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## Is Risk Aversion a Theoretical Diversion?

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## IS RISK AVERSION A THEORETICAL DIVERSION?

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Working Paper No. 46

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## SECTION I — INTRODUCTION

Economists have proposed three theories as to why firms use futures markets. In the risk reduction theory it is suggested that commercial participants simultaneously enter the futures and the cash markets hoping to dampen the volatility of their expected income flows (Blau 1944-45; Cootner 1960a, 1960b; Hicks 1978; Kaldor 1939; Keynes 1930).<sup>1</sup> In this, the most widely accepted theory, the critical assumption is that firms act "as if" they are risk-averse. This crucial assumption is not important in the alternative theories. The focus of the informational theory is on differences in beliefs or opinions. Firms enter the futures market to maximize their expected profits by taking advantage of (or gambling on) the superior information they believe they possess (Grossman 1980; Hartzmark 1984, 1987; Rockwell 1964, 1977; Telser 1958, 1960, 1967). The key assumptions are that firms possess heterogeneous beliefs and that the market price does not fully reveal all private information (i.e., the markets are not strongly efficient). Assumptions regarding the nature of the firms' risk preferences are of secondary importance. Finally, in the transactions cost approach it is suggested that commercial traders face different costs of transacting in the futures market relative to their specific cash markets. These firms minimize their expected costs by taking advantage of the relative cost differentials (Telser 1981, 1986; Williams 1986).

These theories are not mutually exclusive. Firms may employ strategies that utilize their informational advantages in combination with their desire to reduce business risks. In addition, one would think that these strategies would be implemented in the lowest cost method. There still remains the question of whether one factor (e.g., risk, information or costs) dominates the decision-making process.

The focus of this paper is on the risk reduction theory. It is tested using detailed cash and futures position data disaggregated to the level of the individual firm. The specific question to be addressed is whether the assumption of risk-aversion is a meaningful construct when modeling individual firm behavior. In the empirical sections of this paper I show that we are unable to reject the notion that the desire to reduce risk plays an important role in the firm's trading decisions. This is demonstrated in three ways: 1) by very high correlations between most firms' cash and futures commitments; 2) with ex post variance and return measures indicating that firms act "as if" they are risk-minimizers; and 3) by low adjustment coefficients suggesting that firms respond slowly to a changing price environment.

The informational theories cannot be tested directly because firm-specific price expectations or reasonable proxies thereof are unobservable. However, with some manipulation I am able to extract the firm's weekly expected price changes deflated by their risk parameter. These measures emerge as residuals from the demand equations for the cash and futures positions. With the assumption that firms formulate their price expectations rationally and adaptively (Maddala 1977; Muth 1961) I am then able to extract the firm's risk preference parameter from the residuals. I then show that the firms adapt their price change expectations very slowly. They do not act like nimble-footed speculators, but more closely resemble mule-like hedgers. This observation corresponds with the results suggesting that the firms are risk-minimizers.

## **SECTION II — WHY COMMERCIAL TRADERS USE FUTURES MARKETS**

In the earliest theories on the firm's portfolio choice and the use of futures markets, firms make trade offs between expected return and risk

(Johnson 1960; Stein 1961). The optimal combination depends on the firm's risk preferences. The risk-return theory is combined with the information theory in Anderson and Danthine (1981). In this model, the risk-averse firm combines both speculative and hedging activity to maximize utility. The firm's utility is a function of the risks it faces (which it desires to minimize) and its expected profits (which it attempts to maximize). Anderson and Danthine (1981) show that a utility maximizing firm<sup>2</sup> that chooses its futures and cash positions simultaneously has futures and cash demands specified as:

$$(1) \quad F_{it} = [(P_{if,t+1} - P_{ft}) / (A_i * v_{ift})] - [(C_{it} * v_{icft}) / v_{ift}]; \text{ and}$$

$$(2) \quad C_{it} = [(P_{ic,t+1} - P_{ct}) / (A_i * v_{ict})] - [(F_{it} * v_{icft}) / v_{ict}]; \text{ where,}$$

$F_{it}$  = the amount of futures purchased ( $F_{it} > 0$ ) or sold ( $F_{it} < 0$ ) by firm  $i$ ;

Commitments are made in period  $t$  and the contract matures in period  $t+1$ ;

$C_{it}$  = the amount of the commodity that firm  $i$  commits in period  $t$  to be purchased ( $C_{it} > 0$ ) or sold ( $C_{it} < 0$ ) in period  $t+1$  at a price fixed in period  $t$ ;

$P_{ft}$  = the current price for a futures contract that matures in period  $t+1$ ;

$P_{ct}$  = the current cash price;

$P_{if,t+1}$  = firm  $i$ 's expectation of the period  $t+1$  futures price;

$P_{ic,t+1}$  = firm  $i$ 's expectation of the period  $t+1$  cash price;

$v_{ift}$  = the variance of firm  $i$ 's prediction error on the futures price or firm  $i$ 's estimation of the second moment of the distribution of futures prices;

$v_{ict}$  = the variance of firm  $i$ 's prediction error on the cash price or firm  $i$ 's estimation of the second moment of the distribution of cash prices;

$v_{icft}$  = the covariance of firm  $i$ 's prediction errors on the cash and futures prices or firm  $i$ 's estimation of the covariation between the cash and futures prices;

$A_i$  = coefficient of risk-aversion.  $A_i > 0$  implies risk aversion.

The demands for cash and the futures commitments are both composed of hedging and speculative elements. The sign of the speculative demand is determined by the firm's price expectations relative to the market price. The absolute magnitude of this component is dampened somewhat because the firm is risk-averse, in addition to being unable to precisely predict the maturity price (i.e., the variances are positive).<sup>3</sup>

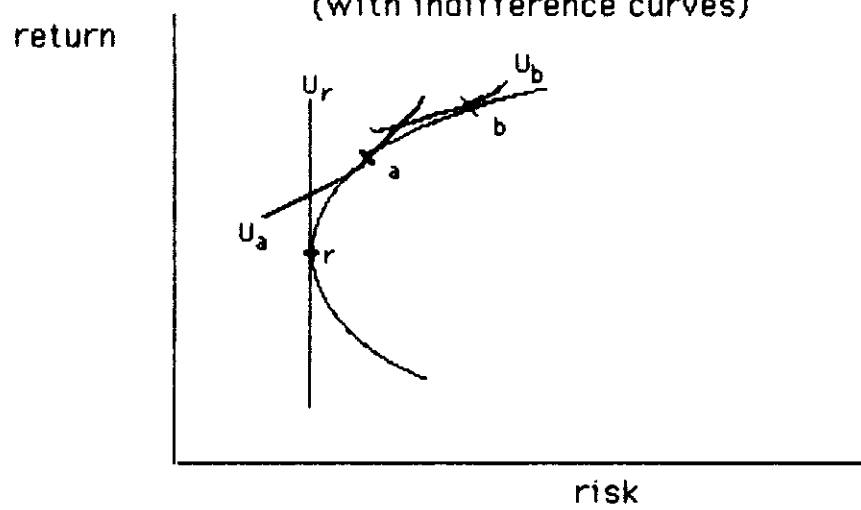
In equations (1) and (2), the hedge component is a function of the cash and futures positions, respectively. The degree of hedging is also determined by the subjective estimates of the covariation between prices (i.e., the hedging opportunities in the market) and the estimated variances of the relevant prices.

We would like to estimate demand equations (1) and (2) directly to determine the relative importance of the speculative and hedge components. Unfortunately, this is impossible because neither individual price expectations nor firm specific risk preferences can be observed. However, there are some straightforward predictions that emerge from these equations. First, if hedging price risk is an important factor in the firm's portfolio decision there should be a high correlation between  $C_{it}$  and  $F_{it}$ . In addition, the magnitudes of  $C_{it}$  and  $F_{it}$  should be related to the relevant variances and covariances of the prices. On the other hand, if speculative activity dominates the demands then the relationships suggested above should not be observed as price expectations will swamp the hedge demand.

An alternative approach to testing whether risk-aversion (and thus hedging) is an important factor in the firms' decisions, is to look at the risk-return trade-offs that the firms choose. If firms enter the markets with the single goal of eliminating as much risk as possible (i.e., pure hedging) then we should observe the variances of their profits as low as possible. In essence, they will give up as much return as necessary to minimize their risks. They will choose to locate on the low risk, low return section of the risk-return opportunity locus. In the empirical section of the paper, statistical methods are used to determine whether the firms do in fact act "as if" they are risk-minimizers.

Like any attempt to directly estimate equations (1) and (2), the approach of determining whether firms appear to be risk-minimizers has its share of problems. As before, it is difficult to separate the hedge and the speculative effects. A visual representation of the problem is found in Figure 1. This figure shows the normal risk-return opportunity locus available to the firm that holds both cash and futures positions. Each point on this locus represents the risk-return possibility for a different size hedge ratio (i.e., fraction of futures positions relative to cash positions). In other words, for a given set of observed cash and futures price changes one can calculate the return and variance of the return over a given period for each hedge ratio. For example, to achieve the combination of risk and return that minimizes the variance the firm would have to locate at point r. If point r represents a hedge ratio of -0.75 this means that a trader must hold three-quarters of a short (long) futures position for each long (short) cash commitment held. Note, it is only rational for firms to attempt to locate along the segment from r to a, extending through b. In the discussion below, assume that the hedge ratios at a and b are -0.5 and -0.25, respectively.

Figure 1  
Hypothetical Risk-Return Locus  
(with indifference curves)





Assuming that firms do not speculate on their price expectations, the firms' tastes for risk (as indicated by their indifference curves) will determine where they locate on the r-b segment. This is the solution derived in the early portfolio theories (Johnson 1960; Stein 1961). A firm which is terrified of adverse price movements will attempt to locate at point r, while the less risk-averse firm will locate closer to points a or b or beyond. Therefore, if we observe all firms locating around the r-a segment we can conclude that firms act as if they are risk averse. Firms locating in the outer segments are less averse to risk and may even be risk neutral or loving.

