futures market, while those with future requirements will tend to go long. Even if endowments are identical, individuals will still want to trade if they have different risk preferences. Keynes, for instance, claimed that highly risk-averse individuals, the hedgers, would transfer the risk of carrying a commodity to less risk-averse individuals, the speculators.

Under uncertainty, differential information provides the second motive for futures trading. In its original form, as presented by Working (1953), this theory points to the obvious fact that two individuals with different probability assessments regarding the future value of a commodity can both increase their utility *ex ante* by entering into a futures contract. Modern versions of this theory are more subtle because of Lucas' (1972) observation that in a world with differential information the market price will tend to aggregate information. Grossman (1975, 1977) has shown, nonetheless, that as long as the market price does not aggregate all information perfectly, differing beliefs will lead to futures trading.

Presumably, both motives account for the volume of trading that is observed in the market at any point in time. Intuitively, it seems that an "increase in uncertainty" should lead to an increase in both belief trading and hedging. This intuition is refined and supported by the theoretical work of Grossman (1975, 1977).

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Grossman's model contains only one good which is traded in both a cash and a futures market. In addition, Grossman assumes that:

(1) Time can be divided into two periods.
(2) There are two groups of investors; the informed, who have access to the information set Z; and, the uninformed, who do not.
(3) All investors have utility functions of the form $U(w) = -e^{-kw}$. For the informed $k = a$; for the uninformed $k = b$. The constant a is part of the set Z.
(4) The total "harvest" of the good Q is random, but none of the agents makes production decisions. (They choose only the size of the inventory to carry to period 2 and the number of futures contracts to buy.) Demand for the good in period 2 is random.
(5) The set Z is composed of the constant a and random variables $\tilde{w}$ and $\tilde{\theta}$, where $\tilde{w}$ is correlated with Q, and $\tilde{\theta}$ is correlated with period 2 demand.

The notation used is as follows:

P_f = futures price,
P_1 = current spot price (period 1),
P_2 = spot price next period (period 2),
Z = set of exogenous variables which only the informed have access to and which affect P_2,
X_a = futures positions taken by informed investors,
I = equilibrium inventory carried forward to period 2,
E, Var = expectation and variance operators.

Within this framework, Grossman derives an expression for the volume of futures trading which is given by

$$E[(X_a)^2 \mid P_1, P_f] = k_1 \operatorname{Var}[E(\tilde{P}_2 \mid Z) P_1, P_f] + k_2 [E(I)^2] \tag{1}$$

where

$$k_1 = [\operatorname{Var}(\tilde{P}_2 \mid Z)(a + b)]^2$$

$$k_2 = [(a - b/a + b) \operatorname{Var}(\tilde{P}_2 \mid Z)]^2$$

Note that X_a^2 rather than X_a is used as the measure of volume, because X_a may change in sign as informed investors take short and long positions.

Equation (1) clearly displays the two motives for futures trading. If all the information contained in Z is conveyed by the observable prices P_1 and P_f, then $\operatorname{Var}[E(\tilde{P}_2 \mid Z)P_1, P_f] = 0$ and futures trading is due solely to differing risk preferences. If $a = b$, on the other hand, differential information is the cause of futures trading.

Equation (1) also shows that an increase in "uncertainty" will increase both belief trading and hedging. By an increase in uncertainty, I mean that *both* the variance of prices given the informed investors' information, $\operatorname{Var}(\tilde{P}_2 \mid Z)$, and the divergence in beliefs measured by $\operatorname{Var}[E(\tilde{P}_2 \mid Z)P_1, P_f]$ increase. In Secs. I and II, the *ex post* variability of the futures price serves as a proxy for the level of uncertainty.

