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Returns to Speculators and the Theory of Normal Backwardation

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ABSTRACT

A nonparametric statistical procedure is employed to examine the returns to speculators in wheat, corn, and soybeans futures markets. We find that the theory of normal backwardation is supported. Moreover, the presence of the risk premiums to speculators tends to be more prominent in recent years than in earlier years. We also find that large wheat speculators as a whole possessed some superior forecasting ability. The evidence is inconsistent with the hypothesis that commodity futures prices are unbiased estimates of the corresponding future spot prices.

THE CLASSIC ECONOMIC RATIONALE for futures markets is that they facilitate hedging. That is, futures markets allow those who deal in commodities to obtain contracts through which the risk of price changes can be transferred to those who are willing to assume it. A side benefit of the market is that a publicly known, uniform future value for a commodity is created. Therefore, all commodity market participants can make production, storage, and processing decisions by looking at the pattern of futures price, even if they don't take positions in the futures market. Many believe that the current price of a futures contract equals the market consensus expectation of the spot price on the delivery date.[1]

Keynes [10], however, in his theory of normal backwardation, suggests that it is unlikely that the above two functions can be fulfilled simultaneously. He argues that hedgers use the futures market to avoid risks, and that they pay a significant premium to speculators for this insurance. He concludes implicitly that the futures price is an unreliable estimate of the spot price prevailing on the date of expiration of the futures contract. Keynes' conclusion is based upon the argument that the long (short) speculator realizes the premium by refusing to purchase a contract from the short (long) hedger except at a price below (above) that which the futures price is expected to approach.[2] Over the years, various studies have sought to confirm the existence of such a risk premium to speculators in the

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[1] For example, Samuelson [15] has argued that futures prices should not have any upward or downward drift on the average.

[2] Grauer and Litzenberger [7] have shown that the price of a commodity futures contract is a biased estimate of the future spot price of the commodity due to the real social risk and the inflation exposure of the contract.

futures market. However, the evidence has been mixed. No consensus has yet been reached.[3]

In this paper, we argue that the absence of consistent evidence about the theory of normal backwardation is due either to the heterogeneous assumptions usually imposed or to the lack of sound statistical procedures employed in earlier studies. We also provide a rigorous statistical test based upon more practical assumptions. The test is adapted from a procedure recently developed by Merton [13] and Henriksson and Merton [8] (hereafter referred to as HM). One of the advantages of the HM methodology is that it does not require any assumptions about the distribution of returns on assets. Contrary to several earlier studies, we provide statistical evidence in support of the risk premium hypothesis suggested by Keynes.

The remainder of the paper proceeds as follows. Section I of the paper reviews previous research and develops specific hypotheses for this study. Section II describes HM's model and reinterprets it to fit our analysis. Section III reports our data base and lists data sources. The empirical results are presented in Section IV, and Section V summarizes the analysis and findings.

I. Hypotheses

In the early development of Keynes' theory, three assumptions were made to motivate the existence of risk premiums. Speculators had to be risk averse, hold net long positions, and be unable to forecast future prices. Empirical tests attempting to find risk premiums in futures contracts can be categorized by the extent to which they adopted Keynes' original three assumptions.

Tests accepting all these assumptions include Telser [16, 17] and Dusak [6]. All these assumptions can be met if there is a rise, on the average, in futures prices during the life of each contract. Accordingly, Telser [16, 17] examined trends in futures prices and found no evidence to support the theory of normal backwardation. Dusak [6] examined the existence of a risk premium within the context of the Capital Asset Pricing Model (CAPM). She found that the systematic risks of the three commodity contracts investigated were not significantly different from zero.

The assumption that speculators are net long throughout the lives of the futures contracts has been relaxed by several researchers who recognized that a short hedge position did not predominate at all times for all commodities and that speculators could still obtain a risk premium even if prices did not rise on the average. Cootner [3–5], for example, presented several cases in support of the contention that risk premiums can exist in commodity futures. Particularly, he showed that it was possible for speculators to profit merely by being long after the peak of net short hedging and by being short after the peak of net long hedging. Also, Carter, Rausser, and Schmitz [2] (hereafter referred to as CRS) modified Dusak's study by allowing systematic risk (in the CAPM framework)

[3] For example, a recent investments textbook by Khoury [11, p. 486] states:

> These and other studies do not allow the researcher convincingly to confirm or deny the validity of the normal backwardation theory. This must await further evidence.

to be stochastic and to be a function of the speculators' actual net position. By using a combined stock and commodity index as proxy for the market portfolio,[4] they found nonzero estimates of systematic risk for most of the speculative return series they examined.