Unfortunately, if it is assumed that firms also speculate on their individual price expectations the observed results are less clear. What can be inferred from observing a firm at point a or another firm at point b? Now one can say very little about the firms' tastes for risk unless the speculative activity can be disengaged from the hedging activity. For example, a short hedger (i.e., a firm holding cash inventories with offsetting short futures positions) may locate at point a. This firm is not a risk-minimizer. However, if over the relevant period the firm were to believe that the futures price were going to fall relative to the cash price, it might increase its short futures position relative to its long cash position. In other words, it will decrease its hedge ratio of -0.5 toward the "risk-minimizing" hedge ratio of -0.75. Thus, the firm will be acting as if it were becoming more averse to risk as it moves toward point r. If we observe the firm locating at point r can we conclude that it is a risk-minimizer? The answer is no. The combination of both the hedging and speculative demands moved it to point r. The indifference curves as drawn are irrelevant.

To circumvent this problem of identifying which factor is important we turn back to equations (1) and (2). These equations show that, ceteris

paribus, speculative activity will be a less important for the firms that are highly averse to risk relative to those that are less risk averse. For a given expected price change, as  $A_1$  increases the speculative demand falls. A firm that has tastes such that it would locate at point  $r$ , in the absence of speculative activity, will only stray far from that point if the expected price change is sufficiently large. In other words, ceteris paribus, the larger the aversion to risk, the less important the speculative behavior. Therefore, when we combine the speculative effects with the hedge effects we will observe few traders moving from a point such as  $r$  to another like  $b$ . Alternatively, for traders less averse to risk they will be very sensitive to changes in price expectations. Therefore, we expect to see them clustered all over the locus, beyond  $b$  and back towards  $a$ .

In general, it is unlikely that speculative activity will guide all traders to choose to locate around point  $r$ . Traders who speculate must believe that they possess some private information. Unless these beliefs are consistently unfounded, it is unlikely that this information will move all traders in the same direction. Therefore, if we observe most traders locating around point  $r$  we can conclude that risk-aversion and specifically, risk-minimization must be important factors in the firms' decisions.

### SECTION III — DESCRIPTION OF DATA

Data from the oats and wheat markets are examined for the calendar year 1980. Observations on the end-of-week cash positions of large commercial traders are taken from Commodity Futures Trading Commission (CFTC) cash market reports. These reports are required of bona fide hedgers anticipating that they may exceed the speculative position limits in the futures market. Reporting cash positions enables these firms to receive exemptions from the limits. The firm must report its long and short fixed price cash commitments

held at the close of business on each Friday. The long position is calculated by combining the stocks owned with the fixed price, forward purchase commitments. The short cash position represents the fixed price forward sale commitments.<sup>4</sup> For each firm for each week a net cash position ( $C_{it}$ ) is constructed by subtracting long commitments from short commitments.

For each firm, the futures position held on each Friday is taken from the CFTC large trader database.<sup>5</sup> The firm's long and short futures positions are aggregated across all maturity months.<sup>6</sup> Its net futures position ( $F_{it}$ ) is then derived by subtracting the aggregate short from the long position.

The futures prices come from the CFTC database. Friday closing prices for each maturity month are used.<sup>7</sup> Each week a "derived" futures price ( $P_{ft}$ ) is calculated by taking a weighted average of all closing prices, where the weights are the number of open contracts in each maturity month. Friday cash price quotes ( $P_{ct}$ ) are taken from the 1980 yearbooks of the Chicago Board of Trade (CBT), the Minneapolis Grain Exchange (MGE) and the Kansas City Board of Trade (KBT).<sup>8</sup>

All three wheat futures markets are combined in the calculations and tests that follow. This method of aggregation is used because it is impossible to decompose the cash market reports into those that are related to the CBT versus the KBT versus the MGE. Therefore, when calculating the risk-minimizing hedge ratios or other measures using price data a modified mean price is used. For example, if the firm is in the CBT and MGE wheat futures markets (i.e., not in KBT) then the relevant cash (futures) price (or price change) for that week's calculations is the mean of CBT and MGE cash (futures) prices (or price changes in these means). The KBT price is excluded in this case.

Variances and covariances of cash and futures prices are also calculated. These measures are used in the regressions and correlations in Section VI. All variance and covariance calculations utilize price information from the past nine weeks as well as the current week's observation. This is straightforward for the oats cash price variances ( $v_{ict}$ ). The method to calculate the oats futures price variance ( $v_{ift}$ ) is slightly more complicated. First, a variance using ten weeks worth of data, including the current week, is calculated for each maturity month. Second, a weighted average of all the variances is calculated where the weights are the number of open contracts (on the current Friday) in each maturity month. The covariance of cash and futures prices ( $v_{icft}$ ) for oats is calculated in a similar manner. First, the ten week covariance between the cash price and each futures maturity month price is calculated. Second, a weighted average of these covariances is calculated, where the weights are the number of open contracts in each maturity month.

In each of the three wheat markets variances and covariances are calculated using the methods mentioned above. Like the modified prices used for all wheat calculations, the relevant variances and covariances are averaged across 1, 2 or 3 markets depending on the number of futures markets the trader is participating in.

#### **SECTION IV — DESCRIPTIVE STATISTICS FOR PRICES AND POSITIONS**

##### PRICES

In Table 1 descriptive statistics for the price series are presented. In all markets the prices trend upward with the close observation (December 24, 1980) greater than the open observation (January 4, 1980).<sup>9</sup> This can also be seen in Figures 2 and 3.<sup>10</sup> In all the markets, the mean of the weighted average closing futures price series is greater than the mean of the cash

Figure 2

# CHICAGO BOARD OF TRADE OAT PRICES FOR 1980

CASH (C) VERSUS FUTURES (F)

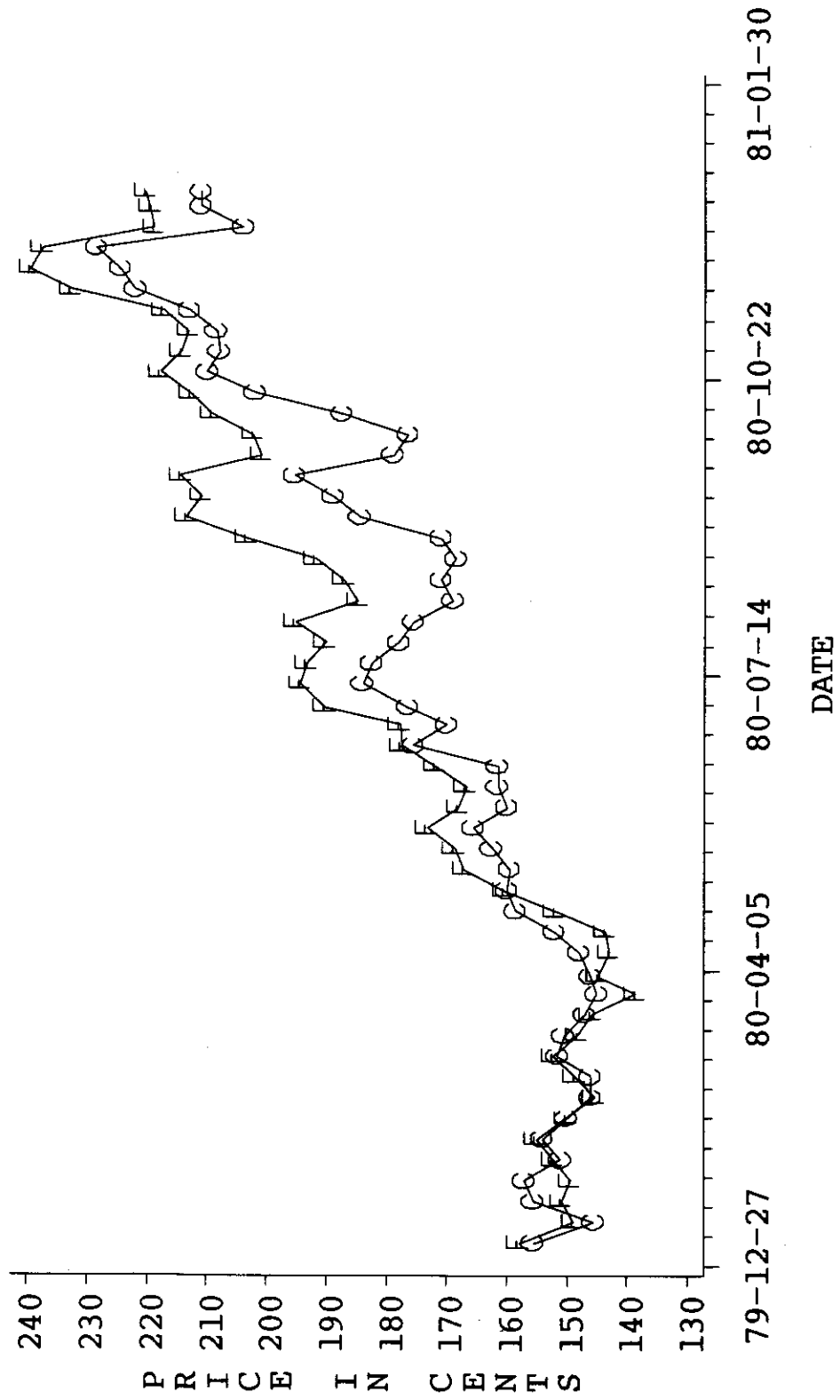
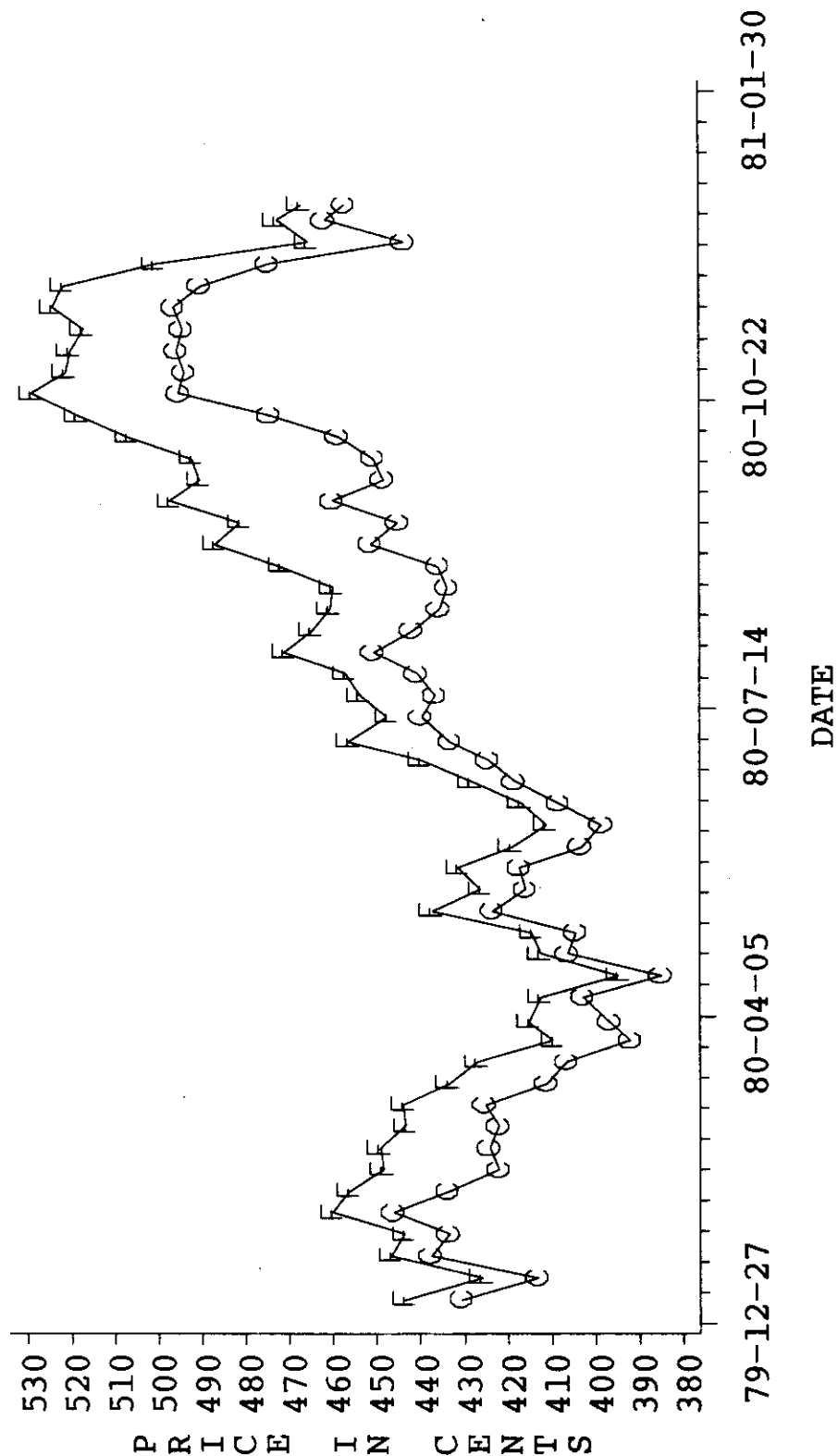