One other aspect of eq. (1) is worth noting. It is possible that the volume of futures trading will be large even if there is no inventory of the underlying commodity. Conversely, the inventory can be very large, but the volume of futures trading negligible if $\mathrm{Var}(\tilde{P}_2 | Z)$ is small. The exchanges should not overlook this fact in designing new contracts. When the commercial paper contract was introduced, the Chicago Board of Trade stated in its newsletter that the contract was bound to succeed because of the huge amount of cash paper outstanding. What the exchange ignored was that speculation or hedging in short-term interest rates could already be undertaken in the Treasury-bill futures market. Thus, the addition of the new market only opened the possibility of trading on the differential between the Treasury-bill rate and the commercial paper rate. If this differential is not sufficiently volatile, traders will have little incentive to enter the paper market no matter what the outstanding inventory of commercial paper. Section III contains a further discussion of this issue.

I. THE EMPIRICAL FRAMEWORK AND POTENTIAL PROBLEMS

The Grossman model assumed the existence of only one futures market. In actuality, as Anderson and Danthine (1980) stress, potential hedgers can trade simultaneously in many future markets. A corn farmer, for example, may improve his hedge by trading contracts in oats and barley as well as corn. Such a complete portfolio approach, however, is not employed in this article. Instead, the present study restricts itself to the relationship between the volume of futures trading in a particular commodity and the variability of the futures price for that commodity. Nonetheless, the results should be of value in understanding the relationship between volume and price variability, and in predicting the viability of potential contracts. If a significant relationship is found between volume and price variability, then new contracts should first be established for commodities with highly variable prices.

Some initial insight into the behavior of the data is provided in Table I, which shows the ratio of average open interest to average volume for the 17 future contracts used in the study. The full sample period, which runs from February 1968 through June 1979, has been divided into three subperiods to check the stability of the ratios. With the exception of silver, the maximum turnover times for the open interest was ten days for sugar in the first period, while the minimum was less than two days for pork bellies in the final period. For the major agricultural commodities with the longest trading history—wheat, corn, oats, and soybeans—the turnover was generally about five days.

On the surface these ratios seem extraordinarily small. There are a number of factors, however, which tend to inflate the volume figures. First is the intermediation activity of floor traders, which increases reported volume. Some floor traders, commonly called "scalpers," stand willingly to buy a tick below the last trade or sell a tick above it. When an outside order comes in, scalpers frequently take the other side of the position. The scalper then covers his position as soon as possible. The activity of the scalpers adds liquidity to the market and increases reported volume. Instead of one trade among outsiders, several trades are recorded.

Second, spread trading can affect reported volume. Speculative spread trading obviously will increase reported volume, and, to the extent that hedgers use spreads, reported volume figures also rise. On the other hand, tax spreading could

[1] The use of spread positions in silver to defer taxes is currently under investigation by the IRS. The issues are complex and tangential to the results reported in this article, so no further discussion is offered here.

Table I
RATIO OF OPEN INTEREST TO VOLUME

	Period 1 1/1/68-10/10/71	Period 2 10/10/71-7/19/74	Period 3 9/19/75-5/1/79
Copper	9.9	8.3	8.4
Corn	6.8	5.2	5.0
Cotton	8.9	9.2	6.1
Gold (COMEX)	—	—	6.2
Gold (IMM)	—	—	5.1
Hogs	8.8	3.7	2.8
Live cattle	9.7	3.2	3.4
Oats	9.5	5.4	5.7
Pork bellies	2.8	2.4	1.8
Silver (CBT)	14.3	19.7	17.2
Silver (COMEX)	16.3	13.0	13.5
Soybeans	6.4	4.6	3.4
Soybean meal	8.0	8.3	4.6
Soybean oil	6.0	5.4	4.8
Sugar	10.4	5.3	8.7
Wheat	6.2	3.9	4.2
Treasury bills	—	—	5.3

increase the ratio of open interest to volume. In a simple tax spread only three trades are required and the holding period is a minimum of six months. This is one possible explanation for the higher open-interest-to-volume ratios reported for silver. Over the sample period, silver was reportedly a favorite vehicle for tax straddles.[1]

The two statistics estimated for each commodity are the average daily volume and the variance of the daily log price relative, Var($\ln P_{f,t+1} - \ln P_{f,t}$). To estimate these statistics the sample was broken into a sequence of two-month intervals. (Intervals of one month and six weeks were also used without having any major impact on the results.) Daily settlement prices were used to estimate the variance. No adjustment was made for holidays or weekends. Since we are only interested in *changes* in the estimated variance, not adjusting should have little impact on the results.