However, Cootner's studies provided no statistical evidence on whether such profits were actually made by speculators and the evidence of CRS needs to be interpreted with caution. The term "risk premium" generally refers to an average reward to investors for being willing to assume a risk position in a risk-averse financial world. The reward in this form should not be conditional on any superior judgment or inside information. Since there are equal numbers of long and short positions in futures tradings, one of the unavoidable decisions every speculator must make at the outset of every transaction is whether to be long or short in the market. Decisions usually are made according to both public and inside information. In order to test the theory of normal backwardation, it is important to differentiate reward for bearing risk from reward for superior forecasting ability. It is clear that CRS failed to recognize that the actual net speculative position itself is a decision variable. Consequently, their evidence does not indicate whether speculators were rewarded for risk assumption or for forecasting skills.[5]

Houthakker [9] and Rockwell [14] recognized that, empirically, assumptions two (hold net long position) and three (unable to forecast future prices) should be relaxed simultaneously. They emphasized the necessity of distinguishing rewards for risk taking from those of forecasting skills. In their respective studies, estimated returns to three types of individuals—large hedgers, large speculators, and small traders—were compared. Rockwell recognized that normal backwardation is supposed to describe the profits of marginal speculators who possess no forecasting ability. Therefore, he defines normal backwardation as the returns earned by a hypothetical speculator who follows a naive strategy of being long when hedgers are net short and short when hedgers are net long. His empirical results indicate that returns on this naive strategy were zero, implying a zero risk premium. However, he found that large speculators did earn large positive profits attributable to their ability to forecast eventual spot prices. The principal problem of the Rockwell and Houthakker studies was that they included no statistical significance tests. A test of the theory of normal backwardation is not based on whether the market ever provided speculators with profits in any periods; instead

[4] Carter, Rausser, and Schmitz argue, since the S&P Index of 500 Common Stocks does not account for the price instability of the nation's stock of agricultural and nonagricultural commodities, an equally weighted S&P Index and the Dow Jones Commodity Future Index is more appropriate. To support the weight scheme, they report the following information: the value of commodities represented by the contracts traded in 1977 was estimated at $1,230,000 million while the market value of stocks listed on all registered exchanges in 1977 was approximately $950,000 million. However, despite the fact that the market portfolio is not identifiable, the theory seems to reject the inclusion of commodity contracts as part of the market portfolio. As Black [1] notes, commodity contracts are pure bets, in that there is a short position for every long position; so when we are taking all futures contracts together, futures contracts net out to zero.

[5] Another problem associated with the study is that the definition of the rate of return on futures tradings is controversial and the statistical properties of the return distribution are essentially unknown.

it is based on whether or not a risk premium is systematically (in the statistical sense) rewarded to naive speculators as defined. Another difficulty was that additional assumptions were adopted in their studies to estimate actual profits and losses to all participants.

This study focuses on two hypotheses which have their roots in the Rockwell interpretation of the theory of normal backwardation. The first null hypothesis states that large speculators as a whole were not consistent winners in commodity futures markets. We test it against the alternative hypothesis that they have systematically made positive profits in the markets. It is clear from our earlier discussion that the rejection of the null hypothesis would support either the normal backwardation theory or some degree of market inefficiency (namely, a portion of traders have superior forecasting ability) or both.

The second hypothesis we investigate states that the hypothetical naive speculator, as defined by Houthakker and Rockwell, was not a consistent winner in commodity futures markets. Since the trading strategy followed by the hypothetical speculator does not require any superior forecasting ability, the rejection of the null hypothesis can be viewed as evidence in favor of the presence of a positive expected risk premium. If we *only* reject the first null hypothesis, the implication is that all speculative profits were accounted for by the ability of speculators to forecast eventual spot prices. If we reject both hypotheses, the theory of normal backwardation is supported. It seems safe to conclude that futures prices are probably not unbiased estimates of the expected spot prices. However, in that event, we may not be able to confirm the existence of superior forecasting ability of the large speculators even if it was present. Therefore, a third test is needed which examines whether or not large speculators earned more than the profit available to the hypothetical naive speculator. A positive answer to the question implies that large speculators' profits were a combined reward for both risk bearing and for some superior forecasting ability.

II. Methodology

Difficulties with earlier studies result from the restrictive economic assumptions employed. Statistical procedures have also been deficient. As indicated earlier, Cootner, Houthakker, and Rockwell provided no statistical tests. Dusak and CRS implictily assumed that "rates of return" on futures contracts are distributed normally. Since both the definition of the rate of return on futures tradings and the statistical properties of the return distribution are controversial, a nonparametric statistical procedure provides a reasonable alternative.

In Henriksson and Merton [8], a nonparametric statistical procedure is presented for testing market-timing forecasting ability in a portfolio management setting. Although the substantive context of the test presented is market timing, they suggest that the same test can be used to evaluate forecasting ability between any two assets. In this section, the HM nonparametric statistical procedure is briefly summarized. Most terms involved in the description have been altered to fit our tests.