Figure 3

# WHEAT PRICES FOR 1980

CASH (C) VERSUS FUTURES (F)  
FOR CHICAGO, MINNEAPOLIS, KANSAS CITY



price series. A normal cost-of-carry relationship would explain this. In addition, over the previous years general price inflation had been extremely high, and therefore it is likely that there is an inflation premium implicit in the futures price. Even so, there are some weeks where the contango relationship reverses itself to backwardation.

<<<INSERT TABLE 1 HERE>>>

Risk-minimizing hedge ratios are calculated for each price series by running an OLS regression of the futures price change on the cash price change. The beta coefficient from this regression is the hedge ratio. The R-square represents the effectiveness of a one week hedge, where the hedge ratio is kept constant and equal to beta (see Ederington 1979). The results for all 4 markets are shown in columns 7 and 8. With the exception of the MGE prices, the hedge ratios are all significantly different from both zero and one at the 0.0001 probability level.<sup>11</sup> This indicates that in 1980 neither a fully hedged nor an unhedged position would have been a risk-minimizing strategy. The effectiveness of the hedges are all comparable to the two week, wheat and corn hedge effectiveness measures found in Ederington (1979).

#### POSITION DATA AND HEDGE RATIOS FOR INDIVIDUAL COMMERCIAL TRADERS

Tables 2A and 2B present various statistics describing the individual firms. An observation for an individual firm is used only if both a cash and a futures position is reported for that week.<sup>12</sup> Firms possessing fewer than 15 simultaneous observations are not included in the analysis. Each week the net positions of all firms in each market at that time are aggregated to create two synthetic firms or aggregate market measures. In all the tables that follow, these market proxies are labelled **TRADER O(ats)** and **TRADER W(heat)**.

<<<INSERT TABLES 2A AND 2B HERE>>>

Table 1  
PRICE STATISTICS FOR WHEAT AND OATS MARKETS  
(in cents per bushel)

	<u>Mean</u>	<u>Standard Deviation</u>	<u>Low</u>	<u>High</u>	<u>Open</u>	<u>Close</u>	<u>Hedge Ratio</u>	<u>Hedge Effectiveness</u>
<u>WHEAT</u>								
<u>Combined</u>								
Cash	437.2	29.0	384.9	496.1	430.4	456.9	0.88	0.83
Future	458.5	35.8	394.6	528.8	443.6	467.1		
<u>Chicago</u>								
Cash	430.3	30.8	374.0	495.5	435.5	446.8	0.94	0.81
Future	469.0	42.0	397.5	549.7	456.9	481.4		
<u>Minneapolis</u>								
Cash	445.3	34.9	386.3	507.0	414.8	475.5	0.77	0.52
Future	456.3	33.3	401.9	523.4	449.6	461.9		
<u>Kansas City</u>								
Cash	436.0	28.3	388.0	498.3	441.0	448.5	0.84	0.60
Future	450.0	33.8	384.4	513.2	424.2	457.8		
<u>OATS</u>								
Cash	174.3	24.0	145.0	228.5	155.5	211.0	0.82	0.55
Future	182.4	29.7	138.6	239.5	157.9	220.4		



Table 2A

## HEDGE RATIOS AND MEAN NET COMMITMENTS OF INDIVIDUAL OAT TRADERS

(positions in bushels  $\times 10^6$ )

<u>Trader (# obs.)</u>	<u>Net Cash Position</u>	<u>Net Futures Position</u>	<u>Hedge Ratio</u>	<u>Risk-Minimizing Hedge Ratio</u>	<u>Correlation Cash-Futures</u>
Trader A 46	0.59 (0.77)	-0.02 (1.37)	-11.14 (82.02)	-0.84	-0.08
Trader B 37	0.57 (0.49)	-0.12 (0.14)	-0.07 (0.49)	-0.85	-0.50**
Trader C 17	0.00 (0.00)	-0.56 (0.14)	-181.54 (79.62)	-0.59	-0.04
Trader D 49	2.25 (0.74)	-1.35 (0.69)	-0.56 (0.14)	-0.81	-0.99**
Trader E 37	78.94 (110.01)	-0.30 (0.08)	-1.12 (6.83)	-0.89	0.10
Trader F 48	5.75 (2.90)	-3.84 (1.62)	-1.03 (1.58)	-0.84	-0.16
Trader G 47	0.74 (0.27)	-0.72 (0.30)	-0.93 (0.25)	-0.84	-0.99**
Trader H 16	2.63 (0.47)	-1.97 (0.56)	-0.75 (0.15)	-0.78	-0.63**
Trader I 19	0.32 (0.07)	-0.31 (0.09)	-0.95 (0.22)	-0.95	-0.93**
Trader O 52	66.13 (100.37)	-6.68 (2.91)	-0.45 (0.41)	-0.82	-0.51**

Standard deviations in parentheses.

\* Significant at a 10% probability level.

\*\*Significant at a 1% probability level.

Table 2B

## HEDGE RATIOS AND MEAN NET COMMITMENTS OF INDIVIDUAL WHEAT TRADERS

(positions in bushels  $\times 10^6$ )

<u>Trader (# obs.)</u>	<u>Net Cash Position</u>	<u>Net Futures Position</u>	<u>Hedge Ratio</u>	<u>Risk-Minimizing Hedge Ratio</u>	<u>Correlation Cash-Futures</u>
Trader J 51	-0.73 (10.14)	-4.29 (3.49)	-5.12 (35.46)	-0.87	-0.35**
Trader K 46	7.84 (1.99)	-6.10 (1.38)	-0.79 (0.16)	-0.89	-0.66**
Trader L 52	16.99 (23.94)	1.70 (13.60)	1.42 (5.22)	-0.95	-0.74**
Trader M 51	6.58 (2.47)	-4.22 (1.16)	0.57 (9.33)	-0.88	-0.32*
Trader N 49	4.52 (1.28)	4.24 (2.67)	0.97 (0.74)	-0.88	0.02
Trader P 28	2.00 (1.39)	-2.50 (1.05)	-1.83 (1.25)	-0.95	-0.91**
Trader Q 50	12.08 (6.81)	-11.03 (5.24)	-0.52 (3.06)	-0.88	-0.87**
Trader R 46	19.81 (42.93)	-13.90 (35.87)	-1.38 (6.81)	-0.89	-0.95**
Trader S 51	3.45 (1.66)	-3.50 (1.64)	-1.03 (0.06)	-0.89	-1.00**
Trader T 49	-1.01 (2.23)	-2.21 (1.08)	1.72 (12.60)	-0.92	0.53**
Trader U 37	5.54 (3.91)	-0.23 (0.25)	-0.05 (0.14)	-0.89	-0.75**
Trader W 52	70.51 (76.60)	-37.98 (46.19)	-0.49 (0.64)	-0.88	-0.95**

Standard deviations in parentheses.