The variance of the log price relative is used rather than the variance of the rate of return on investment because, as Black (1976) states, the initial investment in a futures position is zero. (In addition, daily settlement returns the value of the position to zero at the end of each day.) Using the rate of return on initial margin would also be misleading, because not all investors face the same margin requirements. Furthermore, speculators are allowed to put up Treasury bills to satisfy the requirements, so the opportunity cost of the margin deposit is zero.

Another potential source of bias is the maturity of the futures contract used to estimate the variance. Samuelson (1965) argued that commodity returns become riskier as a contract approaches maturity. If this is true, using the time series of returns from a given contract to estimate the variance may be inappropriate. Nonetheless, that procedure is employed here because it is the only feasible way to measure the variance and the trading volume over the same interval. Specifically, the first contract to mature after the end of each two-month interval is used to estimate the variance over the interval. Though the maturity problem exists, its impact should be limited because of two considerations: the effect is the same over each interval, and we are only studying changes in the estimated variance.

One advantage of using the longer interval, two months instead of one month or six weeks, is that it dilutes the potential impact of exchange-imposed daily price limits on results. Because of limitations on price fluctuations, a commodity can "lock limit," meaning its price can move the maximum allowed amount for that day with few or even no trades occurring. In rare cases several consecutive days of limit moves may occur before a market-clearing price is reached and significant trading volume reappears. Such limit moves obviously increase the estimated variance while decreasing volume. If daily data were used, for example, price limits could induce a negative correlation between the squared change in the log price relative and trading volume. Over the long run, however, price limitations do not prevent the market from reaching equilibrium so that desired trades can be made.

II. DATA AND EMPIRICAL RESULTS

The data for this study were taken from the Commodity Systems Inc. computer tape made available by the Center for the Study of Futures Markets at Columbia University. My sample begins on January 1, 1968 and ends on May 1, 1979. The commodities selected were those that actively traded on the major U.S. exchanges during this period. The one exception is gold for which my sample begins on January 1, 1975 for the COMEX and on March 1, 1975 for the International Monetary Market of the Chicago Mercantile Exchange. The data include daily observations on the settlement prices for all outstanding contracts on each commodity and aggregate figures, across the contracts, on volume and open interest.

Two values were computed from the sequence of variance estimates and average daily volume: DVOL, the change in average daily volume; and DSD, the change in the standard deviation of the log price relative. Sample statistics for these two variables are presented in Table II. The volume data are reported in percentage change terms to document the dramatic growth in commodity trading. Annualized growth rates range from 26 percent for pork bellies to 216 percent for COMEX gold. Nonetheless, the bimonthly growth rates are only marginally significant in many cases, because the trading volume is so variable. The standard deviation sequences are trendless; none of the mean change figures are close to being significant.

Table III reports the autocorrelations for DVOL and DSD. It is important to note that DSD is close to white noise. The first-order autocorrelations are consistently negative, but that is partly attributable to measurement error. Suppose, for example, that the true standard deviation σ^* followed a random walk, but that σ^* is estimated with error. Thus,