The rational behavior of risk-averse speculators in futures markets can be described as follows: they will only be long futures contracts at prices below those expected at the anticipated liquidation time or will be short such contracts at prices above those prevailing at the expected offset period. Let $F(t)$ denote the price of futures contracts at t, and $R(t)$ denote the change in futures prices during period t; that is, $R(t) \equiv F(t) - F(t-1)$. Thus, before taking actions in the market, the speculator either forecasts that $R(t) > 0$ or that $R(t) \leq 0$. Let $\gamma(t)$ be the speculator's forecast variable where $\gamma(t) = 1$ if the forecast, made at time $t-1$, for time period t is that $R(t) > 0$, and $\gamma(t) = 0$ if the forecast is that $R(t) \leq 0$. Following HM, we define the probabilities for $\gamma(t)$ conditional upon the realized price changes on the futures contracts by

$$P_1^s(t) \equiv \text{prob}[\gamma(t) = 0 \mid R(t) \leq 0] \tag{1a}$$

$$P_2^s(t) \equiv \text{prob}[\gamma(t) = 1 \mid R(t) > 0] \tag{1b}$$

Therefore, $P_1^s(t)$ is the conditional probability of a correct forecast given that $R(t) \leq 0$, and $P_2^s(t)$ is the conditional probability of a correct forecast given that $R(t) > 0$. It is assumed that $P_1^s(t)$ and $P_2^s(t)$ do not depend upon the magnitude of $|R(t)|$.[6] Hence, the conditional probability of a correct forecast depends only on whether or not $R(t) > 0$.

Under this assumption, Merton [13] shows that a necessary and sufficient condition for a speculator's prediction to have no value is that the sum of the conditional probabilities of a correct forecast, $P_1^s(t) + P_2^s(t)$, equals one.[7] It follows that a necessary condition for timing speculation to have a positive value is $P_1^s(t) + P_2^s(t) \neq 1$. Specifically, a sufficient condition for a positive value is $P_1^s(t) + P_2^s(t) > 1$.

The nonparametric tests of HM take advantage of the fact that the conditional probabilities of a correct forecast can be used to measure forecasting ability, yet they do not depend on the distribution of price changes on futures contracts. A test of the null hypothesis that the speculators have earned no positive profits is accomplished by testing H_0: $P_1^s(t) + P_2^s(t) = 1$, where the conditional probabilities of a correct forecast, $P_1^s(t)$ and $P_2^s(t)$, are not known. We want to determine the probability that a given outcome from our sample came from a population that satisfies our null hypothesis.

HM show that the null hypothesis is defined by the hypergeometric distribution:

$$P(n_1 \mid N_1, N, n) = \frac{\binom{N_1}{n_1}\binom{N_2}{n-n_1}}{\binom{N}{n}} \tag{2}$$

[6] Thus, we only try to show whether or not risk premiums to speculators exist in the futures market. No attempt is made to estimate the magnitudes of the risk premiums.

[7] When an investor's prediction is of no value, for example, in the common stock market, it is implied that any abnormal return is not received. Since trading in the futures market is a zero-sum game, a prediction of no value is a sufficient condition such that speculators are not consistent winners in futures market.

where

n_1 ≡ number of correct forecasts, given $R(t) \leq 0$,
n ≡ number of times a forecaster predicts that $R(t) \leq 0$,
N_1 ≡ number of observations where $R(t) \leq 0$,
N_2 ≡ number of observations where $R(t) > 0$, and
$N \equiv N_1 + N_2$ = total number of observations.

The distribution is independent of both $P_1^s(t)$ and $P_2^s(t)$. Thus, to test the null hypothesis, it is unnecessary to estimate either of the conditional probabilities. So, provided that the forecasts are known, all the variables necessary for the test are directly observable. Given N_1, N_2, and n, the distribution of n_1 under the null hypothesis is determined by (2) where the feasible range for n_1 is given by

$$\underline{n_1} \equiv \max(0, n - N_2) \leq n_1 \leq \min(N_1, n) \equiv \bar{n}_1 \tag{3}$$

Equations (2) and (3) can be used to establish confidence intervals for testing the hypothesis of no forecasting ability. Given the nature of a zero-sum game and that speculators behave rationally, a one-tailed test is more appropriate. For such a one-tailed test with a probability confidence level of c, one would reject the null hypothesis if $n_1 \geq x^*(c)$ where $x^*(c)$ is defined as the solution to

$$\sum_{x=x^*}^{\bar{n}_1} \binom{N_1}{x}\binom{N_2}{n-x} \Big/ \binom{N}{n} = 1 - c \tag{4}$$

