Commodity Futures: Trends or Random Walks?

Richard A. Stevenson, Robert M. Bear

Journal of Finance, Volume 25, Issue 1 (Mar., 1970), 65-81.

COMMODITY FUTURES: TRENDS OR RANDOM WALKS?

RICHARD A. STEVENSON AND ROBERT M. BEAR*

A PREPONDERANCE OF EVIDENCE during recent years has been presented to demonstrate that in highly competitive and organized markets, price changes will be indistinguishably close to random. The model for such market behavior is called the random walk theory. The underlying economic foundation for this hypothesis is that an efficient market, characterized by numerous well-informed participants, should create prices which accurately reflect all current information. Thus the commodity in question will be priced at a reliable estimate of its intrinsic value.[1] Price changes will reflect new information and hence will approximate a random variation.

A model of this nature has profound interest and impact in the analysis of speculative markets. In both stock and commodity markets, there are professional groups representing chartist, or technical, means of analysis and fundamental, or intrinsic value, analysis. Chartists study previous changes in price for indications of future changes in price. Fundamentalists seek early knowledge of price changes by studying factors important in the future supply and demand for the commodity. Both groups have in common an assumption of the existence of trends.[2]

If the theory of random walks holds, past prices do not provide any information useful in estimating future prices. The next move of a speculative price is independent of all past moves. This implies that technical analysis is without value and places strong performance demands on the fundamentalist, who must prove himself superior in his forecasts to what would occur through random selection.[3]

The purpose of this paper is to draw together in one analysis several tests of the nature of speculative price movements and to view the results of their application to two series of commodity future prices. The results obtained suggest that these series do move in a systematic, as opposed to a random, manner.

I. PREVIOUS RESEARCH

The random walk hypothesis has had more rigorous testing in stock markets than it has in commodity markets. Some work has been done in the field of

* The authors are, respectively, Associate Professor of Finance and N.D.E.A. Fellow at The University of Iowa. Mr. Bear was formerly a market analyst with the Commodity Exchange Authority, U.S.D.A. The authors wish to thank Robert Soldofsky, The University of Iowa, and Michael Jensen, University of Rochester, for advice and criticisms. We wish also to recognize the Bureau of Business and Economic Research of The University of Iowa and Edith Ennis of the Bureau for assisting in the preparation of this manuscript.

1. Eugene F. Fama, "Random Walks in Stock Market Prices," *Financial Analysts Journal,* Vol. 21, No. 5 (September-October, 1965), p. 56.

2. Sidney S. Alexander, "Price Movements in Speculative Markets: Trends or Random Walks," *Industrial Management Review,* Vol. 2, No. 2 (May, 1961), p. 7.

3. Fama, *op. cit.,* p. 58.

commodities, however. Mandebrot presented information on cash wheat and corn prices, determining that they conform to Paretian distribution instead of the previously assumed normal (Gaussian) distribution. Mandelbrot concluded that the distinction between causal and random areas is very diffuse in speculative markets.[4] In his comments on the article, Paul Cootner criticized the use of commodity cash (spot) prices by Mandelbrot on the grounds that they are not the type of series that would exhibit Brownian motion because these prices are related to the size of inventories.[5] Cootner also stated that his work on commodities suggests that a much closer approach to randomness exists in commodity than in stock markets.[6]

In another article, Larson applies a measure of random variation based on the range of series as developed by Holbrook Working. Larson's presentation of Working's economic arguments on the subject of commodity futures markets is very pertinent:

> . . . anticipatory prices depend on expectations regarding the future course of events affecting demand and supply of the commodity being traded. Traders base their expectations on market news which in broad and highly organized commodity markets tends to be generally accurate, timely, and relevant.
>
> In an ideal market, existing knowledge of market conditions would be reflected in current price, any new information . . . would produce a price movement. Truly new information emerges randomly, and so price movements would tend to be random.
>
> No actual market behaves exactly like an ideal market. Many commodity futures markets approach the ideal, and differ principally in that traders react with varying skill to varying sources of information, and so some of the response to price-making forces is delayed.[7]

Larson illustrates how autocorrelograms of close-to-close price changes in corn futures are not sensitive enough to adequately test price movement. His statistical procedure here is not well defined, raising some pertinent questions. An autocorrelation representing a ten-year period may not be representative of all discontinuous yearly futures from which it is composed. A trader cannot speculate on a ten-year outcome but must face each commodity future as a separate entity with a relatively limited life. This suggests that each yearly segment (future) should be analyzed separately. Nor would a continuous series using an average of all currently outstanding futures (usually five) or a series using the future nearest expiration be satisfactory. In the former, the changing mix of old crop-new futures through each calendar year would inject a bias. Using the future nearest expiration would risk another type of bias resulting from the fact that approximately half the time the future would be subject to

4. Benoit Mandelbrot, "The Variation of Certain Speculative Prices," *Journal of Business*, Vol. 36, No. 4 (October, 1963), p. 415.

5. Paul H. Cootner, "Comments on the Variation of Certain Speculaive Prices," *The Random Character of Stock Market Prices*, p. 334.

6. Paul Cootner, "Stock Prices: Random vers. Systematic Changes," *Industrial Management Review*, Vol. 3, No. 2 (Spring, 1962), p. 37. His work on stock prices indicates negative correlations over short time intervals with positive correlations over longer periods.