$$\sigma_t^* = \sigma_{t-1}^* + w_t$$

and

$$\sigma_t = \sigma_t^* + z_t$$

Table II
SUMMARY STATISTICS

		DVOL% [a]			DSD [b]		
	Observations	Mean	SD	t-stat	Mean	SD	t-stat
Copper	68	0.094	0.341	2.26	−0.332	13.3	−0.20
Corn	68	0.075	0.354	1.73	0.136	14.2	0.24
Cotton	68	0.049	0.403	1.01	−0.215	15.1	−0.12
Gold (COMEX)	26	0.212	0.519	2.04	0.009	13.5	0.01
Gold (IMM)	25	0.157	0.402	1.95	−0.036	13.8	−0.04
Hogs	68	0.148	0.465	2.61	−0.256	32.1	−0.05
Live cattle	68	0.100	0.362	2.26	0.178	13.6	0.11
Oats	68	0.099	0.549	1.48	0.464	16.1	0.24
Pork bellies	68	0.039	0.269	1.19	0.406	13.3	0.25
Silver (CBT)	68	0.095	0.359	2.17	0.210	15.8	0.11
Silver (COMEX)	68	0.086	0.378	1.87	−0.544	16.2	−0.27
Soybeans	68	0.143	0.812	1.44	0.120	12.8	0.08
Soybean meal	68	0.092	0.423	1.78	0.019	25.4	0.01
Soybean oil	68	0.085	0.403	1.73	0.057	19.6	0.02
Sugar	68	0.062	0.380	1.34	−1.35	29.8	−0.37
Wheat	68	0.045	0.359	1.05	4.84	14.6	0.27
Treasury bills	27	0.179	0.433	1.98	0.57	22.3	0.02

[a] DVOL% = percentage change in average daily volume per period.
[b] DSD = change in estimated standard deviation of return.

where both $\{w_t\}$ and $\{z_t\}$ are assumed to be white noise and to be uncorrelated with each other. Using the symbol "Δ" to denote first differences,

$$\operatorname{corr}(\Delta\sigma_t^*, \Delta\sigma_{t-1}^*) = 0$$

but

$$\operatorname{corr}(\Delta\sigma_t, \Delta\sigma_{t-1}) = \frac{\operatorname{Var}(z_t)}{\operatorname{Var}(z_t) + 2\operatorname{Var}(w_t)}$$

Thus, estimation error would cause DSD to show negative first-order autocorrelation. Unfortunately, the magnitude of this effect cannot be measured without estimates of both $\operatorname{Var}(z_t)$ and $\operatorname{Var}(w_t)$.

Tables IV and V report regression results for the equation

$$\begin{aligned}\mathrm{DSD}_t = c &+ a_{-2}\mathrm{DVOL}_{t-2} + a_{-1}\mathrm{DVOL}_{t-1} + a_0\mathrm{DVOL}_t \\ &+ a_1\mathrm{DVOL}_{t+1} + a_2\mathrm{DVOL}_{t-2}\end{aligned} \tag{8}$$

The change in the standard deviation is put on the left-hand side of the equation, despite the fact that causality probably runs the other direction, to reduce the impact of the errors-in-variables problem. (The data on DVOL are given, while DSD are estimates.) The estimated coefficients are multiplied by 10^7 to adjust for the fact

Table III
AUTOCORRELATIONS[a]