For large samples, the hypergeometric distribution can be approximated accurately by the normal distribution.[8] The parameters used for this normal approximation are the mean and variance for the hypergeometric distribution given in (2), which can be written as[9]

$$E(n_1) = \frac{nN_1}{N} \tag{5a}$$

and

$$\sigma^2(n_1) = [nN_1(N - N_1)(N - n)]/[N^2(N - 1)] \tag{5b}$$

III. The Sample and the Data

Tests of the normal-backwardation theory are based on a sample of wheat, corn, and soybeans futures, the same three agricultural commodities that were examined by Dusak and CRS.[10] There are five different contracts per year for wheat

[8] HM have shown that the normal distribution can be an excellent approximation for determining the confidence intervals for the hypergeometric distribution, even for observation samples as small as 50. However, it will not be a good approximation even for quite large samples in those cases where there are substantial differences between N_1 and N_2 or between n and $N/2$. Equations (5a) and (5b) are employed to determine the confidence intervals in our study.

[9] See Lehmann [12, theorem 19] for a general proof.

[10] Carter, Rausser, and Schmitz also examined the risk structures of cotton and live cattle futures contracts.

and corn, and six (more than six in later years) for soybeans. For all contracts, semimonthly price quotations on the Chicago Board of Trade were obtained from July 15, 1951 through June 30, 1972. Monthly quotations were obtained from December 31, 1972 through December 31, 1980.[11] An average futures price (denoted as Avg. in Tables I to V) of each commodity in every period was also calculated. The maximum number of intervals for all contracts is 599. All semimonthly price quotations were taken from the U.S. Department of Agriculture and the monthly price quotations were obtained from the Commodity Futures Trading Commission reports.

The above mentioned publications also report various traders' market positions (or open commitments) over time. The commitments are divided into three groups: (large) hedging, (large) speculative, and nonreporting. It is required that all traders whose commitments in any one futures contract exceed the applicable reporting limit must communicate their entire position to the government agencies, which classify futures commitments as either hedging or speculative.[12] The remaining commitments are those of small traders; it is commonly assumed that these traders are predominantly speculative in nature.

The statistical procedure we are going to use requires that the speculator's predictions are known or that a proxy for the forecasts can be found. The reported market positions for various groups are in terms of both the number of contracts and the percentage of total open interests. We assumed that traders' reported commitments were distributed evenly among all contract months and that they were the same throughout each interval, as at the end of the interval when they were reported to the government agencies.[13] Thus, the reported commitments provided us with a clear picture of whether each group of traders was net long or net short in any period on each commodity. The net long or short position chosen by speculators during each interval is used as a proxy for the forecast or either an up- or down-futures market. Given the fact that not all speculators are on the same side of the market at any instant in time, the net market positions taken are used as the proxy for speculators' average predictions about the directions of price movements. Thus, the results of this study need to be interpreted with care. Large speculators as a whole may have made either positive or negative profits in the market, but the profitability of individual large speculators has not been examined and may not be consistent with our findings. Thus, we can view the

[11] Effective January 1, 1974, an amendment to Section 16.02 of the regulations under the Commodity Exchange Act requires that the respective commodity exchanges assume the responsibility for publishing a volume of trading and open contract information. In accordance with this regulation, the Commodity Exchange Authority (CEA) ceased publication of the Monthly and Annual Commodity Futures Statistics. Since the large traders' market positions could only be obtained from the Commodity Futures Trading Commission (CFTC) and it has reported on a monthly basis after January 1, 1974, we changed our investigated interval from semimonth to full month. To enlarge the sample size in the later period for subperiod analysis, we effected this change after December 31, 1972.

[12] Traders whose commitments in any one of the three futures contracts exceed 200,000 bushels have to communicate their entire position to the CEA or the CFTC.

[13] This assumption is similar to, but not identical with, the assumption made by Rockwell and CRS.

study as an examination of the profitability of a *representative* speculator who followed a simple strategy of being long when large speculators were net long and short when they were net short.

IV. The Empirical Evidence

The first step in applying HM's nonparametric procedure was to calculate price changes in each semimonthly or monthly interval for various delivery contracts. Sixteen actual price-change series and three price-change series of average contract prices were obtained. To facilitate the following discussion, we gave the name "up-futures" to all positive price change intervals for any contract. All negative price change intervals were denoted as "down-futures."

We began our investigation by examining whether large speculators as a whole earn a profit in the futures market from the rest of the market participants. This is equivalent to asking whether or not the large speculators' forecasts, as indicated by their net market positions, have any positive value. A perfect forecaster who is always correct should be a long trader in all up-futures and be a short trader in all down-futures. That is, both conditional probabilities of correct forecast given that $R(t) > 0$ and $R(t) \leq 0$ are one; therefore, $P_1(t) + P_2(t) = 2$. In the case of less than perfect forecasting ability, the sufficient condition for the speculators' position to have a positive value is that the sum of the conditional probabilities of a correct forecast be greater than one. Specifically, we estimated conditional probabilities of correct net positions for speculators in both up- and down-futures on each delivery contract. We then tested the null hypothesis of H_0: $P_1^s(t) + P_2^s(t) = 1$. If the null hypothesis of no value is rejected, we may conclude that large speculators are consistent winners in futures markets which is consistent with the existence of the reward either for bearing risk or for superior forecasting ability or both. It is apparent that this is a test of independence between speculators' net futures position and whether or not the price change on the examined contract is positive.