7. Arnold B. Larson, "Measurement of a Random Process in Futures Prices," *Food Research Institute Studies*, Vol. 1, No. 3 (November, 1960), p. 316.

settlement by delivery. Larson's alternative procedure, the index of continuity, is also applied to ten-year periods.

Larson summarizes his work as generally supporting Working's theory but comes to the conclusion that a tendency exist for shocks (sudden large price movements) to be followed by reversals over short periods of time and then by a weak trend effect over longer periods. Seymour Smidt has concluded from serial correlations that daily price changes in May soybean futures exhibit statistically significant negative serial dependence.[8]

Sidney Alexander has presented the view that, while price changes in speculative markets may be random over fixed time intervals, a move once initiated will persist.[9] By use of a filter technique, he demonstrated nonrandom trends in the "move dimension" (varying time intervals). Hendrick Houthakker has applied filters to commodity futures, leading him to the conclusion that commodity prices do move in trends.[10]

The results of these and other studies are mixed, and no single result concerning the nature of price movements in commodity futures has become widely accepted. Past studies of commodity markets have generally applied one statistical technique upon a rather broad market segment or time span. The empirical work of this paper will attempt to incorporate and apply a wide range of tests for randomness—including serial correlation, analysis of runs, and filter techniques—upon a narrow sample of price series. By so doing, it is hoped that a more concise statement concerning random walks as they pertain to commodity futures can be formulated.

II. Model and Data Used

This paper will undertake an analysis of two commodity futures to determine if the random walk hypothesis is a valid representation of the price movements of those two futures. The random walk hypothesis may be symbolically represented as:

$$x_t = x_{t-1} + \delta_t$$
$$(t = 1, 2, \ldots, n;\ E(\delta_t) = 0;\ r(\delta_t, \delta_{t+k}) = 0 \text{ for } k \neq 0)$$

where x_t = the closing price of the selected future on day t and δ_t = a random variable.

The random walk hypothesis assumes, at the outset, that the market will be "efficient."[11] A variety of articles and tests exist to support this statement for commodity markets.[12] The two commodities selected for this paper, corn

8. Seymour Smidt, "A Test of the Serial Independence of Price Changes in Soybean Futures," *Food Research Institute Studies* (Stanford University), Vol. V, No. 2, 1965, p. 124.

9. Alexander, *op. cit.*, p. 26. See Cootner, *op. cit.*, "Stock Prices: Random vers. Systematic Changes," pp. 37-38 and Mandelbrot, *op. cit.*, p. 418, among others, for criticism of his methodology.

10. Hendrick Houthakker, "Systematic and Random Elements in Short Term Price Movements," *American Economic Review*, Vol. 51 (May, 1961), p. 164.

11. Fama's definition is assumed, ". . . a market where there are large numbers of rational, profit-maximizers actively competing, with each trying to predict future market values . . . and where important current information is almost freely available to all participants." *Op. cit.*, p. 56.

12. Paul H. Cootner, "Comments on Variation of Certain Speculative Prices," *op. cit.*, p. 334. Also see the quotation from Larson earlier in the paper.

and soybeans, are two of the three most important commodities traded, both in terms of total open interest and volume of trading, on the Chicago Board of Trade. In fiscal year 1967, there were 961,080 5,000-bushel contracts of soybeans and 1,511,900 5,000-bushel contracts of corn traded on the Chicago Board of Trade. July commitments were 156,898 soybean futures contracts and 113,710 corn contracts. As crops, both have the same growing season and are substitute crops in most areas. The July future represents a period in time about 75 percent of the way through the crop year for both commodities. Over the past seventeen years, the amount of corn grown annually has risen slowly, while hybridization has increased average yields per acre from 36.9 bushels in 1951 to 79.5 bushels in 1968. Soybean production has grown dramatically, especially in the last five years. Increased soybean production has come mainly by increasing acreage because a major breakthrough in yields has not yet been made.

Federal government programs generally have been a factor in the corn market because of the government-owned surpluses and support prices. The government maintains a support price for soybeans; but historically this price has been well below the market price, and therefore direct government influences have until recently been negligible.

All the price series data used are from the official records of the U.S.D.A. Commodity Exchange Authority. The Commodity Exchange maintains price record books showing the open, high, low, close, and change from the preceding day's close for all regulated futures on the Chicago Board of Trade.

Two other questions concerning the data and their use need to be considered. The series x_t has been transformed in many papers; for example, M. Osborne uses log x_t. While transformation is theoretically more appropriate, the practical need for its use in such circumstances has been shown to be of little importance.[13] A second and related question is: What differences, if any, exist in the price behavior pattern of the two price series for the July futures selected for study in this paper? Since both commodities have the same growing season, the selection of the same future for both is suitable.[14]

The simple random walk model involves two separate hypotheses: (1) successive price changes are independent; and (2) price changes conform to some probability distribution.[15] Of the two hypotheses, independence is the more important. Independence means that:

$$\Pr(x_t = x \mid x_{t-1}, x_{t-2}, \ldots) = \Pr(x_t = x)$$

where the left-hand side of the equation is the conditional probability that the price change will take the value of x, conditional upon knowledge of previous

13. C. W. J. Granger and O. Morgenstern, "Spectral Analysis of Stock Market Prices," *Kyklos*, Vol. 16 (1963), pp. 16-19.