\* Significant at a 10% probability level.

\*\*Significant at a 1% probability level.

The net positions in columns 1 and 2 represent long minus short commitments. For example, TRADER D (in Table 2A) is net long in the cash market an average of 2,250,000 bushels of oats. He is net short 1,350,000 bushels in the futures market. His hedge ratio (shown in column 3) is  $-0.56$  which is calculated by taking the ratio of futures commitments to cash commitments and averaging it over 37 weeks. The risk-minimizing hedge ratios for the individual firms are calculated in the same way as those presented in Table 1. The ratios differ across firms because only those weeks where the firm reports both cash and futures positions are used in the regression.<sup>13</sup>

Actual hedge ratios vary from  $-181.54$  to  $1.72$ , while risk-minimizing hedge ratios are all between  $-0.59$  and  $-0.95$ .<sup>14</sup> It is misleading to test whether the individual firms are risk-minimizers by comparing the average of the actual hedge ratios to the risk-minimizing hedge ratio. For example, suppose a firm has hedge ratios equal to  $-101$  half the time and  $+100$  the other half. This firm may appear to be a risk-minimizer with an average hedge ratio of  $-0.50$ . However, when the variability of profits is examined, risk-minimization might be rejected.

With the exception of TRADERS J and T, firms practice short hedging. TRADERS O and W (representing the aggregate positions of all traders in the market) hedge about half of their net long cash commitments in the futures market, on average. TRADER O's average net cash position is ten times its net futures position, even though the average hedge ratio is  $-0.45$ . This is due to very large cash positions (relative to futures positions) being held during a couple weeks in January and October.

The standard deviations of the net cash positions are greater than or equal to the standard deviations of the net futures positions in almost every case. This suggests that these traders move in and out of the cash market

with even greater ease than they trade in the futures market. It is usually assumed that the lower transactions costs in the futures market induce the firms to engage in more frequent position adjustments in the futures market than in the cash market. For these commercial entities this is not the case.

## **SECTION V — THE PERFORMANCE OF THE FIRMS**

In Tables 3A and 3B the dollar profits and percentage returns earned by the individual traders are presented. Weekly profits earned on the cash and futures positions are reported in columns 1-3. Cash profits are calculated by multiplying the cash position held on week  $t$  by the change in the cash price between weeks  $t$  and  $t+1$ .<sup>15</sup> For the oats market this calculation is straightforward. This is not the case for the wheat market. Here the cash price change is the change in the modified price mentioned above. Calculations of the futures profits are made separately for the CBT, MGE, and KBT markets and then summed. These profits are calculated as the futures position (in the particular market) at time  $t$  multiplied by the change in the related futures price between weeks  $t$  and  $t+1$ .

**<<<INSERT TABLES 3A AND 3B HERE>>>**

Given the price trends, it is not surprising that the oats firms earn positive profits on their net long cash positions. TRADER C is the only oats firm to realize cash losses. Four firms lose money in the cash wheat market. Of these firms, only TRADER J is bucking the trend by remaining net short in the cash market, on average. For the most part, the combined futures and cash operations prove to be money makers for these traders. TRADERS O and W earn positive dollar profits (although the means are not significantly different from zero).

Table 3A

## PROFITS OF INDIVIDUAL TRADERS OF OATS

(in dollars  $\times 10^5$ )

<u>Trader</u>	<u>Daily Futures <math>\pi</math></u>	<u>Weekly Futures <math>\pi</math></u>	<u>Weekly Cash <math>\pi</math></u>	<u>Total Weekly <math>\pi</math></u>	<u>Return in \$ per 1000 bu.</u>	<u>Return in % of Cash Price</u>
Trader A	7.29	1.52 (1.07)	0.22 (0.97)	1.75 (1.60)	-28.44* (223.88)#	-19.60* (146.77)#
Trader B	-0.69	-0.94 (0.12)	2.99 (0.74)	2.05 (0.67)	1.38** (7.58)	0.86** (4.03)
Trader C	1.51	0.32 (0.28)	-0.01 (0.00)	0.31 (0.28)	13.37* (904.21)#	4.45* (597.64)#
Trader D	-1.59	-8.15 (1.12)	9.52 (1.83)	1.37 (1.17)	0.19 (4.61)	0.16 (2.64)
Trader E	-0.11	-1.16 (0.23)	602.09 (101.55)	600.93 (101.43)	-3.51* (34.47)##	-2.01* (19.81)##
Trader F	8.52	-7.66 (3.20)	23.36 (5.05)	15.71 (3.29)	1.59* (8.93)	1.03* (5.60)
Trader G	-1.65	-4.33 (0.56)	2.43 (0.61)	-1.90 (0.39)	-0.43 (4.69)	-0.23 (2.75)
Trader H	-0.93	-5.38 (1.62)	4.84 (1.94)	-0.53 (0.99)	0.15 (3.73)	0.07 (1.97)
Trader I	-0.39	-0.32 (0.24)	0.71 (0.29)	0.38 (0.14)	0.67 (4.15)	0.41 (2.05)
Trader O	11.96	-26.24 (5.21)	646.00 (91.15)	619.75 (87.90)	1.04 (6.03)	0.62 (3.37)

Standard deviations are in parentheses.

\*Indicates t-statistic significant at 1% level for test of actual mean return different from risk-minimizing mean return.

\*\*Indicates t-statistic significant at 10% level for test of actual mean return different from risk-minimizing mean return.

#Indicates CHI-SQUARE statistic significant at 0.05% level for test of actual variance being different from risk-minimizing variance.

##Indicates CHI-SQUARE statistic significant at 10% level for test of actual variance being different.

Table 3B  
PROFITS OF INDIVIDUAL TRADERS OF WHEAT  
(in dollars  $\times 10^6$ )

<u>Trader</u>	<u>Daily Futures <math>\pi</math></u>	<u>Weekly Futures <math>\pi</math></u>	<u>Weekly Cash <math>\pi</math></u>	<u>Total Weekly <math>\pi</math></u>	<u>Return in \$ per 1000 bu.</u>	<u>Return in % of Cash Price</u>
Trader J	2.00	-0.76 (0.56)	-0.94 (1.19)	-1.70 (1.15)	45.77* (400.72)#	11.10* (94.34)#
Trader K	4.43	-3.93 (0.81)	3.61 (1.05)	-0.32 (0.46)	0.00 (5.14)	0.00 (1.16)
Trader L	3.72	5.10 (1.97)	5.68 (4.18)	10.78 (4.16)	4.53* (56.53)#	1.05* (12.87)#
Trader M	1.93	0.02 (0.55)	5.26 (0.92)	5.28 (0.58)	-22.94* (174.52)#	-5.39* (41.05)#
Trader N	-0.68	0.58 (0.67)	1.51 (0.61)	2.09 (1.21)	0.31 (25.09)	0.12 (5.91)
Trader P	1.06	0.64 (0.41)	-0.76 (0.41)	-0.12 (0.18)	-4.95* (23.46)	-1.24* (5.74)
Trader Q	5.24	-2.72 (1.58)	3.40 (1.59)	0.68 (0.82)	8.25* (55.27)#	2.11* (14.34)#
Trader R	-7.66	8.08 (4.14)	-1.15 (5.15)	6.93 (2.79)	8.52* (51.44)#	1.99* (11.86)#
Trader S	-1.44	-1.80 (0.53)	0.79 (0.48)	-1.01 (0.22)	-0.66 (5.92)	-0.16 (1.38)
Trader T	2.17	0.84 (0.36)	1.34 (0.37)	2.18 (0.64)	-43.40* (321.80)#	-8.61* (66.23)#
Trader U	0.01	0.03 (0.04)	-3.06 (0.89)	-3.03 (0.86)	0.75 (14.12)	0.24 (3.35)
Trader W	10.78	6.07 (6.40)	15.69 (12.28)	21.76 (7.83)	-0.63 (12.50)	-0.15 (2.99)

Standard deviations are in parentheses.

\*Indicates t-statistic significant at a 1% level for test of actual mean return being different from risk-minimizing mean return.

#Indicates Chi-square statistic significant at a 0.05% level for test of actual variance being different from risk-minimizing variance.

## SECTION VI — TESTS OF THE RISK REDUCTION THEORY

In this section the individual firm means and standard deviations are examined and compared to the ex post risk-minimizing means and standard deviations. The ex post risk-return choices of the commercial participants are examined to get an idea of whether they act "as if" they are risk-averse. The appropriate risk-return measure is the dollar profits (Black 1976; Hartzmark 1984, 1987) These profits are shown in column 3. Unfortunately, this measure does not allow for comparisons across the firms. Therefore, two alternative return measures are presented in columns 4 and 5.

The weekly return in dollars per 1000 bushels is calculated as:

$$(6) \quad [P_{c,t+1} - P_{ct}] + [H_{it} * (P_{f,t+1} - P_{ft})].$$

This standardized return is calculated "as if" the firm is long one bushel in the cash market and adjusts its futures position depending on the relative size of its actual cash and futures positions. A corresponding weekly risk-minimizing return is also calculated for each firm:

$$(7) \quad [P_{c,t+1} - P_{ct}] + [RMH_i * (P_{f,t+1} - P_{ft})].$$

where,  $RMH_i$  = risk-minimizing hedge ratio given in Table 2, column 4.<sup>16</sup>

An alternative performance measure is the return as a percentage of the cash price, and is given as:

$$(8) \quad [(P_{c,t+1} - P_{ct}) + (H_{it} * (P_{f,t+1} - P_{ft}))] / P_{ct}.$$

A corresponding risk-minimizing percentage return is also computed substituting  $RMH_i$  for  $H_{it}$  in the same way as in equation (7).

From these return measures, the mean and the standard deviation of the weekly returns are computed. The statistics for equations (6) and (8) are reported in columns 4 and 5, respectively. In the oats market, 4 (3) of 9 of the firms' mean returns (standard deviations) are significantly different from their respective risk-minimizing mean returns (standard deviations). The

statistical tests do not allow us to reject that TRADER O is an ex post risk-minimizer. For TRADER O, the two risk-minimizing means (with standard deviations in parentheses) are 0.04 (4.68) and 0.05% (2.65%), respectively.