Table I contains the estimated conditional probabilities of correct positions of large speculators in both up- and down-futures for all 19 contracts as well as the sum of the conditional probabilities. Column (2) of the table shows the number of valid observations for each delivery contract. We remind the reader that the last row under each commodity describes the statistics for speculating in a portfolio consisting of all available delivery contracts. It can be seen from Column (5) that all tests of the null hypothesis that speculators do not earn positive returns can be rejected at a significance level of 0.01. The results are valid for all contracts investigated. Our findings are thus consistent with Rockwell's in providing statistical evidence that large speculators are consistent winners in the futures markets. This evidence furnishes a basic explanation about how the market is able to retain a group of speculators so that it continues to function.

By focusing on the conditional frequencies of correct forecasts, the HM procedure takes into account the possibility that the traders may not have the same skill in forecasting up-futures as down-futures. As shown in Columns (3) and (4), speculators in all commodities tend to forecast better in up-futures movement periods than in down-futures. This result is expected, given the

Table I

Conditional Probabilities of a Correct Market Position of Large Speculators Given That $R(t) \leq 0$ and $R(t) > 0$: July 15, 1951 through December 31, 1980
Null Hypothesis: $P_1^s(t) + P_2^s(t) = 1$
Alternative Hypothesis: $P_1^s(t) + P_2^s(t) > 1$

Commodity (1)	N (2)	Down Market $P_1^s(t)$ (3)	Up Market $P_2^s(t)$ (4)	All Markets $P_1^s(t) + P_2^s(t)$ (5)
Wheat:				
July	542	0.320	0.869	1.189*
Sept.	534	0.310	0.874	1.184*
Dec.	550	0.299	0.866	1.165*
March	547	0.303	0.887	1.190*
May	549	0.306	0.895	1.201*
Avg.	599	0.307	0.885	1.192*
Corn:				
July	538	0.260	0.866	1.126*
Sept.	529	0.267	0.886	1.153*
Dec.	531	0.314	0.884	1.198*
March	539	0.304	0.856	1.160*
May	528	0.290	0.864	1.154*
Avg.	599	0.291	0.876	1.167*
Soybeans:				
July	530	0.470	0.707	1.177*
Sept.	525	0.486	0.656	1.142*
Nov.	541	0.492	0.669	1.161*
Jan.	534	0.460	0.673	1.133*
March	532	0.466	0.686	1.152*
May	523	0.472	0.698	1.170*
Avg.	599	0.479	0.702	1.181*

* denotes significant at 0.01 level.

conventional belief that speculators tend to be net long traders in the market. For example, there were, on the average, 296 up-futures and 303 down-futures intervals on wheat futures during our investigation period, but speculators were net long traders in 472 out of 599 intervals.[14] The forecasting skills of soybean speculators in down-futures were better than those of corn and wheat speculators. We found that soybean speculators tended to switch their positions more frequently than the others. They were net short traders in 234 intervals which explains the relatively higher $P_1^s(t)$ and lower $P_2^s(t)$ in Table I as compared to the other commodities. Given that we consider all large speculators in each commodity market as a single group, however, Table I shows that positive profits in the so-called zero-sum games have been made.

The fact that large speculators tend to be more successful in predicting up-futures market than in down-futures market has another important implication.

[14] Coincidentally, speculators were net long 472 times in corn futures too.

Since the nonparametric statistical procedure we adopted considers only the dependence between the speculators' long or short position and the sign of the change in futures prices, it is possible for us to commit a Type I error if the distribution of price changes was skewed. This could happen, for example, if speculators made one dollar, on the average, when they were on the right side of the market but lost three dollars each time when they were on the wrong side of the market. However, a close examination of our data indicates that if a skewness exists in the price change distributions, it should bias the test in favor of a Type II error. As we saw above, there was nearly an equal number of up-futures and down-futures intervals in all three markets; however, the prices of all contracts at the end of our investigation period were at least two times their beginning prices. Therefore, any other tests attempting to consider the magnitude as well as the direction in price changes should only strengthen our results.