14. Holbrook Working has observed that the amount of price variation is related to the position in time that a future expires relative to that commodity's harvest.

15. These hypotheses and the presentation in the next two paragraphs follow the presentation by Eugene F. Fama, "The Behavior of Stock Market Prices," *Journal of Business*, Vol. 38 (January, 1965), pp. 34-105.

changes x_{t-1}, etc. The right-hand portion is the unconditional probability that price change in t will take the value of x.

In the general theory of random walks, the form of the distribution need not be specified. The distribution provides descriptive information concerning the nature of the process generating price changes. Any distribution is consistent with the theory as long as it correctly characterizes the process generating the price changes.

Rule 1823 of the Chicago Board of Trade sets a daily trading limit of 8 cents per bushel per day for corn and 10 cents per bushel per day for soybeans.[16] This is figured from the closing price on the preceding day. This rule never affected the July corn future during the period observed, but it did affect the July soybean future in about one per cent of the observations. Since this restriction limited movement of soybeans on some occasions from moving fully in the direction desired by the market on any one day, there is the possibility of obtaining a slight positive bias in the serial correlation of soybean prices using a one-day lag. It is hypothesized that this bias is not large enough to be significantly observed or to affect the random walk model.

III. Statistical Tests and Trading Strategy Results

This section tests the model from both a statistical and trade veiwpoint. The first involves probability distributions, serial correlations, and run analyses. The second involves various mechanical trading patterns with comparison to the norm of a buy-and-hold criteria.

Frequency distributions

For an analysis of distributions, the quotations of change from the preceding day were used over a seventeen-year period for the July future of corn and soybeans. This resulted in about 4,100 observations for each commodity. Figures 1 and 2 show the results with respect to the normal (Gaussian) curve. As has been found with other speculative series, the distributions are definitely leptokurtotic.[17]

The distribution for July soybeans is more sharply curved, crossing the normal line at three points instead of the more flat S-curve for corn, which crosses the normal line only once. The results of these observations appear to lend support to Mandelbrot's hypothesis that certain speculative price series belong to the family of stable Paretian distributions.[18] An alternative explanation would be that the variance of future contract prices changes over maturity.

Figure 3 illustrates a phenomenon common to all observations: the preference of daily differences to be round eighths. This is due to the method used by the Clearing Corporation of the Chicago Board of Trade in determining the

16. "Rules and Regulations of the Chicago Board of Trade," p. 446.

17. Fama, *op. cit.*, "The Behavior of Stock Market Prices," pp. 80, 89. Also Mandelbrot, *op. cit.*, pp. 394-419.

18. Mandelbrot, *op. cit.*, p. 406.

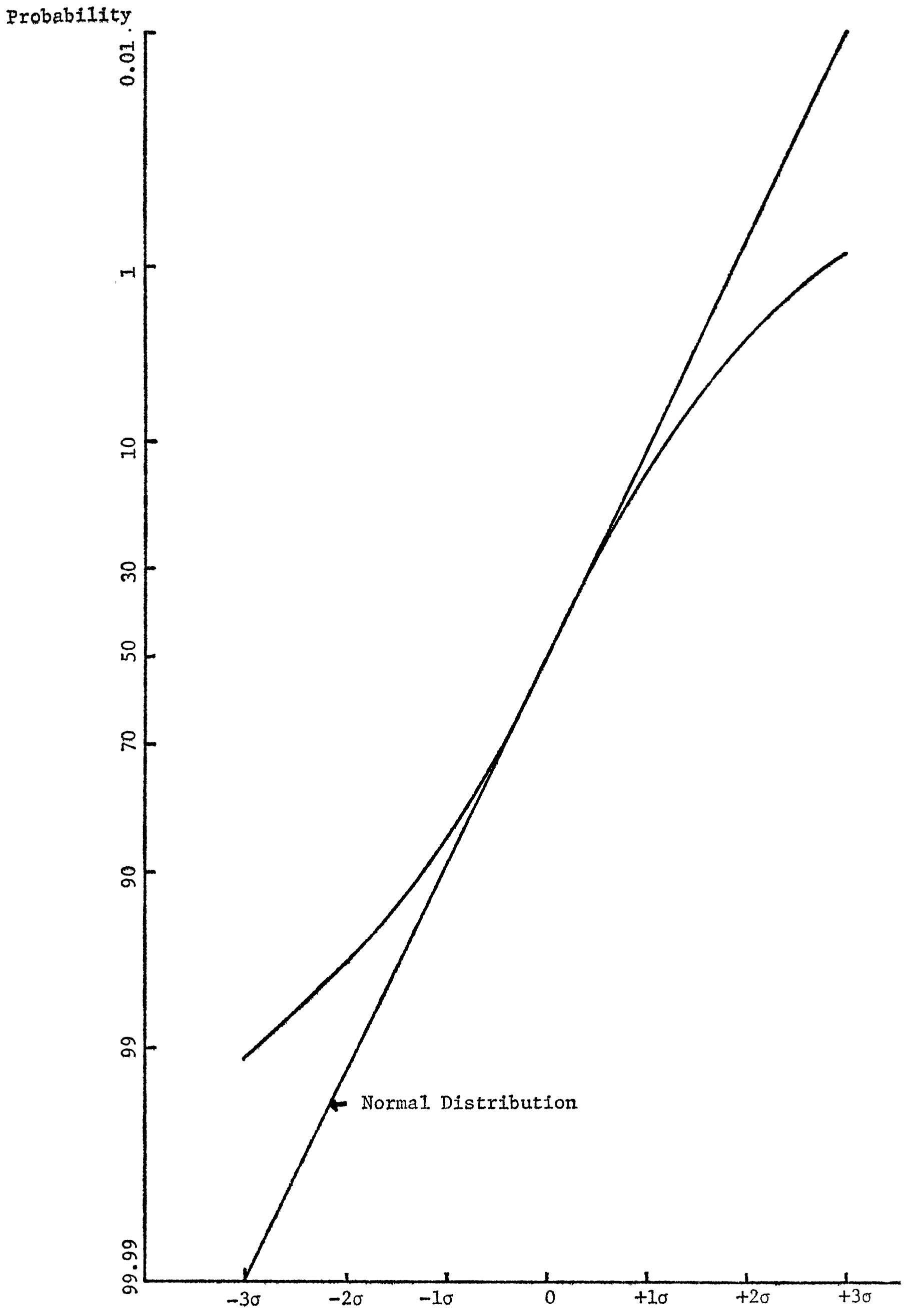
Probability
0.01
1
10
30
50
70
90
99
99.99
Normal Distribution
-3σ
-2σ
-1σ
0
+1σ
+2σ
+3σ