In the wheat market 7 of 11 of the individual firms are not risk-minimizers. However, TRADER W is close enough to the risk-minimizing location that we cannot reject risk-minimizing behavior. For TRADER W, the two risk-minimizing means (with standard deviations in parentheses) are 0.13 (4.98) and 0.03% (1.14%), respectively.

These numerical relationships are shown visually in Figures 4 and 5. In these figures the ex post results for the individual firms are plotted relative to an ex post market-wide risk-return opportunity locus. The opportunity locus is derived using equation (8) and substituting hedge ratios between -2.5 and 3.5 for  $H_{it}$ .<sup>17</sup> All 52 weeks are used to calculate the means and standard deviations of these different hedge ratios. As the locus moves to the northeast the hedge ratios get more negative. The risk-minimizing point is minus one times the hedge ratio given in Table 1.

The oats market is represented in Figure 4. TRADERS A and C are excluded because they distort and compress the opportunity locus. TRADER A lies to the southeast (i.e., has an extremely low-return and high-risk), while TRADER C is found in the northeast (i.e., high-return and high-risk). Certain firms are actually able to achieve a risk-return trade-off that moves them outside the opportunity locus. This is possible since these firms are constantly adjusting their hedge ratios, while the locus is calculated using constant hedge ratios. TRADERS D, G, H, and I all are able to achieve lower standard deviations than the risk-minimizing standard deviation.

The wheat market opportunity locus is shown in figure 5. TRADERS J, M, and T are excluded from the plot. TRADER J is a high-return, high-risk firm,



Figure 4

# EX POST RISK-RETURN TRADEOFF FOR OATS

WITH INDIVIDUAL TRADERS EX POST CHOICE  
JANUARY THROUGH DECEMBER 1980  
(outliers excluded)

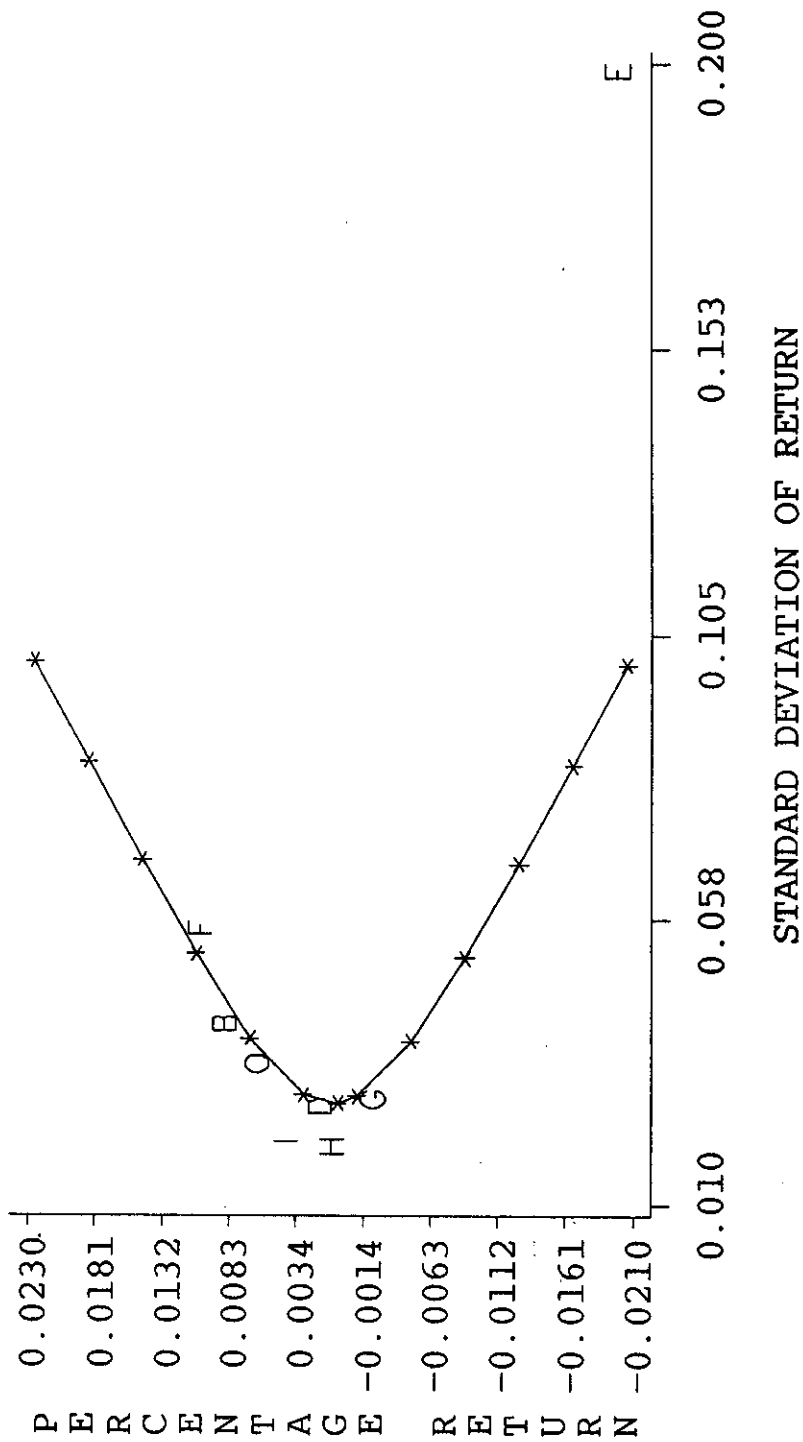
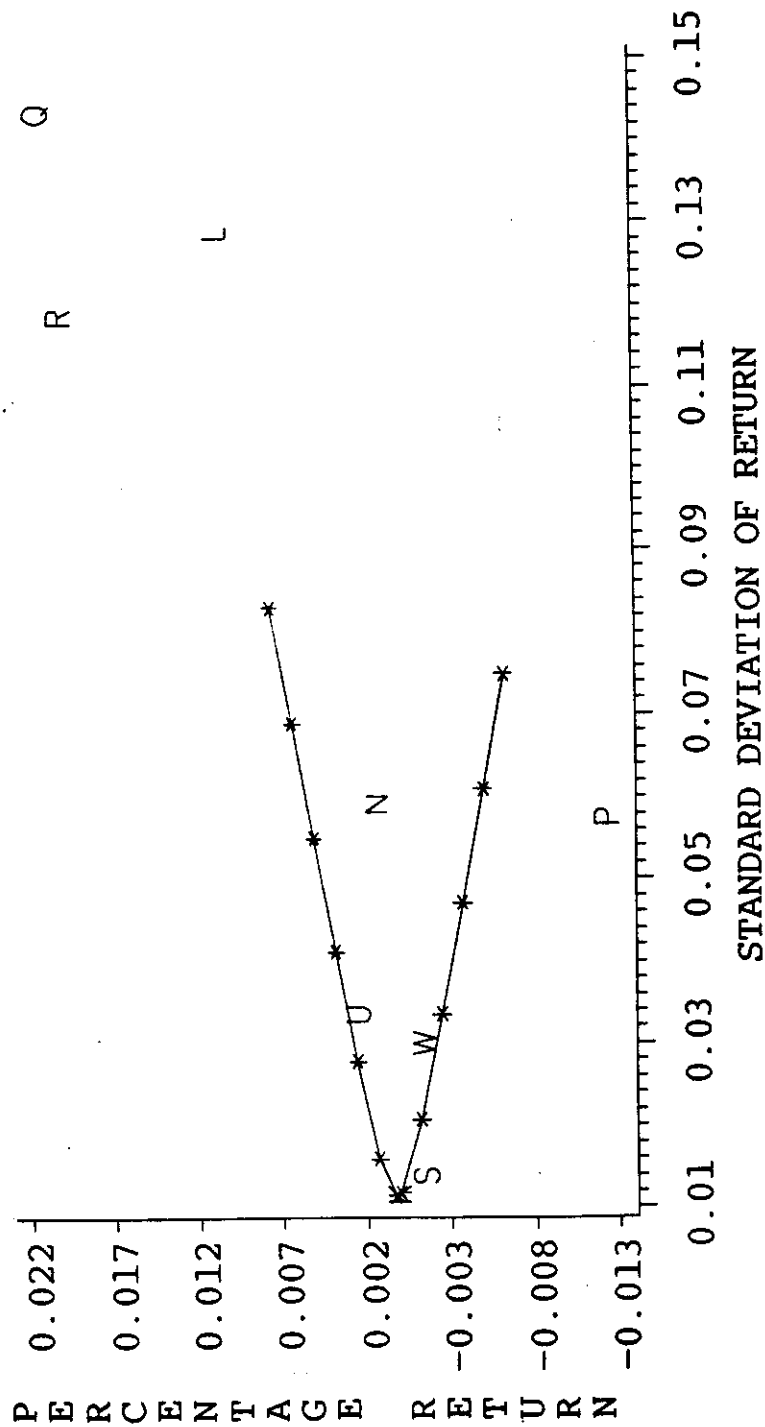


Figure 5

# EX POST RISK-RETURN TRADEOFF FOR WHEAT

WITH INDIVIDUAL TRADERS EX POST CHOICE  
JANUARY THROUGH DECEMBER 1980  
(outliers excluded)



while TRADERS M and T are low-return, high-risk players. TRADER W appears to be inside the opportunity locus, thus earning a lower return than is possible given the same level of risk (=2.99%).