To examine whether the results are robust across different calendar time periods, we have broken down the entire test period into three intervals: July 15, 1951 through June 30, 1962, July 15, 1962 through June 30, 1972 and December 31, 1972 through December 31, 1980. Table II indicates that all sums of conditional probabilities of correct forecasts are greater than one, and that the vast majority of them are significant at either a 5% or 1% level. This is especially true in the period from 1973 to 1980 in which all null hypotheses are rejected at the 1% level. There were no such profits in existence for some futures contracts during the 1951 to 1962 period. This may be partially caused by our assumption that speculators' reported commitments were distributed evenly among all contract months, which may not be true.

We have provided strong statistical evidence that large speculators have consistently made positive profits in the three futures markets examined. However, no attempts have yet been made to determine wherther or not such profits were rewards for risk bearing or purely for superior forecasting skills.

We will now examine the main focus of this study, the normal backwardation hypothesis. According to Keynes, hedgers as a group pay some premium to speculators in the futures market as insurance. This fact would logically imply that hedgers are consistent "losers" in the market. In other words, the forecasts made by hedgers and implied by their net market positions should have a negative value. HM indicate that this hypothesis can be tested by determining whether or not the sum of conditional probabilities of hedgers' correct positions is significantly less than one.

It is worthwhile to point out that this test procedure is consistent in spirit with Rockwell's definition of risk premium. One can reasonably argue that positions with $P_1^H(t) + P_2^H(t) < 1$ have positive value since contrary forecasts with $P_1'(t) = 1 - P_1^H(t)$ and $P_2'(t) = 1 - P_2^H(t)$ would satisfy $P_1'(t) + P_2'(t) > 1$. That is, $P_1^H(t) + P_2^H(t) < 1$ implies that positive returns would have been rewarded to a naive speculator who was long when hedgers were net short and short when hedgers were net long. This is the essence of the theory of normal backwardation when speculators are allowed to be either long or short.

Table III shows not only that all the sums of conditional probabilities of correct net positions of hedgers are less than one, but also that 17 out of the 19 statistics are significantly different from one at the 5% level or higher. This evidence

Table II

Sum of Conditional Probabilities of a Correct Market Position of Large Speculators Given That $R(t) \leq 0$ and $R(t) > 0$: Three Subperiods
Null Hypothesis: $P_1^s(t) + P_2^s(t) = 1$
Alternative Hypothesis: $P_1^s(t) + P_2^s(t) > 1$

Commodity (1)	1951–1962 (2)	1963–1972 (3)	1973–1980 (4)
Wheat:			
July	1.125* (237)[a]	1.068 (216)	1.661* (89)
Sept.	1.105** (230)	1.103** (218)	1.623* (86)
Dec.	1.057 (237)	1.084** (222)	1.634* (91)
March	1.125* (236)	1.092** (221)	1.567* (90)
May	1.162* (240)	1.070 (223)	1.623* (86)
Avg.	1.130* (263)	1.103** (240)	1.600* (96)
Corn:			
July	1.049 (227)	1.122** (219)	1.377* (92)
Sept.	1.096** (218)	1.148* (220)	1.345* (91)
Dec.	1.173* (223)	1.183* (212)	1.318* (96)
March	1.153* (223)	1.100** (221)	1.330* (95)
May	1.121* (220)	1.115** (216)	1.334* (92)
Avg.	1.111* (263)	1.179* (240)	1.361* (96)
Soybeans:			
July	1.115** (215)	1.203* (223)	1.295* (92)
Sept.	1.031 (215)	1.208* (222)	1.279* (88)
Nov.	1.071 (218)	1.227* (227)	1.236* (96)
Jan.	1.072 (213)	1.146** (226)	1.294* (95)
March	1.112** (215)	1.145** (224)	1.301* (93)
May	1.160* (212)	1.130** (218)	1.322* (93)
Avg.	1.168* (263)	1.178* (240)	1.282* (96)

[a] The number in parentheses denotes the number of valid observations.
*denotes significant at 0.01 level.
** denotes significant at 0.05 level.

strongly supports the theory of normal backwardation. Column (3) clearly reflects the fact that hedgers tended to take more short positions in the markets than long positions. In wheat futures markets, they were net short hedgers, for example, 514 out of 599 times.[15] This disinclination to change positions reflects their desire to shift cash market price risks to speculators by contracting at prices, on the average, in favor of speculators' positions.[16] The gains they obtained from a downward futures price movement, on the average, were not sufficient to cover the losses during up-futures periods. This finding conflicts with Rockwell's conclusion that near-zero profits were provided to the hypothetical speculator as risk premiums.

[15] Hedgers were net short in corn and soybeans futures 483 and 391 times, respectively.
[16] The evidence is consistent with the hypothesis that the futures prices are not unbiased estimates of the expected spot prices on the delivery dates. The futures prices tend to be biased downward when speculators are net long and vice versa.