FIGURE 1

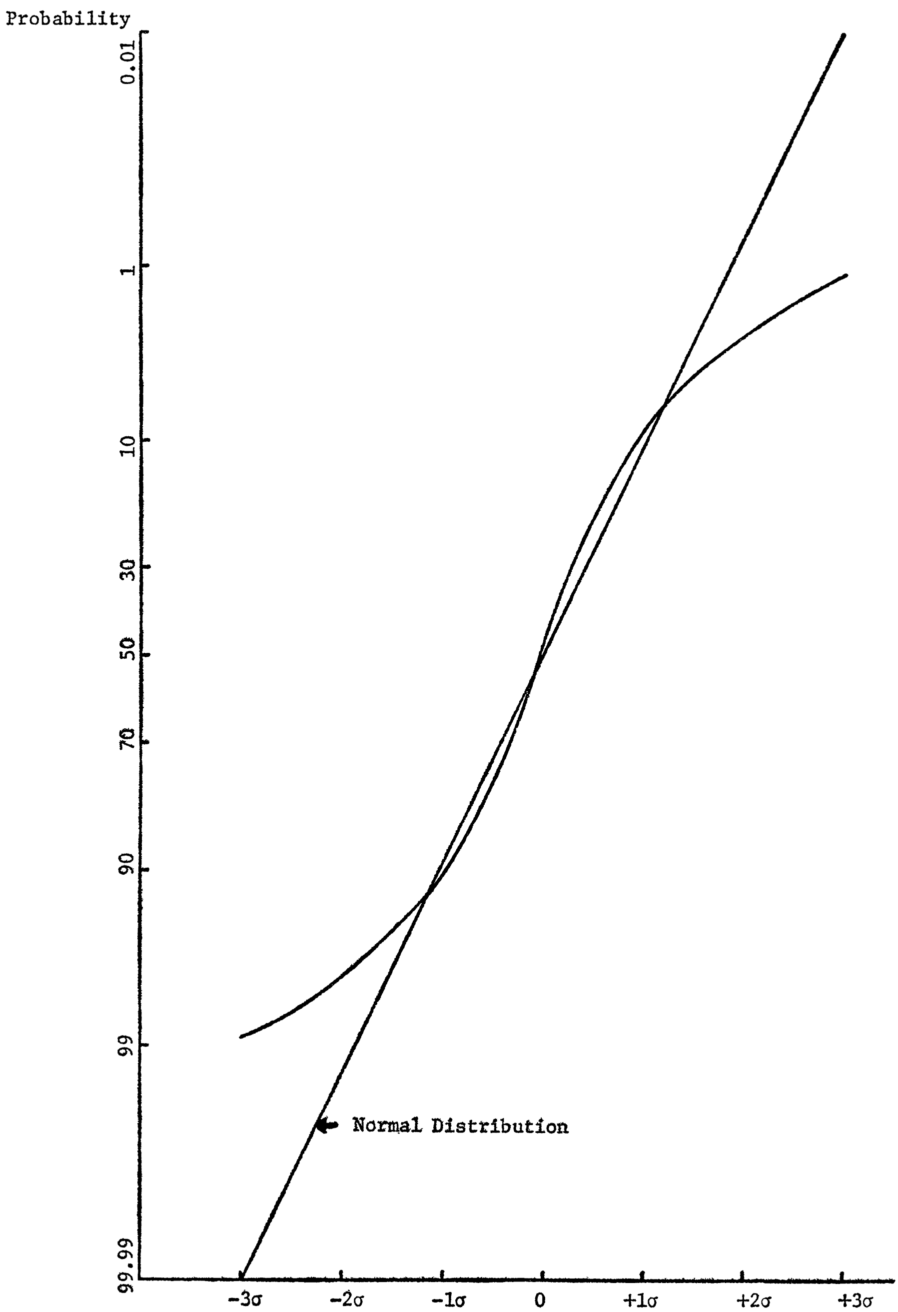
Probability
0.01
1
10
30
50
70
90
99
99.99
Normal Distribution
-3σ
-2σ
-1σ
0
+1σ
+2σ
+3σ

