Impact of the Price Adjustment Process and Trading Noise on Return Patterns of Grain Futures

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INTRODUCTION

Serial dependence in commodity futures price changes is a general finding of previous studies. Working (1954, 1967) suggests that both intraday and interday tendencies toward negative serial dependence in price changes are caused by the trading activity of scalpers who buy futures during a dip in prices and sell during a bulge. Gray (1979), Trevino and Martell (1984), and Brorsen and Nielsen (1986) also argue that negative dependence in intraday price movements reflects the presence of efficient market-making, or scalping, in a futures market. Gray (1979) further explains that price reversals due to scalping competition do not reflect any change in real price.

Recent microstructure analysis recognizes the interaction among market participants, trading mechanisms, and the dynamic behavior of commodity prices. Real world trading is impeded by frictions (i.e., information, decision, and transaction costs). Therefore, market outcomes are dependent on institutional arrangements, and observed trading prices differ from underlying equilibrium values that would prevail in frictionless surroundings.[1] Markets may be portrayed by general processes that allow a finite period of adjustment and transactions at current (nonequilibrium) market prices.

Noise trading is one of the factors that has an impact on the price adjustment process. Noise trading is different from information trading, and is essential to the existence of liquid markets (Black, 1986). Noise trading includes both market-making (scalping in futures markets) which services the transitory liquidity needs of

[1]Three major types of price-adjustment delays caused by institutional factors are discussed by Cohen, Maier, Schwartz, and Whitcomb (CMSW) (1986, p. 114): (1) transaction price adjustments lag quotation price adjustments; (2) specialist-dealers impede quotation price adjustments; and (3) quotation price adjustment lags for individual traders.

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traders and investors, as well as trading that results from errors in the analysis and interpretation of information (i.e., the inability of market participants to accurately recognize market forces). De Long, Shleifer, Summers, and Waldmann (1989) try to assess the welfare effects and incidence of noise trading. They demonstrate that the additional risk generated by noise trading can reduce the capital stock and consumption of the economy, and that part of that cost may be borne by rational investors.

In Amihud and Mendelson's (1987) price adjustment model, the influence of the price adjustment process and trading noise on the sign of the first-order autocorrelation coefficient in security returns is explored. As shown below, the contribution of trading noise to the first-order autocorrelation is always negative, whereas the contribution of the adjustment process depends on whether prices partially or overly adjust to their equilibrium values. Consequently, the first-order autocorrelation coefficient and the price adjustment factor together can indicate whether trading noise or the price adjustment process resulting from information trading has a larger impact on return patterns of commodity futures.

The objectives of this research are to: (1) derive an ARIMA model from the specifications of the Amihud–Mendelson model; (2) identify the price adjustment process in grain futures contracts across various time intervals by using an ARMA (1, 1) estimation approach implicit in Amihud–Mendelson's model; (3) investigate the first-order autocorrelation patterns of return series of grain futures; and (4) analyze the relative importance of trading noise and price adjustment in explaining return behavior across various time intervals in grain futures using the relationships developed in Amihud–Mendelson's model.[2]

This analysis will allow an assessment of the relative impact of market-making on price behavior across time intervals of different lengths in grain futures markets. It is expected that the effect of market-making will be most pronounced over shorter time intervals (e.g., on a tick-to-tick basis) rather than over longer time intervals (e.g., daily) because the function of market-makers, which is to provide immediate liquidity, is most salient over shorter time intervals. This analysis will also address the issue of price adjustment across various time intervals in grain futures. In a study by Liu and Thompson (1990), the price adjustment process is analyzed to investigate the efficiency of these markets.

MODELS AND DATA

It is assumed in this study that the time path of underlying equilibrium values of grain futures follows a lognormal distribution, and that observed futures prices adjust continuously toward their current equilibrium values. Although it is unknown how far away an observed price is from its equilibrium value, the farther the price of a grain futures moves from its value, the faster it will tend to move back [Black (1986)]. Let V_t be the true price (value) of a grain futures contract in a frictionless environment at time t, and P_t the observed price. For the purpose of simplicity, both V_t and P_t are in logarithm forms. Then, the observed return is defined by $R_t = P_t - P_{t-1}$.