Table III

Conditional Probabilities of a Correct Market Position of Large Hedgers Given That $R(t) \leq 0$ and $R(t) > 0$: July 15, 1951 through December 31, 1980
Null Hypothesis: $P_1^H(t) + P_2^H(t) = 1$
Alternative Hypothesis: $P_1^H(t) + P_2^H(t) < 1$

Commodity (1)	N (2)	Down Market $P_1^H(t)$ (3)	Up Market $P_2^H(t)$ (4)	All Markets $P_1^H(t) + P_2^H(t)$ (5)
Wheat:				
July	542	0.815	0.124	0.939**
Sept.	534	0.822	0.126	0.948
Dec.	550	0.821	0.120	0.941**
March	547	0.841	0.110	0.951**
May	549	0.863	0.116	0.979
Avg.	599	0.832	0.115	0.947**
Corn:				
July	538	0.793	0.134	0.927**
Sept.	529	0.784	0.131	0.915*
Dec.	531	0.721	0.137	0.858*
March	539	0.730	0.144	0.874*
May	528	0.738	0.153	0.891*
Avg.	599	0.753	0.134	0.887*
Soybeans:				
July	530	0.640	0.261	0.901*
Sept.	525	0.582	0.312	0.894*
Nov.	541	0.536	0.311	0.847*
Jan.	534	0.572	0.317	0.889*
March	532	0.566	0.279	0.845*
May	523	0.573	0.258	0.831*
Avg.	599	0.593	0.284	0.877*

* denotes significant at 0.01 level.
** denotes significant at 0.05 level.

Table IV also divides the investigation period into the same three time intervals. The most prominent result of this segmentation is that the theory of normal backwardation seems to be valid in different degrees in different markets and in different periods. In the post-1973 period, the naive speculators as defined above received risk premiums in all three commodity markets. There were no such risk premiums in existence in the wheat and corn markets over earlier years, however. This may partially reconcile our study with Rockwell's findings, since his research covers the period up to 1965. Nevertheless, the soybeans futures market seems to be one which consistently provides such a premium. No attempt is made in this study to explain the observed differences.

A comparison of Table II with Table IV indicates that the large wheat speculators' profits might be a combined reward for both risk bearing and for some superior forecasting ability. This is because the large wheat speculators were "winners" in the market even in earlier years when no premiums for risk

Table IV

Sum of Conditional Probabilities of a Correct Market Position of Large Hedgers Given That $R(t) \leq 0$ and $R(t) > 0$: Three Subperiods
Null Hypothesis: $P_1^H(t) + P_2^H(t) = 1$
Alternative Hypothesis: $P_1^H(t) + P_2^H(t) < 1$

Commodity (1)	1951–1962 (2)		1963–1972 (3)		1973–1980 (4)	
Wheat:						
July	1.002	(237)[a]	0.969	(216)	0.679*	(89)
Sept.	1.004	(230)	0.985	(218)	0.685*	(86)
Dec.	0.991	(237)	0.996	(222)	0.687*	(91)
March	0.995	(236)	0.982	(221)	0.774*	(90)
May	1.015	(240)	1.032	(223)	0.756*	(86)
Avg.	1.004	(263)	0.980	(240)	0.698*	(96)
Corn:						
July	0.972	(227)	0.954	(219)	0.631*	(92)
Sept.	0.954	(218)	0.962	(220)	0.637*	(91)
Dec.	0.861*	(223)	0.930	(212)	0.606*	(96)
March	0.887*	(223)	0.932	(221)	0.652*	(95)
May	0.914**	(220)	0.944	(216)	0.673*	(92)
Avg.	0.923**	(263)	0.905*	(240)	0.627*	(96)
Soybeans:						
July	0.933	(215)	0.892**	(223)	0.755*	(92)
Sept.	0.944	(215)	0.840*	(222)	0.752*	(88)
Nov.	0.857*	(218)	0.826*	(227)	0.804**	(96)
Jan.	0.904	(213)	0.880**	(226)	0.765*	(95)
March	0.876**	(215)	0.837*	(224)	0.704*	(93)
May	0.802*	(212)	0.889**	(218)	0.679*	(93)
Avg.	0.859*	(263)	0.880**	(240)	0.780**	(96)

[a] The number in parentheses denotes the number of valid observations.
* denotes significant at 0.01 level.
** denotes significant at 0.05 level.

bearing were present. In order to "beat the market," they had to do more than naively follow the opposite of the net position taken by hedgers.