	DVOL				SD				DSD			
	ρ_1	ρ_2	ρ_3	ρ_6	ρ_1	ρ_2	ρ_3	ρ_6	ρ_1	ρ_2	ρ_3	ρ_6
Copper	0.066	0.029	0.011	−0.098	0.750	0.626	0.552	0.174	−0.173	−0.049	0.068	0.209
Corn	−0.057	−0.205	−0.129	−0.059	0.749	0.525	0.424	0.417	−0.087	−0.234	−0.211	0.181
Cotton	0.114	0.136	0.019	0.065	0.771	0.654	0.557	0.281	−0.230	−0.065	−0.143	−0.180
Gold (COMEX)	−0.100	−0.239	−0.071	0.334	0.404	0.117	−0.282	0.040	−0.244	−0.022	−0.204	−0.006
Gold (IMM)	−0.114	−0.070	0.154	−0.019	0.497	0.098	−0.254	0.013	−0.304	−0.010	−0.198	−0.032
Hogs	0.319	0.162	−0.143	0.015	0.321	−0.055	−0.080	0.015	−0.269	−0.269	−0.045	−0.108
Live cattle	0.093	−0.090	−0.159	0.156	0.660	0.533	0.454	0.445	−0.325	−0.066	−0.108	0.317
Oats	0.014	−0.081	0.008	−0.091	0.745	0.596	0.484	0.345	−0.233	−0.067	−0.220	−0.043
Pork bellies	0.144	−0.239	−0.237	0.427	0.495	0.296	0.346	0.290	−0.287	−0.265	−0.030	0.215
Silver (BT)	−0.245	−0.104	−0.054	0.207	0.722	0.685	0.638	0.330	−0.303	−0.095	0.188	0.199
Silver (COMEX)	−0.277	−0.194	0.303	0.498	0.674	0.613	0.548	0.351	−0.376	−0.013	0.124	0.477
Soybeans	−0.167	−0.059	0.061	−0.063	0.797	0.648	0.594	0.681	−0.107	−0.260	−0.171	0.245
Soybean meal	−0.151	−0.094	−0.088	−0.042	0.752	0.603	0.575	0.421	−0.196	−0.256	0.229	0.302
Soybean oil	−0.018	−0.188	0.115	0.071	0.716	0.613	0.575	0.421	−0.317	−0.131	0.116	0.289
Sugar	−0.311	0.080	−0.136	0.434	0.538	0.340	0.316	0.251	−0.263	0.040	−0.061	0.176
Wheat	−0.081	−0.125	0.076	0.186	0.797	0.758	0.715	0.533	−0.425	0.001	0.051	0.078
Treasury bills	0.113	−0.098	−0.084	0.216	0.695	0.610	0.532	0.421	−0.032	−0.298	−0.254	0.250

[a] All correlations exceeding 0.244 are significant at the 5-percent level, except for gold in which case the 5-percent significance level is 0.400.

[b] SD = standard deviation of return.

Table IV
REGRESSION RESULTS[a]

$$DSD_t = c + a_{-2}DVOL_{t-2} + a_{-1}DVOL_{t-1} + a_0 DVOL_t a_1 DVOL_{t-1} + a_2 DVOL_{t-2}$$

	c	a_{-2}	a_{-1}	a_0	a_1	a_2	R^2
Copper	−73.0	5.92	4.28	22.9	−9.12	−6.69	0.248
	(−0.19)	(0.79)	(0.53)	(2.98)	(−1.55)	(−1.22)	
Corn	−306.7	0.74	0.54	1.71	0.24	−0.20	0.517
	(0.71)	(1.21)	(2.23)	(6.86)	(0.98)	(−0.90)	
Cotton	−112.2	−9.04	12.6	38.1	−15.2	−7.58	0.350
	(−0.24)	(−1.04)	(1.50)	(4.86)	(−1.96)	(−0.97)	
Gold (COMEX)	−383.7	−0.04	−0.82	10.0	−3.88	1.88	0.244
	(−0.29)	(−0.01)	(−0.13)	(2.08)	(−0.83)	(0.48)	
Gold (IMM)	−651.3	−1.81	3.69	11.0	−3.78	3.36	0.281
	(−0.48)	(−0.33)	(0.67)	(2.03)	(−0.69)	(0.63)	
Hogs	149.4	−2.97	−3.60	21.4	−14.9	−0.73	0.147
	(0.23)	(−0.34)	(−0.42)	(2.51)	(−1.68)	(−0.08)	
Live cattle	47.0	−2.09	1.45	7.13	−2.43	−1.45	0.369
	(0.23)	(−1.32)	(0.98)	(4.97)	(−1.70)	(−1.03)	
Oats	−49.9	−9.03	−0.74	32.0	0.42	8.39	0.388
	(0.10)	(−1.46)	(−0.12)	(4.85)	(0.07)	(1.37)	
Pork bellies	−4.0	−5.57	−6.17	9.50	−2.39	−7.72	0.312
	(0.01)	(−1.66)	(1.85)	(2.65)	(−0.69)	(−2.22)	