It is obvious from the plots that there are very large confidence intervals for determining whether the mean return and the standard deviation are different from the risk-minimizing levels. In fact, the mean returns and standard deviations for the fully hedged and unhedged positions are not significantly different from the risk-minimizing statistics. For example, in the oats market the 52-week calculations are as follows:

HEDGE RATIO	MEAN RETURN	STD DEVIATION	STD ERROR OF MEAN
RISK-MINIMIZING	0.0453%	2.6509%	0.3742%
FULLY HEDGED ( $H_1 = -1.0$ )	0.1002%	2.8180%	0.3908%
UNHEDGED ( $H_1 = 0.0$ )	0.6828%	3.8011%	0.5271%

The comparisons are similar for the wheat market. Therefore, even though we cannot reject risk-minimizing behavior for half of the firms, as well as for TRADERS O and W, we must realize that the power of the test employed is not very strong. We must also realize that there may be a speculative element that we are unable to account for. On the other hand, it does appear that risk is an important determinant of trader behavior. We should also be careful interpreting the results for TRADERS O and W. Because these traders are market aggregates there may be some diversification effects that cause the variances of the return to be lower than the average of the variances of the individual traders that make up these proxies.

#### ADJUSTED CALCULATIONS OF HEDGE RATIOS AND RETURNS

Exceptionally high and low hedge ratios are observed for a number of the firms. This is especially true for TRADER C. All precautions have been taken to guarantee that the data is clean. Even so, it is impossible to determine

whether the outlying observations are truthful reports or clerical errors. To get some idea of the impact of these outliers, all hedge ratios and risk-return calculations are revised after discarding observations where the absolute value of the hedge ratio is greater than 10 or less than 0.1. These adjusted results are presented in Table 4.

**<<<INSERT TABLE 4 HERE>>>**

Only 13 observations are discarded in the wheat market. However, there are some significant changes. TRADERS J, L, M, Q, and R no longer deviate significantly from the risk-minimizing point. The rest of the outlying firms are only marginally different. No firm's standard deviation is significantly different from the minimum risk standard deviation. In the oats market, only 2 of the 4 deviants remain outside the confidence interval (note that TRADER C has disappeared since fewer than 15 observations remained). However, substantially more observations are deleted.

**CORRELATIONS OF CASH AND FUTURES POSITIONS**

From equations (1) and (2) it is obvious that there is a direct relationship between the cash and the futures positions. This relationship should be closest when there is no speculative demand. Correlations of the cash and futures positions are presented in Tables 2A and 2B. In the wheat market there are high correlations (in absolute value) between the firms' cash and futures positions. All but one of the firms have significance levels exceeding 3% (this aberrant firm's correlation is also positive). In the oats market, there are 3 firms with correlations below -0.90. On the other hand, there are 4 firms with insignificantly low correlations.

It is interesting to note that in the wheat market, where there are fewer ex post risk-minimizers, there are more traders with strong relationships between their cash and futures positions. These high correlations, especially

Table 4

ADJUSTED HEDGE RATIOS AND RETURNS  
FOR THOSE TRADERS WHERE OUTLIERS WERE OBSERVED

<u>Market/ Trader</u>	<u>Observations/ Outliers</u>	<u>Hedge Ratio</u>	<u>Return in \$ per 1000 bu.</u>	<u>Return in % of Cash Price</u>
<u>Oats</u>				
Trader A	35	-0.43	-1.26**	-0.60
	11	(2.39)	(13.83)	(7.06)
Trader B	25	-0.10	2.76	1.63
	12	(0.60)	(6.85)	(3.90)
Trader E	15	-0.82	1.50**	0.76
	22	(3.17)	(17.98)	(10.38)
Trader O	52	-1.63	-1.88	-1.13
	0	(0.75)	(6.97)	(4.12)
<u>Wheat</u>				
Trader J	49	-0.44	0.62	0.18
	2	(1.96)	(22.71)	(5.40)
Trader L	47	0.28	0.26	0.08
	5	(1.68)	(38.84)	(8.82)
Trader M	50	-0.73	1.47	0.36
	1	(0.50)	(8.39)	(1.92)
Trader P	27	-1.91	-5.48*	-1.38*
	1	(1.22)	(23.73)	(5.80)
Trader Q	49	-0.95	0.48	0.10
	1	(0.25)	(6.40)	(1.45)
Trader R	45	-0.39	1.14	0.29
	1	(1.21)	(12.13)	(2.82)
Trader T	47	-0.39	-3.17*	-0.58*
	2	(2.36)	(38.97)	(8.85)
Trader W	52	-0.59	-0.67	-0.17
	0	(0.79)	(12.47)	(2.99)

\* Indicates significance at a 10% probability level.

\*\* Indicates significance at a 1% probability level.

for TRADERS O and W indicate that the hedge demand must be an important element in the overall demands for cash and futures positions. However, the high correlations do not preclude other factors from having influence on the cash and futures demands.

Is there a relationship between the performances of the firms and the correlations of their cash and futures positions? If the results for the two markets are pooled the correlation between the cash-futures correlations and the mean return the firms have is  $-0.341$  (and insignificant). The correlation between the absolute mean return and the cash-futures correlation is significant at a 5% level and equal to  $0.50$ . The correlation of the cash-futures correlation and the variance measure is  $0.38$  (and significant at the 10% level). For the wheat market, these correlations are  $-0.41$  for the return,  $0.58$  (and significant at the 6% level) for the absolute return and  $0.59$  (and significant) for the variance. They are  $-0.28$ ,  $0.48$  and  $0.47$  (and all insignificant) in the oats market, respectively.

The lower the risk the closer the relationship between the cash and futures positions. The closer the relationship between the cash and futures positions the the lower the absolute return. Thus traders with low absolute correlations are either big winners or big losers. This is consistent with the parabolic shape of the risk return opportunity locus. Therefore, the correlation of cash and futures positions, and the variance of the return are both reasonable indicators of the degree of hedging demand and the degree of risk aversion.

## **SECTION V — EXPECTATIONS AND HEDGING**

It is possible to use equations (1) and (2) to extract a measure of the individual trader's expected price changes. The speculative demand is represented by the expected price change deflated by the risk parameter and

the variance of the prices. It can be thought of as the residual demand or the demand after the hedge demand is taken out. Equations (1) and (2) can be rewritten as:

$$(3) \quad EXF_{it} = (P_{if,t+1} - P_{ft})/A_i = [v_{ft} * F_{it}] + [C_{it} * v_{cft}]; \text{ and}$$

$$(4) \quad EXC_{it} = (P_{ic,t+1} - P_{ct})/A_i = [v_{ct} * C_{it}] + [F_{it} * v_{cft}]; \text{ where}$$

$EXF_{it}$  = the trader's expected futures price change between period  $t$  and  $t+1$ ; and

$EXC_{it}$  = the trader's expected cash price change between period  $t$  and  $t+1$ .

In the empirical results I shall assume that all traders have the same estimates of the relevant variances and covariances. Therefore, in equations (3) and (4) the  $i$  subscripts on these terms have been deleted.

If the commercial trader is a risk-minimizer (i.e.,  $A_i$  is very large) or possesses no private information (i.e.,  $P_{if,t+1} = P_{ft}$ ) then  $EXF_{it}$  and  $EXC_{it}$  should equal zero. If  $EXF_{it}$  does not equal zero, then the commercial trader is carrying out some speculative activity. In either case, as will be shown later, it is impossible to separate the price and risk components that makeup  $EXF_{it}$  and  $EXC_{it}$  without some important assumptions.

#### THE ADAPTIVE EXPECTATIONS MODEL

I shall assume that the firm is updating its expectations each week. The expectation (at time  $t$ ) is for the next week's (time  $t+1$ ) price. This is the case for both the cash and futures prices. I shall also assume that firms formulate their expectations adaptively. The adaptive expectations framework suggests that firms revise their price expectations in period  $t$  depending on the magnitude of the prediction error they had for their period  $t-1$  forecast (Maddala 1977). Muth (1961) shows that this type of specification can be considered rational if exogenous shocks today impact on the current period,

as well as later periods. For example, if inventories are being held shocks today will be related to future price changes. It seems reasonable that in agricultural markets like oats and wheat the disturbances will have both permanent and transitory effects. Therefore, an adaptive expectations framework is appropriate. By assuming this structure in the formation of individual trader expectations a great deal more information is extracted from the data.

To save space and avoid duplication the subscripts indicating cash and futures prices are dropped for the moment. The model is the same for either market. The adaptive expectations model is written as:

$$(5) \quad P_{i,t+1} - P_{it} = L * [P_t - P_{it}]; \text{ or}$$

$$(6) \quad P_{i,t+1} = [L * P_t] + [(1 - L) * P_{it}]; \text{ where } L \text{ is the expectation adjustment coefficient.}$$

The price that trader  $i$  expects to observe in period  $t+1$  ( $P_{i,t+1}$ ) is a function of his period  $t-1$  expectation for the price he thought he would observe in period  $t$  ( $P_{it}$ ). In addition, the actual price observed in period  $t$  ( $P_t$ ) affects his price expectation for period  $t+1$ . If the trader overestimates the price in period  $t$  (when he makes his estimate in period  $t-1$ ) then he will revise his expectation downward for the period  $t+1$  price. Or, in other words,  $P_{i,t+1} < P_{it}$  if  $P_t < P_{it}$ .

If both sides of equation (6) are divided by  $A_i$ , we can then manipulate equations (3), (4) and (6) to get an equation to estimate the firm's expected price changes. The expected prices are first written in terms of the expected price changes and the currently observed futures or cash prices:

$$(7) \quad P_{if,t+1} / A_i = EXF_{it} + [P_{ft} / A_i]$$

$$(8) \quad P_{ic,t+1} / A_i = EXC_{it} + [P_{ct} / A_i]$$



Equations (7) and (8) are substituted into equation (6). With a little manipulation we get:

$$(7) \text{EXF}_{it} = [(1-L_{if})/A_i](P_{f,t-1} - P_{ft}) + [(1-L_{if})\text{EXF}_{i,t-1}].$$

$$(8) \text{EXC}_{it} = [(1-L_{ic})/A_i](P_{c,t-1} - P_{ct}) + [(1-L_{ic})\text{EXC}_{i,t-1}];$$

where  $L_{if}$  ( $L_{ic}$ ) is the lagged adjustment coefficient for the futures (cash) prices.  $0 < L_{ic} < 1$  and  $0 < L_{if} < 1$ .