The above conjecture can be formally tested. Let n_1^s and n_1^H denote the number of correct forecasts made by large speculators and the hypothetical naive speculator, respectively, given $R(t) \leq 0$. Both n_1^s and n_1^H are hypergeometrically distributed and can be approximated by the normal distribution. For large samples, the sampling distribution of the differences, $n_1^s - n_1^H$, is also normally distributed. The mean and standard deviation of this sampling distribution, denoted respectively by $E(n_1^s - n_1^H)$ and $\sigma(n_1^s - n_1^H)$, are given by

$$E(n_1^s - n_1^H) = E(n_1^s) - E(n_1^H) \tag{6a}$$

and

$$\sigma(n_1^s - n_1^H) = \sqrt{\sigma^2(n_1^s) + \sigma^2(n_1^H)} \tag{6b}$$

Table V

A Test of Large Speculators' Forecasting Ability

Null Hypothesis:

$$P_1^s(t) + P_2^s(t) - [2 - P_1^H(t) - P_2^H(t)] = 0$$

Alternative Hypothesis:

$$P_1^s(t) + P_2^s(t) - [2 - P_1^H(t) - P_2^H(t)] \neq 0$$

Commodity	1951–1962	1963–1972	1973–1980	1951–1980
Wheat:				
July	0.127**	0.037	0.340*	0.128*
Sept.	0.109	0.088	0.308**	0.132*
Dec.	0.048	0.080	0.321**	0.106*
March	0.120**	0.074	0.341*	0.141*
May	0.177*	0.102	0.379*	0.180*
Avg.	0.134**	0.083	0.298**	0.139*
Corn:				
July	0.021	0.076	0.008	0.053
Sept.	0.050	0.110	−0.018	0.068
Dec.	0.034	0.113	−0.076	0.056
March	0.040	0.032	−0.018	0.034
May	0.035	0.059	0.007	0.045
Avg.	0.034	0.084	−0.012	0.054
Soybeans:				
July	0.048	0.095	0.050	0.078
Sept.	−0.025	0.048	0.031	0.036
Nov.	−0.072	0.053	0.040	0.008
Jan.	−0.024	0.026	0.059	0.022
March	−0.012	−0.018	0.005	−0.003
May	−0.038	0.019	0.001	0.001
Avg.	0.027	0.058	0.062	0.058

* denotes significant at 0.01 level.
** denotes significant at 0.05 level.

where $E(n_1^s)$ and $E(n_1^H)$ and $\sigma^2(n_1^s)$ and $\sigma^2(n_1^H)$ are defined respectively by Equations (5a) and (5b).[17]

Table V shows the differences between the sum of conditional probabilities of a correct market position of large speculators and that of the hypothetical naive speculator. For example, the estimate of the sum of conditional probabilities of a correct market position of hedgers in the July wheat is 0.939 (Table III). The same estimate for a hypothetical naive speculator who follows the opposite of the net position taken by hedgers is 1.061 (2 − 0.939). We subtract this number from 1.189 (Table I), the estimate of the sum of conditional probabilities of a correct market position of large speculators, and obtain 0.128 which is shown in

[17] Equation (6b) assumes implicitly that the forecasts made by large speculators and the hypothetical naive speculator have been done independently of each other. Since the purpose of the test is to confirm the existence of inside information on the part of large speculators, this is a valid assumption. In the event that this is not true, Equation (6b) results in an estimate of the standard deviation which is too large, thus leading to an underestimate of the significance of the statistics. Therefore, if bias exists in the procedure, it is in favor of the null hypothesis.

the first row and the last colum of Table V. The same calculation is done for all commodities for the whole period and for the three subperiods.

The null hypothesis of the test is that the differences equal zero. As can be seen, all the statistics for wheat speculators are positive and more than half of them are significantly different from zero.[18] Thus, we conclude that large wheat speculators as a whole possessed some superior forecasting ability.

Table V also shows that none of the statistics for corn and soybeans are significantly different from zero. Therefore, the statistical profit performance of the hypothetical naive speculator was as good as that of the large speculators in these two markets. The market inefficiency hypothesis was not valid in these markets and the theory of normal backwardation was ideal for explaining the large speculators' returns in these two markets. This is inconsistent with Rockwell's conclusion that it is forecasting and not the bearing of risk that determines the profits of speculators.

V. Summary

This paper employs a nonparametric statistical procedure to examine the existence of a positive profit to speculators in wheat, corn, and soybeans futures markets. Specifically, we examine in what forms such "profits" were rewarded. We presented statistical evidence in support of the theory of normal backwardation as suggested by Keynes. Moreover, we showed that the validity of the theory seems to be in different degrees in different markets and in different periods. The presence of such risk premiums tends to be more prominent in recent years than in earlier years.

We also showed that "large wheat speculators" as a whole possessed some superior forecasting ability. In general, the commodity futures market rewards such skill; however, no attempt was made to estimate the relative size of the two rewards. Both findings show that large speculators, on the average, were consistent winners in futures markets. In sum, the evidence is inconsistent with the hypothesis that commodity futures prices are unbiased estimates of the corresponding future spot prices.

[18] Since no theory suggests that the differences should be positive, a two-tailed test is used.

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