Silver (CBT)	93.8	−0.99	−0.73	2.23	−5.40	1.66	0.129
	(0.16)	(−0.27)	(−0.21)	(0.82)	(−1.75)	(0.52)	
Silver (COMEX)	−160.7	1.30	0.25	1.45	−0.84	2.61	0.124
	(−0.36)	(0.98)	(0.18)	(1.00)	(−0.62)	(2.00)	
Soybeans	483.7	0.26	−0.32	0.43	−0.91	−0.46	0.279
	(0.66)	(0.85)	(−1.03)	(1.30)	(−3.01)	(−1.59)	
Soybean meal	−224.4	5.35	−1.83	22.1	−8.00	−3.66	0.266
	(−0.23)	(0.74)	(−0.23)	(2.91)	(−1.10)	(−0.56)	
Soybean oil	−195.6	9.44	−5.15	17.9	−5.42	3.60	0.386
	(0.34)	(2.87)	(−1.59)	(5.13)	(−1.68)	(1.20)	
Sugar	41.3	−4.03	0.88	20.2	−13.1	−15.0	0.141
	(0.04)	(−0.32)	(0.06)	(1.47)	(−1.02)	(−1.25)	
Wheat	−44.0	0.78	−1.76	2.94	−0.24	0.32	0.416
	(0.09)	(1.37)	(−3.09)	(5.10)	(−0.44)	(0.57)	
Pooled data	92.4	0.03	−.11	.86	−.27	−.17	0.102
	(0.06)	(0.28)	(−0.87)	(6.29)	(−2.09)	(−1.33)	
Treasury bills	−161.3	7.99	−4.02	6.50	−3.73	−0.06	0.704
	(0.48)	(3.41)	(−1.73)	(3.11)	(−1.85)	(−0.03)	

[a] t-Statistic is in parentheses.

Table V
RESIDUAL AUTOCORRELATIONS FOR REGRESSION EQUATIONS

	ρ_1	ρ_2	ρ_3	ρ_6
Copper	−0.071	−0.083	0.068	−0.191
Corn	−0.214	−0.196	0.017	0.208
Cotton	−0.450	0.215	−0.118	−0.137
Gold (COMEX)	−0.208	−0.145	−0.347	0.163
Gold (IMM)	−0.374	0.148	−0.413	0.399
Hogs	−0.228	−0.361	0.035	0.002
Live cattle	−0.215	−0.184	−0.111	0.231
Oats	−0.222	−0.186	0.001	−0.207
Port bellies	−0.368	0.057	−0.232	0.017
Silver (CBT)	−0.151	0.105	−0.161	0.208
Silver (COMEX)	−0.025	−0.143	−0.006	0.016
Soybeans	−0.021	−0.318	−0.113	0.089
Soybean meal	−0.048	−0.143	−0.121	0.256
Soybean oil	−0.203	−0.075	−0.064	0.150
Sugar	−0.221	0.085	−0.114	0.126
Wheat	−0.228	−0.121	−0.202	−0.064
Treasury bills	0.060	−0.355	−0.292	0.248

that average daily volume is on the order of 10^5 contracts while the standard deviation of log price relative is on the order of 10^{-2} dollars.

The results show a consistently significant relationship between volume and price variability. In all but four cases, two of which are silver, the coefficient a_0 is significantly greater than zero at the 5-percent level or higher. For all 17 commodities the coefficient a_0 has the predicted positive sign, indicating that volume increases with price variability. The results also show that the relationship between the two variables is almost entirely contemporaneous. Of the 68 leading or lagging coefficients only five are significantly different from zero at the 5-percent level; three positive and two negative. In general, there is no pattern among insignificant coefficients; 23 are positive and 45 are negative.