Equations (7) and (8) show that the period  $t$  expected price change is a weighted average of the period  $t-1$  expected price change and the actual price change between periods  $t-1$  and  $t$ . This corresponds directly to the equation (6). However, in equation (6) the variable of interest is the expected price level, not the expected price change.

If the observed change in price (between periods  $t-1$  and  $t$ ) is less than the expected change in price, then the expected change in price between periods  $t$  and  $t+1$  will be positive (or  $P_{if,t+1} > P_{ft}$ ). Alternatively, if the actual change in price is greater than the expected change in price (between periods  $t-1$  and  $t$ ), then the expected change in price between periods  $t$  and  $t+1$  is negative (or  $P_{if,t+1} < P_{ft}$ ). This comes about because it takes time for the expected price to catch up to the actual price given the adjustment coefficient.

#### THE EMPIRICAL RESULTS

To estimate  $L_{ic}$ ,  $L_{if}$  and  $A_i$  a simple regression is run.  $\text{EXC}_{it}$  and  $\text{EXF}_{it}$  are calculated as the residual demand as shown in equations (3) and (4). The futures and cash prices are the observed market prices. Therefore, the OLS regression without an intercept term is specified as:

$$(9) \text{EXF}_{it} = [a_{if}(P_{f,t-1} - P_{ft})] + [b_{if}\text{EXF}_{i,t-1}]; \text{ and}$$

$$(10) \text{EXC}_{it} = [a_{ic}(P_{c,t-1} - P_{ct})] + [b_{ic}\text{EXC}_{i,t-1}]; \text{ where}$$

$$a_{if} = (1-L_{if})/A_{if}$$

$$b_{if} = (1-L_{if})$$

$$a_{ic} = (1-L_{ic})/A_{ic}$$

$$b_{ic} = (1-L_{ic})$$

The results are presented in Tables 5A and 5B. All of the  $b_i$  coefficients are significant at low probability levels. The  $a_i$ 's are varied and are more important (significant) in the oats market. Columns 4 and 9 indicate that the traders adapt their expectations very slowly. The adjustment coefficients (L) for the futures price changes range from 0.04 to 0.30 in oats (-0.08 to 0.57 in wheat). The cash adjustment coefficients range from -0.01 to 0.21 in oats (0.01 to 0.45 in wheat). The magnitudes of the cash and futures lag adjustment coefficients are quite similar.

**<<<INSERT TABLES 5A AND 5B HERE>>>**

The correlations between  $L_{ic}$  and  $L_{if}$  across all traders are 0.83 in oats, 0.74 in wheat and 0.75 in the markets combined. These correlations are all significant at the 1% level. Therefore, the traders adjust their price expectations in similar ways in the futures and cash markets. One would expect this given that information impacts on the markets in similar ways.

The risk preference parameters appear to differ between the cash and futures specifications. However, the correlations between  $a_{ic}$  and  $a_{if}$  across all traders are 0.69 in oats, 0.50 in wheat, and 0.47 when the two markets are combined. Only the correlation between the  $a$ 's in the wheat market is not significant at the 5% level. In addition, when both  $a_{if}$  and  $a_{ic}$  are significant  $A_{ic}$  and  $A_{if}$  are not very different. In general, because most of the  $a$ 's are not statistically significant one should be careful in assessing the values of the risk parameters. Eight of nine of the individual oat traders appear to be risk-lovers from the futures regressions. Seven of nine

Table 5A

## RESULTS OF FUTURES AND CASH PRICE REGRESSIONS FOR OATS MARKET

(Dependent variables are expected changes in prices)

Trader/ Degrees of Freedom	E(Futures Price Change)					E(Cash Price Change)				
	Mean $\times 10^4$	$\Delta P$ $\times 10^3$	Lagged E( $\Delta P$ )	L/ $A \times 10^{-4}$	R- square	Mean $\times 10^4$	$\Delta P$ $\times 10^3$	Lagged E( $\Delta P$ )	L/ $A \times 10^{-4}$	R- square
Trader A 41	3.97 (1.55)	0.37 (0.21)	0.81 (7.69)	0.19 -5.05	0.61	6.67 (1.93)	3.68 (2.29)	0.91 (11.76)	0.09 -0.25	0.78
Trader B 30	2.48 (0.53)	1.02 (2.16)	0.84 (9.75)	0.16 -1.55	0.77	5.26 (1.23)	2.50 (3.20)	0.90 (12.51)	0.10 -0.41	0.85
Trader C 16	-1.77 (0.20)	1.04 (3.65)	0.96 (14.18)	0.04 -0.39	0.94	-0.79 (0.10)	0.41 (2.25)	0.94 (9.76)	0.06 -1.36	0.87
Trader D 45	3.03 (0.78)	1.84 (2.93)	0.91 (14.09)	0.09 -0.48	0.83	10.16 (1.85)	2.73 (2.33)	0.93 (19.32)	0.07 -0.26	0.90
Trader E 34	308.47 (84.95)	-44.72 (-0.54)	0.79 (7.78)	0.21 0.05	0.66	764.02 (230.48)	-37.23 (-0.20)	0.82 (9.19)	0.18 0.05	0.73
Trader F 43	7.52 (2.26)	5.87 (3.78)	0.93 (16.16)	0.07 -0.12	0.87	24.28 (4.37)	9.42 (3.95)	0.94 (22.37)	0.06 -0.06	0.93
Trader G 44	-0.43 (0.20)	0.28 (2.01)	0.94 (14.88)	0.06 -2.29	0.84	1.91 (0.43)	0.75 (3.31)	0.93 (20.92)	0.07 -0.89	0.91
Trader H 9	3.57 (0.90)	1.16 (1.06)	0.99 (5.77)	0.01 -0.05	0.87	14.20 (2.60)	2.32 (1.09)	1.01 (13.10)	-0.01 0.03	0.96
Trader I 16	0.19 (0.16)	0.16 (1.50)	0.85 (7.62)	0.15 -9.68	0.81	1.69 (0.36)	0.36 (1.67)	0.93 (11.68)	0.07 -2.00	0.91
Trader O 52	234.77 (64.59)	-25.77 (-0.31)	0.70 (6.67)	0.30 0.27	0.48	591.70 (176.07)	111.74 (0.66)	0.79 (9.26)	0.21 -0.07	0.65
Trader O' 52	13.61 (3.87)	6.85 (2.51)	0.93 (16.21)	0.07 -1.36	0.84	44.55 (8.57)	16.44 (3.21)	0.93 (19.63)	0.07 -0.57	0.89

t-statistics in parentheses, except for means where standard errors are in parentheses.

Table 5B

## RESULTS OF FUTURES AND CASH PRICE REGRESSIONS FOR WHEAT MARKET

(Dependent variables are expected changes in prices)

Trader/ Degrees of Freedom	E(Futures Price Change)					E(Cash Price Change)				
	Mean $\times 10^4$	$\Delta P$ $\times 10^3$	Lagged E( $\Delta P$ )	L/ $A \times 10^{-4}$	R- square	Mean $\times 10^4$	$\Delta P$ $\times 10^3$	Lagged E( $\Delta P$ )	L/ $A \times 10^{-4}$	R- square
Trader J 49	-8.30 (1.93)	4.89 (0.33)	0.67 (6.09)	0.33 -0.68	0.44	-6.62 (2.42)	-5.02 (-0.27)	0.55 (4.50)	0.45 0.90	0.30
Trader K 41	0.50 (0.80)	5.03 (1.31)	0.88 (10.68)	0.12 -0.23	0.75	7.61 (1.16)	7.02 (1.43)	0.95 (18.03)	0.05 -0.06	0.89
Trader L 51	42.81 (7.97)	-2.61 (-0.11)	1.03 (21.46)	-0.03 -0.13	0.90	56.98 (11.91)	67.76 (2.43)	0.98 (24.67)	0.02 -0.00	0.93
Trader M 49	1.15 (1.00)	4.40 (0.53)	0.45 (2.37)	0.55 -1.24	0.11	7.15 (0.92)	0.53 (0.07)	0.84 (8.54)	0.16 -2.99	0.61
Trader N 45	16.75 (2.04)	-7.93 (-0.80)	0.95 (16.66)	0.05 0.06	0.87	17.22 (1.92)	5.26 (0.75)	0.97 (21.68)	0.03 -0.06	0.92
Trader P 27	-1.43 (0.46)	3.52 (1.38)	0.83 (6.75)	0.17 -0.50	0.65	0.01 (0.45)	2.76 (1.73)	0.82 (7.99)	0.18 -0.64	0.72
Trader Q 47	-1.35 (1.39)	3.87 (0.34)	0.43 (3.07)	0.57 -1.49	0.17	9.93 (2.02)	6.12 (0.37)	0.64 (5.57)	0.36 -0.59	0.41
Trader R 40	18.54 (5.31)	9.73 (0.36)	0.84 (10.42)	0.16 -0.16	0.75	37.23 (9.52)	54.63 (1.61)	0.97 (17.11)	0.03 -0.01	0.89
Trader S 49	-0.97 (0.33)	3.31 (2.55)	1.08 (14.85)	-0.08 0.23	0.82	1.62 (0.46)	2.05 (1.31)	0.94 (15.37)	0.06 -0.28	0.84
Trader T 45	-7.86 (1.50)	7.15 (1.70)	1.05 (20.98)	-0.05 0.07	0.91	-6.72 (1.16)	4.27 (1.15)	0.99 (18.47)	0.01 -0.01	0.90
Trader U 32	11.98 (1.84)	5.79 (0.82)	0.94 (16.07)	0.06 -0.11	0.90	16.88 (3.35)	23.00 (2.06)	0.96 (17.01)	0.04 -0.02	0.91
Trader W 52	54.70 (14.20)	35.97 (0.58)	0.98 (14.29)	0.02 -0.27	0.81	115.57 (23.48)	173.22 (2.27)	0.97 (20.88)	0.03 -0.06	0.90

t-statistics in parentheses, except for means where standard errors are in parentheses.

are risk-lovers from the cash regressions. In the wheat market the corresponding figures are eight of eleven for futures and ten of eleven for cash. Only TRADER O's futures regression indicates that he might be risk-averse.