FIGURE 2

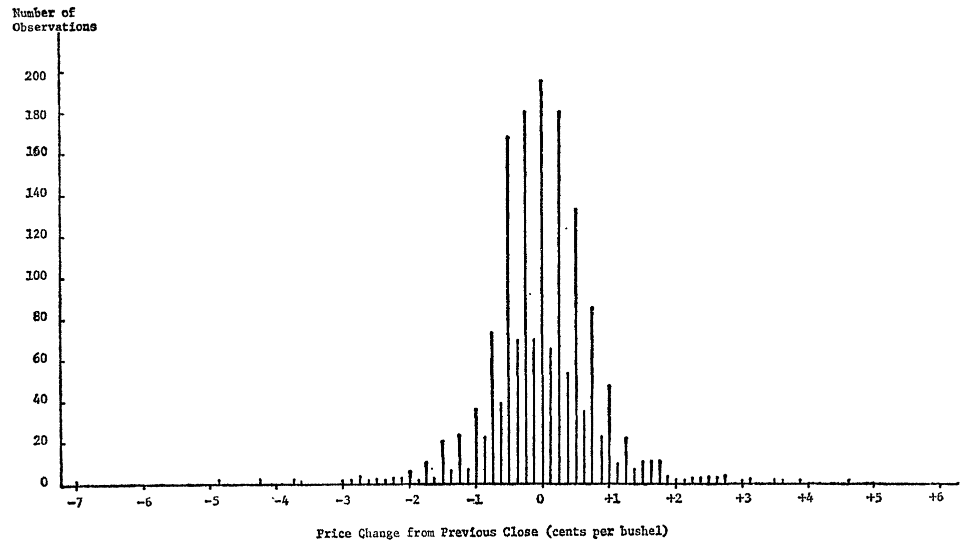

FIGURE 3

settlement price (official closing quotation). The settlement price is determined by the Clearing Corporation from the closing quotations, which are almost always a range of prices. If, for example, the closing range of July soybeans on a day is 280-280 1/2 cents per bushel, the settlement price will be the simple average, 280 1/4 cents per bushel. If the range on the following day is 280 1/2-280 7/8 cents, the settlement price could be either 280 5/8 cents or 280 3/4 cents and in this case will be 280 3/4 cents, chosen deliberately to give a round eighth difference from the previous close. This procedure simplifies the daily data and financial record processing.

Serial correlations

Serial correlations for each year were made to determine if any significant correlation exists. To give credence to the random walk hypothesis, there should be no pattern to the size or sign of correlation coefficients, each of which should not be significantly different from zero.

Table 1 shows the serial coefficients for each future using lags of one day (12 one-year observations), two days, and five days. There are approximately 240 observations of daily differences for each year. Of the 72 coefficients, 7 are large enough to be noteworthy.[19] In reviewing the data for these years, it was found that the magnitude of the coefficient commonly resulted from short periods of very large price movements, relative to the norm of the year, and not from any general trend or pattern existing through a substantial portion of the year in question. For example, the largest coefficient was —.276 for a two-day lag in July corn during 1965. If one observation, the largest single observation that year —5 7/8¢), were changed to zero, the r value would be

19. Conventional measures of significance are not appropriate for non-Gaussian distributions. Work done by Larson and Fama suggests significance above $\pm.15$. Also R. L. Anderson, "Distribution of the Serial Correlation Coefficient," *Annual of Mathematics & Statistics,* XIII, pp. 1-13. Significance assuming a normal distribution with $P = .01$ would be at $\pm.147$.

TABLE 1
SERIAL CORRELATION COEFFICIENTS OF CLOSE-TO-CLOSE DAILY PRICE DIFFERENCES FOR JULY CORN AND SOYBEANS AT ONE-, TWO-, AND FIVE-DAY INTERVALS

	Corn with lags of			Soybeans with lags of		
July	1 day	2 days	5 days	1 day	2 days	5 days
1968	−.029	−.152*	+.088	−.018	−.088	+.092
1967	−.061	+.007	+.031	−.004	−.121	−.017
1966	−.045	−.019	+.212*	+.071	−.047	+.093
1965	−.029	−.276*	−.048	−.038	−.003	+.007
1964	+.052	−.196*	+.173*	−.018	−.143	−.012
1963	−.057	−.122	+.049	−.059	−.050	+.071
1962	−.068	+.054	+.016	+.015	−.113	−.085
1961	+.153*	−.070	+.072	+.047	−.089	−.033
1960	+.049	−.001	−.034	−.078	−.020	+.085
1959	+.047	+.026	+.056	−.036	−.178*	+.079
1958	−.021	+.055	−.048	−.016	+.001	−.061
1957	−.013	−.094	+.048	−.089	+.039	+.111

* Above what would be significant under assumption of a normal distribution with $p = .01$ and $n = 240$.

only −.139. If that single value were given the opposite sign, the r value would be +.028. Because the average daily price differences in July corn futures were much smaller than those in July soybeans, a large daily change (5 cents or more) had a greater effect on the correlation coefficient of the former. Six of the seven "large" coefficients were in July corn.[20] It may be that the life of one future, averaging about 240 days, gives too few observations for a wholly satisfactory serial correlation analysis.