The autocorrelations show that the regression model invariably fails to yield white noise residuals. In general, this would imply that the model was misspecified, but once again measurement error may be to blame. If the negative autocorrelation of DSD is due to measurement error, as we have shown it could be, then it should reappear in the regression residuals. Comparing Tables III and V, the residual autocorrelations are seen to match closely the autocorrelations of DSD. Finally, Table IV also reports the results of a pooled time series and cross-sectional regression. A two-stage process was employed to estimate the equation with the residuals from the first stage being used to adjust for heteroskedasticity in the second stage. Once again a highly significant contemporaneous relationship between volume and price variability was found.

Some insight into the applications of these results is provided by Table VI. The reported coefficients $1/a_0$ were calculated in two steps. First, the equation

$$\mathrm{DSD}_t = c + a_0 \mathrm{DVOL}_t \tag{9}$$

was estimated eliminating the generally insignificant leading and lagging terms. Then eq. (9) was inverted yielding

$$\mathrm{DVOL}_t = c/a_0 + (1/a_0)\,\mathrm{DSD}_t \tag{10}$$

Though biased for small samples, the estimate of $1/a_0$ arrived at by this procedure is consistent. If eq. (10) were estimated directly, errors in variables would lead to both biased and inconsistent coefficients.

From the coefficients and the average standard deviation of log price relatives, the increase in daily volume that would result from a 50-percent increase in the standard deviation was computed. Though the results must be taken with a grain of salt because of the substantial measurement error in $1/a_0$, they show that the volume of trading can be altered dramatically by a change in price variability.

III. TREASURY BILLS VERSUS COMMERCIAL PAPER: THE NEW CONTRACT PROBLEM

The preceding results show that price variability is correlated significantly with trading volume. This has the obvious implication that new contracts should be written on commodities with "sufficient" price variability. The new-contract problem is

Table VI
SENSITIVITY OF VOLUME TO PRICE VARIABILITY

	Mean Value of SD	Implied Coefficient $1/a_0$	Increase in Average Daily Volume for a 50-Percent Increase in SD
Copper	14.3	0.45	3217
Corn	11.2	7.00	39,200
Cotton	12.3	0.28	1780
Gold (COMEX)	12.2	1.52	9270
Gold (IMM)	12.5	0.79	4940
Hogs	14.4	0.48	3460
Live cattle	10.9	1.44	7850
Oats	15.0	0.34	2650
Pork bellies	17.7	0.72	6370
Silver (CBT)	15.7	3.57	28,020
Silver (COMEX)	15.6	10.02	78,030
Soybeans	13.5	12.82	86,400
Soybean meal	17.3	0.43	3720
Soybean oil	19.1	0.72	6880
Sugar	24.2	0.40	4840
Wheat	14.2	3.50	72,100
Treasury bills	28.5	0.51	7200

complicated if the price changes for the proposed contract are correlated with the price changes for previously existing contracts. The case of Treasury bills and commercial paper is a good example.

Trading in 90-day Treasury-bill futures began on January 6, 1976. To compare the behavior of the Treasury-bill futures market with those previously studied, results for Treasury bills have been added to the bottom of each of the six tables. The sample period for the Treasury-bill data is from March 1, 1976 to September 1, 1980.

From Table I, the ratio of open interest to volume for Treasury bills is seen to be 5.3, about the average value of the other commodities. Table II documents the success of the T-bill futures market. The annualized growth rate of volume is 179 percent, second only to COMEX gold.

The most interesting results are contained in Table IV, where the regression of price variability on trading volume for Treasury bills is shown to have a higher R^2 than any of the other commodities. In addition, the contemporaneous term is significant at the 1-percent level and remains so when the lagged terms are deleted.

Trading in 90-day commercial paper futures began on September 26, 1977. Unlike the T-bill market, the commercial paper market never attracted significant volume. By 1980 trading had fallen to less than 100 contracts a day.