The means of the expected price changes are given in columns 1 and 6 in the tables. Most traders have expectations that are significantly different from zero. For the most part the expectations are for rising prices, although a few traders expected falling prices. Therefore, it does appear that there is some speculative activity. The traders that have the highest lag adjustment coefficients appear to have the lowest ratios of the means to their standard errors. This is consistent with the fact that these traders are more flexible in adjusting their expectations. Therefore, they have more volatile expected price change series.

## **SECTION V — SUMMARY AND CONCLUSIONS**

The results on the ex post risk-return performance of individual firms do not allow us to reject the mean-variance framework of modeling individual firm behavior. This means that the risk-aversion assumption is valid. Many firms fit the description of risk-minimizers. Many firms adjust their cash and futures positions in concert. This is also observed with the simple correlations. Unfortunately, because the tests presented are not that powerful, it is also impossible to reject many other types of behavior and specifications of the utility functions.

Traders do not appear to quickly adapt their expectations to changing market conditions. This may indicate that they are not really doing much speculation. Instead hedging dominates. This observation corresponds with the results that indicate that traders can be considered risk-minimizers. The signs of the risk preference coefficients suggest that these traders may not

be risk averse. In addition, they almost all have expected price changes that are nonzero. Therefore, these firms are not pure hedgers, but more like selective hedgers.

Even though these commercial firms enter futures markets mostly to hedge their price risks, it does not mean that there is a risk premium implicit in futures prices. The pure speculative side of the market is not included in this analysis. There could easily be a sufficient number of speculators such that the risk premium is bid to zero. Alternatively, there could be so much information trading by speculators that the risk premium is dwarfed by the differences in price expectations.

Overall, the commercial traders in this sample fit the textbook description of hedgers fairly well. There are some outliers who appear to do extremely well or extremely poorly (in dollar terms). Unfortunately, information about the characteristics of these traders is unavailable. Therefore, we are unable to determine whether the trading behavior of the firms is due to any observable features of the participants.

In general, this paper shows how difficult it is to use even the most detailed data. Generalizing from the behavior of individual firms is questionable. In this case it is also difficult to generalize the results of the market as a whole. Risk appears to be a very important explanatory factor. However, the unexplained portion of the firms' observed trading behavior is too large to assume that risk is the whole story.

## REFERENCES

- Anderson, Ronald W.; and Danthine Jean-Pierre. "Cross-Hedging." The Journal of Political Economy 89 (1981):1182-1196.
- Blau, Gerda. "Some Aspects of the Theory of Futures Trading." The Review of Economic Studies 12 (1944-45):1-30.
- Black, Fischer. "The Pricing of Commodity Contracts." The Journal of Financial Economics 3 (January/March 1976):167-79.
- Chicago Board of Trade. 1980 Statistical Annual Cash and Futures Data. Chicago: Board of Trade of The City of Chicago 1981.
- Cootner, Paul H. "Returns to Speculators: Telser versus Keynes." The Journal of Political Economy 68 (August 1960):396-404.
- \_\_\_\_\_. "Rejoinder." The Journal of Political Economy 68 (August 1960):415-418.
- Ederington, L. "The Hedging Performance of the New Futures Markets." Journal of Finance 34 (March 1979): .
- Hardy, C.O. Risk and Risk Bearing. Chicago: University of Chicago Press 1923.
- Hartzmark, Michael L. "The Distribution Of Large Trader Returns In Futures Markets: Theory and Evidence." Ph.D. Dissertation, University of Chicago, 1984.
- \_\_\_\_\_. "Returns to Individual Traders of Futures: Aggregate Results." The Journal of Political Economy (forthcoming, 1987).
- Hicks, J. R. Value and Capital. 2d ed. Oxford: Oxford University Press, 1978.
- Johnson, Leland. "The Theory of Hedging and Speculation in Commodity Futures." Review of Economic Studies 27 (1960):139-151.
- Kaldor, Nicholas. "Speculation and Economic Stability." Review of Economic Studies 7 (1939):1-27.
- Kansas City Board of Trade. Annual Statistical Report for 1980. Kansas City: Board of Trade of Kansas City, 1981.
- Keynes, J. M. A Treatise on Money. Vol. 2. London: Macmillan, 1930.
- Maddala, G. S. Econometrics. New York: McGraw-Hill, 1977.
- Minneapolis Grain Exchange. Ninety-Eighth Annual Report. Minneapolis: Minneapolis Grain Exchange, 1981.
- Muth J. "Rational Expectations and the Theory of Price Movements." Econometrica 29 (July 1961): .

Rockwell, Charles S. "Profits, Normal Backwardation, and Forecasting in Commodity Futures." Ph.D. dissertation, University of California, Berkeley, 1964.

\_\_\_\_\_. "Normal Backwardation, Forecasting, and the Returns to Commodity Futures Traders." In Selected Writings on Futures Markets. Vol. 2. Edited by A. E. Peck. Chicago: Board of Trade of the City of Chicago, 1977.

Stein, Jerome. "The Simultaneous Determination of Spot and Futures Prices." American Economic Review. 51 (1961):1012-1025.

Telser, Lester G. "Futures Trading and the Storage of Cotton and Wheat." Journal of Political Economy 66 (1958):233-255.

\_\_\_\_\_. "Reply." Journal of Political Economy 68 (August 1960):404-415.

\_\_\_\_\_. "The Supply of Speculative Services In Wheat, Corn and Soybeans." Food Research Institute Studies 7 (SUPP 1967):131-176.

\_\_\_\_\_. "Why There Are Organized Futures Markets." The Journal of Law and Economics 24 (1981):1-22.

\_\_\_\_\_. "Futures and Actuals Markets: How They Are Related." The Journal of Business 59 (April 1986):S5-S20.

Williams, Jeffrey C. The Economic Function of Futures Markets. New York, NY: Cambridge University Press, 1986.



## FOOTNOTES

<sup>1</sup> Commercial firms are futures market participants whose line of business is in the related cash market. They have commitments to buy and sell in both the cash and futures market. Cash commitments are in either the spot or forward markets. At certain times, these firms wish to hedge their unbalanced, fixed price forward cash commitments, as well as the spot inventories that they hold.

<sup>2</sup> This firm has a utility function defined as the expected profits minus the coefficient of risk preference times the variance of profits. There is no output uncertainty in the model. Output uncertainty is probably not important for the firms in my sample. These firms are mostly handlers.

<sup>3</sup> If all firms have homogeneous price expectations and these are perfectly reflected in the market price for a futures contract, there will be no speculative demand. If there is a risk premium implicit in the market price that causes it to differ from the homogeneous price expectation then the firms will engage in some speculative activity. If the firms are assumed to be risk-neutral and can borrow as much as they want at a constant rate then the cash (futures) demand is infinitely elastic anytime  $P_{ct}$  ( $P_{ft}$ ) does not equal  $P_{ic,t+1}$  ( $P_{if,t+1}$ ).

<sup>4</sup> The firms report positions in the actual commodity, as well as other related products. Most firms had only a small proportion of their cash commitments in other related products.

<sup>5</sup> Large traders are futures market participants who hold positions in excess of a given level specified by the CFTC. For the oats market this means holding more than 40 contracts (in any or all maturity month combined). Since the cash market data represents one observation per week, only one observation per week is taken from the daily large trader futures database.

<sup>6</sup> The positions are aggregated because I am unable to match specific cash positions with futures positions. I consider aggregation to be the most reasonable and cost-effective method. In addition, to do analysis on all the futures positions mean a very substantial expansion in the size of the database.

<sup>7</sup> If there is a holiday on the Friday, the prices on the previous trading day are used to value all commitments.

<sup>8</sup> The CBT oats price comes from the MGE yearbook and represents No. 2 heavy oats in Minneapolis. The CBT wheat price represents No. 2 soft red winter wheat in Chicago. The MGE wheat price represents 14% protein divd. wheat in Minneapolis. The KBT wheat price represents the mean of the high-low range for No. 2 hard and dark wheat in Kansas City.

<sup>9</sup> This is especially true in the oats market where the close cash price is 36% greater than the open price. This is due to the small harvest of oats in 1980.

<sup>10</sup>In figure 3, the prices are weekly means calculated by averaging the prices on the three markets.

<sup>11</sup>For MGE the ratio is significantly different from one at the 0.01 probability level.

<sup>12</sup>It is not clear whether missing observations on the cash positions are because the firm has no fixed price commitments, or it fails to report, or the report is lost. For most traders it is unlikely that the cash commitments fall to zero given that they have substantial commitments in weeks prior to and after the missing observation. The missing futures observation may appear because the trader has fallen below the reporting level for that week. Since the trader can be below the reporting level and may still hold substantial futures positions, I felt it best to discard any questionable observations.

<sup>13</sup>A ratio of minus one refers to a fully hedged position, a ratio below this level is an overhedged position, a ratio of zero is an unhedged position and a positive ratio represents a "Texas" hedge (i.e., positions on the same side in both the cash and futures markets).

<sup>14</sup>TRADER C with the hedge ratio of -181.54 stands out like a sore thumb throughout this paper. My feeling is that they misreported their cash positions by a factor of 100. However, they may simply be heavy speculators in the futures market.

<sup>15</sup>This is the case whether the cash position is net long or net short (although most traders are long in the cash market). No accounting for costs-of-carry are made in this paper.

<sup>16</sup>Notice that  $RMH_1$  is assumed to remain constant for all 52 weeks. An alternative method would have allowed  $RMH_1$  to vary such that profits each week are zero (and thus the variance of the returns would be zero). However, this method would be extreme in its assumptions about perfect foresight.

<sup>17</sup>The stars represent hedge ratios between -2.5 and 3.5. For both the oats and wheat market, the star above the risk-minimizing point is for a ratio of -0.5. The next is for 0.0. The next is for 0.5, etc. The star below the risk-minimizing point is for -1.0. The next star is for -1.5, etc.