On the whole, the data show a tendency toward negative coefficients for one-day and two-day lags—35 of 48 such coefficients were negative. This bias was more noticeable in soybeans than in corn. The opposite was true for the five-day lag. Sixteen of 24 coefficients were positive with the greater bias observed in corn.

Analysis of runs

The final statistical test used was run analysis. The purpose of this test is to determine if the number of consecutive days of price movement in one direction conforms to that expected by pure chance. Each year's July future, having about 240 observations of close-to-close daily price differences, was treated as a separate entity. The statistical results for each year were then aggregated to obtain the data in Table 2. A .5 probability of a positive or negative change assumed for the unaggregated data indicated no distinguishable difference between July corn and July soybeans, nor was there any identifiable trend in the length of runs (year-to-year) through the twelve years observed. Generally, the number of up runs of any given duration was about equal to

20. In relative terms, a daily corn price change observation could be 9 times its standard deviation without reaching the daily trading limit. A soybean observation could be only 4 times its standard deviation without hitting the limit. Interestingly, this suggests that trading limits may facilitate a smaller serial correlation than otherwise would exist within the confines of the life of one future.

TABLE 2
DISTRIBUTION OF LENGTHS OF RUN OF DAILY JULY CORN AND SOYBEAN FUTURE PRICES, SUMMARY, 1957-1968

Length of run (days)	July soybeans			July corn		
	Observed run		Expected run	Observed run		Expected run
	Up	Down	Up or down*	Up	Down	Up or down*
1	359	364	345	359	365	361
2	202	169	172	201	185	180
3	82	88	86	78	75	90
4	26	48	43	40	40	45
5	8	12	22	12	12	23
6+	10	15	22	13	7	23
Total	687	696	690	703	684	722

* Expected on the assumption of 0.5 probability of rise or fall and 2,755 close-to-close observations for July corn and 2,888 observations for July soybeans.

the number of down runs of equal duration in each year. While the number of up and down runs observed was always reasonably close, there were slightly more observations of short, one-day and two-day runs than expected. Conversely, there were fewer long runs, five and six or more days, than expected by pure chance. This observed tendency toward reversal is consistent with the slightly larger number of negative correlation coefficients found in the serial analysis.

Filters

If the random walk hypothesis is valid, no mechanical trading rule will consistently yield returns above a buy-and-hold policy.[21] Empirical testing of several mechanical trading techniques (filters) was done to see if, for these tests, returns after deducting commissions could be earned greater than by buying and holding a position through the life of the future.[22] Houthakker applied what has been called filter techniques to commodity futures (corn), but his method was very limited. Houthakker's rule was to always purchase at the opening with a stop-loss order for protection. If executed, no additional position was established in that future. This means that (1) the trader is never short in the market; and (2) the trader only takes a position once in each future, regardless of the price behavior through the life of the future. Most techniques used in this paper are more complex and follow more closely the rules suggested by Alexander[23] and Fama and Blume.[24]

The rapid oscillation of futures prices within the limits of small, but poten-

21. Houthakker, *op. cit.*, p. 164. He notes that randomness can be defined only negatively—namely, as the absence of any systematic pattern.

22. Actually, the filters and buy and hold were calculated from the first day the future opened until the last close prior to possible settlement by delivery. Since deliveries are allocated to the oldest long position first, the game could not be realistically played during the final month of the future's life.

23. Alexander, *op. cit.*, pp. 23-24.

24. Eugene F. Fama and Marshall E. Blume, "Filter Rules and Stock Market Trading," *Journal of Business*, Vol. 39, No. 1, Part II (January, 1966), pp. 226-241.

tially profitable, filters and the inadequacy of available data to trace intra-day price movements prevented testing of very small filters. It remains to be shown if large intra-day profits await the systematic trader who can devote full time to his trading.[25] It is known that there are many professional traders, known as scalpers or day traders, who trade on very small price movements and need pay only half the non-member commission rate on transactions.

IV. Descriptions of Trading Techniques

Trading Technique 1

Buy the future at the opening on the first day of trading. Place a stop-loss order z per cent below the purchase price. If the stop-loss order is not executed, hold the future until the last possible date prior to delivery. If the stop-loss order is executed, no further position is assumed until the opening of trading in the next July future. This is the rule used by Houthakker.

Trading Technique 2 [(Plan A) and (Plan B)]

Starting with the closing price on the first day of trading, wait for the closing price of the future to move up or down z per cent and then establish a position *with the market* by buying if the future has gone up z per cent and by selling if the future has gone down z per cent (Plan A). Place a stop-loss order z per cent from the price of the established position. If the price moves in the favorable direction, establish a new stop-loss order each day z per cent from the close on the preceding day. When the price moves in the unfavorable direction, maintain the stop-loss order until it is executed. The closing price on the day that a stop-loss order is executed becomes the same base as the closing quotation was on the first day of trading in the process of establishing a new position. In effect, to make a profit, a move of z per cent must be followed more often by another move of *more* than z per cent in the same direction than it is by a fall of z per cent.[26]

The same procedure was also applied with the reverse reasoning (Plan B). If price moves z per cent, establish a position *against the market*. This requires the market to more frequently reverse itself by an amount exceeding z per cent than to continue an additional z per cent movement in its initial direction.