By the time trading in commercial paper began, the Treasury-bill futures market was well established and provided a mechanism by which agents could hedge against or speculate on movements in the level of short-term interest rates. The homogeneous nature of Treasury bills also made for relatively easy delivery against the futures contract.

As a potential competitor, the commercial paper market was at a distinct disadvantage. First, new markets are less liquid, making it difficult for them to draw traders away from existing markets. This gives established markets a degree of "monopoly power" in the short run. In the case of Treasury bills and commercial paper, this monopoly power was enhanced by the more complicated delivery procedure for commercial paper. (The debt of 40 different companies could be delivered.)

Nonetheless, the opening of the paper market made it possible for traders to hedge against or speculate on movements in the spread between the 90-day T-bill rate and the 90-day paper rate. If there was "sufficient" uncertainty about this spread, the paper market could coexist successfully with the bill market.

Using each Friday's closing cash rates for the year before the paper market opened, the commercial paper rate was regressed on the Treasury bill rate. The results were

$$\begin{array}{lll} \mathrm{CP}_t \quad = -0.31 & + 0.97\mathrm{TB}_t, & R^2 = 0.94 \\ (t\ \text{statistics})(-1.62) & (27.9) & \mathrm{DW} = 1.52 \end{array}$$

where CP is the discount on 90-day commercial paper and TB is the discount on 90-day Treasury bills. The regression equation documents the well known fact that Treasury-bill rates and commercial paper rates are highly correlated.

Combining the two results paints the following picture. Variability of short-term interest rates is an important, perhaps the most important, determinant of trading in short-term interest rate futures. The Treasury-bill market is an ideal vehicle to hedge against or speculate on movements in the short-term interest rate, because it was established first, is the most liquid, and provides for delivery of a widely recognized, homogeneous instrument. Adding new markets, such as that for commercial paper, makes it possible to trade the spread between bills and the new instrument, but the spreads are much less variable than the absolute level of interest rates. The new market flounders because it is unable to attract trading on the *level* of rates away from the bill market, and because the spreads are not "sufficiently" variable.

Of course, the evidence presented here is not conclusive. Other theories could be offered to explain the failure of the commercial paper futures market. Nonetheless, it is useful to extrapolate the results to predict what will happen to proposed markets in 90-day domestic CDs and 90-day Eurodollar CDs. As was true of commercial paper, rates on both these instruments are highly correlated with the Treasury-bill rate. In addition, the heterogeneous nature of CDs will make delivery more confusing than for bills. It is likely, therefore, that both these proposed markets will fail to attract significant volume.

IV. CONCLUSIONS

This article studied the relationship between the volume of trading and price variability for futures contracts. A significant, positive, contemporaneous correlation was found between the changes in average daily volume and changes in the standard deviation of daily log price relatives for 14 of the 18 commodities in the sample. For the other four commodities, the correlation was also positive though insignificant. A pooled time series, cross-sectional regression showed that the contemporaneous correlation between the two variables was significant at the 1-percent level. Conversely, the correlations between changes in price variability and led or lagged changes in volume were insignificant.

It should be stressed that "true" relationship between volume and price variation is undoubtedly stronger than reported here. Price limits, scalping, spread trading, and noisy estimates of the standard deviation all tend to pollute the data and reduce the estimated correlation.

Perhaps the most important implication of these results is for the design of new futures contracts. All established markets have a degree of monopoly power, because they can promise liquidity. In this environment, there are two ways a new contract can succeed. If there are no other similar contracts—by that is meant existing contracts with highly correlated prices—the critical question is whether the price of the underlying commodity is "sufficiently" uncertain to sustain futures trading. If similar contracts already exist, then the new contract can succeed either by attracting volume away from the established market, perhaps because delivery is easier or the underlying instrument is better known; or, by attracting new volume. For new trading to occur, the spread between the futures price of the established commodity and the futures price of the new commodity must be sufficiently uncertain. If it is not, then there is no reason for traders to enter the new market.

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