Trading Technique 3

Starting with the opening quotation, when a future moves up (down) z per cent, buy (sell) and hold until the future goes either up or down z per cent.[27]

25. For the full-time trader, it should be demonstrated that he achieved results superior to buy and hold and also superior to the extent of his opportunity cost in foregoing gainful employment elsewhere.

26. For example, assume z per cent = 3 cents per bushel and a future moved from 247 cents to 250 cents per bushel with a resultant long position at 250 cents and a stop-loss at 247 cents. If before falling to 247 the price moved up to 253 on a closing quotation, a stop-loss order would be moved to 250 (3 cents under the last closing price) and at worst the trader would break even, exclusive of transaction costs.

27. By means of placing two good-till-cancelled orders, one z per cent above and one z per cent below the price at which the position was put on. The execution of one of these orders automatically cancels the other.

The price at which the position is closed out becomes the base to repeat the process. Unlike Trading Technique 2, a favorable move of z per cent will obtain a gross trading profit of z per cent. However, the ability of letting profits run is sacrificed.

For each of these trading techniques, three sizes of filters were selected. The sizes of the filters are 1 1/2 per cent, 3 per cent, and 5 per cent of the average per bushel trading price of the commodity. In calculating the returns, commissions were charged on transactions made. The commisions were equivalent to about 1/2 cent per bushel for both corn and soybeans. Being a fixed charge, commissions require small filters to be successful a greater percentage of the time than large filters in order to realize equivalent returns. The choice of the filter size was governed by two practical considerations:

(1.) Filters smaller than 1½ per cent could not be accurately tested. Price records give the open, high, low, and closing quotations but do not state if the high or low was reached first. If (for Trading Techniques 2 and 3) both the high- and the low-order price were within the day's range, the filter could not be evaluated.[28]

(2.) Filters larger than 5 per cent would, for some years, produce no trading at all.

A stop-loss order means a market order when that price level is reached or passed. Therefore, if a long position was protected with a stop-loss order at 250 cents per bushel, and if overnight news caused the future to open at 245 cents the next day, the position would be closed out at 245 cents; the trader must bear the unexpected additional loss. This was taken into account in applying all filters.

The results of these tests are summarized in Tables 3 and 4 for the twelve years, 1957-1968. Dollar returns were on an assumed constant commitment of 10,000 bushels or two contracts. These positions would require initial margins over the period ranging from $500 to $1,200 in July corn and $800 to $4,000 in July soybeans. However, initial margin requirements are not a valid indication of the amount of capital a trader would need to maintain a constant commitment since additional capital would be required to withstand losses. The buy-and-hold policy, the measurement of performance for our filter techniques, did very well over the the twelve-year period in soybeans, yielding a profit of $8,545. This was due to the large profit of $10,654 realized in 1966. Buy-and-hold in July corn produced a loss of $5,328 over the same twelve-year period.

A stop-loss order z per cent under the purchase price (Trading Technique 1) was not quite as profitable for the 1 1/2 per cent and 3 per cent filters but was more profitable for the 5 per cent filter in soybeans. In July corn, all filters reduced the loss. Therefore, Trading Technique 1 was able to outperform the buy-and-hold criteria to a small extent.

Interesting results evolved from the Trading Technique 2 filters. For both

28. There were several instances of trading in soybeans and corn where intra-day price movements were volatile enough to prevent adequate evaluation of the smaller filters with the primary data source that gives only the open, high, low, and closing quotations. For these periods, price movements were obtained from records of the Chicago Board of Trade. The Chicago Board of Trade maintains journals of all intra-day price changes posted at ten-second intervals in all futures traded on the exchange.

TABLE 3
RETURNS FROM TRADING TECHNIQUES USING VARIOUS SIZED FILTERS, JULY CORN FUTURES, SUMMARY TABLE FOR 1957-1968

	1½% Filter				3% Filter				5% Filter			
	Profit	Loss	Net	Yrs.-Profit	Profit	Loss	Net	Yrs.-Profit	Profit	Loss	Net	Yrs.-Profit
Buy and Hold	$2,955	$8,283	$(5,328)	5	$2,955	$8,283	$(5,328)	5	$2,955	$8,283	$(5,328)	5
Trading Technique 1	1,187	1,940	(753)	2	1,187	3,440	(2,253)	2	2,849	4,277	(1,428)	4
Trading Technique 2 (Plan A)	460	9,397	(8,937)	1	2,915	2,381	534	7	3,990	1,577	2,413	7
Trading Technique 2 (Plan B)	2,978	5,358	(2,380)	5	5,259	4,332	927	6	2,422	3,241	(819)	4
Trading Technique 3	203	8,833	(8,630)	1	2,728	4,235	(1,507)	6	2,527	3,178	(651)	6

TABLE 4

RETURNS FROM TRADING TECHNIQUES USING VARIOUS SIZED FILTERS, JULY SOYBEAN FUTURES, SUMMARY TABLE FOR 1957-1968

	1½% Filter				3% Filter				5% Filter			
	Profit	Loss	Net	Yrs.-Profit	Profit	Loss	Net	Yrs.-Profit	Profit	Loss	Net	Yrs.-Profit
Buy and Hold	$21,210	$12,663	$ 8,547	4	$21,210	$12,663	$ 8,547	4	$21,210	$12,663	$ 8,547	4
Trading Technique 1	10,556	3,132	7,424	3	10,556	5,832	4,724	3	21,210	6,784	14,426	4
Trading Technique 2 (Plan A)	4,502	11,159	(6,657)	3	15,744	3,428	12,316	7	19,241	2,140	17,101	8
Trading Technique 2 (Plan B)	9,098	8,942	156	5	4,676	13,550	(8,874)	3	5,635	16,107	(10,472)	2
Trading Technique 3	3,589	15,858	(12,269)	3	2,380	11,518	(9,138)	3	16,462	4,130	12,332	8

corn and soybeans, as the size of the filter increased, the profitability of the filter increased when positions were established going with the market (Plan A). In soybeans, the 1 1/2 per cent filter produced a loss; the 3 per cent filter produces a profit greater than the buy-and-hold; and the 5 per cent filter produced a profit greater than the 3 per cent filter. In corn, the 1 1/2 per cent filter produced a larger loss than buy-and-hold; the 3 per cent filter produced a small profit; and the largest filter produced the greatest profit. By going with the market and using a 5 per cent filter, a trader could outperform the technique of buying and holding. The contrast between the large and small filters was a striking result. In terms of years, three were profitable for the smallest filter in beans, and one of twelve was profitable in corn. Eight of twelve were profitable using the largest filter in soybeans, and seven of twelve years (plus one year of zero net profit) were profitable in corn.

Using the same statistical procedure but establishing positions against the market (Plan B) produced nearly opposite results in each filter size (i.e., the smaller filters did relatively better than the larger), with all doing much poorer than the buy-and-hold criteria. These results confirm a tendency toward reversal in small price movements about a larger systematic trend.

Trading Technique 3 was generally a poor performer. In soybeans the 1 1/2 per cent and 3 per cent filters produced losses, while the 5 per cent filter yielded a profit larger than buy-and-hold. In corn, all three filters again resulted in loss, though the 3 per cent and 5 per cent did better than buy-and-hold. With the exception of the largest filter in corn, gross trading profits were obtained by this method, but these profits were smaller than charges incurred (see Table 5). This indicates that the opposite strategy, going against the market instead of with it, would have given much poorer results.[29] The gross profit and loss going with the market in Trading Technique 2 also was favorable, especially for soybeans.[30] Thus, Sidney Alexander's observation that a move once initiated tends to persist is not without foundation for moves exceeding 3 per cent.

There is reason to suspect that further refinement of the trading techniques used here may improve the results with respect to buy-and-hold policy. Samuelson has suggested that futures prices become more volatile as maturity approaches.[31] Thus it may well be that different size filters would be more appropriate at different times.

V. Summary

The various tests applied to July corn and July soybeans suggest that the random walk hypothesis does not offer a satisfactory explanation of the movement of those speculative price series. Specifically, a tendency for negative dependence in short periods of time and positive dependence over longer periods was evident. Not only were these properties recognizable but also the long-

29. This would invert the *gross* profit and loss each year from what it was calculated to be under the Trading Technique 3 criteria.

30. Relative to a random situation with a .5 probability of the following (daily) price change having the same sign.

31. Paul Samuelson, "Proof that Properly Anticipated Prices Fluctuate Randomly," *Industrial Management Review* (Spring 1960), pp. 44-45.

TABLE 5
SUMMARY OF NUMBER OF TRANSACTIONS AND GROSS PROFIT AND LOSS, TRADING TECHNIQUES 2 (PLAN A) AND 3, 1957-1968 COMBINED

	Gross trading		Number of trans-	Commission	Net trading	
	Profit	Loss	actions	Charges	Profit	Loss
Trading Technique 2 (Plan A)						
Corn:						
1½% filter		$1,325	173	$ 7,612		$ 8,937
3% filter	$ 2,998		56	2,464	$ 534	
5% filter	3,425		23	1,012	2,413	
Soybeans:						
1½% filter	2,511		191	9,168		6,657
3% filter	15,820		73	3,504	12,316	
5% filter	19,213		44	2,112	17,101	
Trading Technique 3						
Corn:						
1½% filter		666	181	7,964		8,630
3% filter	1,925		78	3,432		1,507
5% filter	625		29	1,276		651
Soybeans:						
1½% filter	10,675		478	22,944		12,269
3% filter	4,254		279	13,392		9,138
5% filter	18,620		131	6,288	12,332	

term segments were profitable under certain mechanical trading patterns throughout the time period covered by this analysis both in an absolute sense and with respect to a buy-and-hold policy.

These findings are consistent with the work done by Paul Cootner on stock prices and by Larson on commodities. Larson's portrayal of the futures market as consisting of shocks, followed by reversals, and long-term trends is validated.[32] Serial correlation and an analysis of runs substantiated the short-run, one- and two-day, tendency toward reversal. The success of large filters verifies the existence of long-term trends. While the existence of long-term trends does not in itself contradict the random walk hypothesis, the profitability, which was found in this analysis of playing long-term movements on both the long and short sides over a buy-and-hold policy, does cast considerable doubt on the applicability of this hypothesis to the market for commodity futures.

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