Following Amihud–Mendelson's price adjustment model, the difference between V_t and P_t is attributable to noise. The relationship among the true value, observed price, and noise is described by eq. (1).

$$P_t - P_{t-1} = g \cdot [V_t - P_{t-1}] + u_t \tag{1}$$

[2]Amihud and Mendelson estimate an ARMA (1, 1) model as a test for efficiency without directly linking this empirical test to their price adjustment model.

where g is the price adjustment coefficient, satisfying $0 < g < 2$, and, u_t is a "white noise" sequence of i.i.d. random variables with zero mean and finite variance σ^2. That g has a value between 0 and 2 is implicit in the model and is shown later. The adjustment coefficient, g, captures the effect of friction factors, which make the observed price deviate from its value in the real world market. When $g = 0$, observed price movements are unrelated to changes in underlying value. $0 < g < 1$ represents partial price adjustment, and $g > 1$ represents over-reaction of the market. A unit adjustment coefficient ($g = 1$) reflects full price adjustment despite noise, and $P_t = V_t + u_t$.

Suppose the logarithms of commodity futures value conform to a random walk process as follows.

$$V_t = V_{t-1} + e_t + m \tag{2}$$

where m is the expected return drift and e_t is an i.i.d. random variable, independent of u_t, with zero mean and finite variance v^2. Usually, m is assumed equal to zero for commodity futures return [Black (1976)]. The assumption that m is equal to zero will also be made here.

The first-order autocovariance and the first-order autocorrelation coefficient of observed returns based on Amihud–Mendelson's model from eqs. (1) and (2) are shown by eqs. (3) and (4), respectively.

$$\text{Cov}(R_t, R_{t-1}) = \frac{g}{2 - g}[(1 - g)v^2 - \sigma^2] \tag{3}$$

$$\text{Corr}(R_t, R_{t-1}) = \frac{g(1 - g)v^2 - g\sigma^2}{gv^2 + 2\sigma^2} \tag{4}$$

The sign of the first-order autocorrelation coefficient, r_1, is determined by both the adjustment process and the noise. Since the sign of the denominator in (4) is always positive, the sign of r_1 is determined by the relative magnitudes of $(1 - g)v^2$ and σ^2. The contribution of the noise to r_1 is always negative, whereas the contribution of the adjustment process depends on the magnitude of g. Put another way, r_1 is negative when the noise return variance exceeds the value return variance weighted by $1 - g$. Partial price adjustment ($g < 1$) contributes positively to r_1 through the value return variance. When the market over-reacts ($g > 1$), v^2 contributes negatively, and r_1 is negative. An immediate (or near immediate) price adjustment process is associated with $r_1 < 0$. In the special case of $g = 1$, r_1 equals the relative weight of the noise variance in the total return variance. Finally, when $r_1 = 0$, noise variance equals the value return variance weighted by $1 - g$. If g is also near one (g should not exceed 1, since σ^2 must be ≥ 0), then the noise variance must approximately equal zero.

A Box–Jenkins-type ARMA (1, 1) model of the return series may be built based on Amihud–Mendelson's model from eqs. (1) and (2). Eq. (1) can be rewritten as: $[1 - (1 - g)B]P_t = gV_t + u_t$, where B is a backward operator. Eqs. (1) and (2) are combined to form:

$$[1 - (1 - g)B]P_{t-1} = gV_{t-1} + u_{t-1} \tag{5}$$

and

$$[1 - (1 - g)B](1 - B)P_t = ge_t + gm + u_t - u_{t-1} \tag{6}$$

As stated earlier, m is assumed equal to zero. Then, from (5) and (6), one obtains

$$[1 - (1 - g)B]R_t = ge_t + u_t - u_{t-1}. \tag{7}$$

Since the terms on the right-hand side of eq. (7) are composed of noise of present and previous periods, they can be described by a moving-average process. Eq. (7), therefore, can be rewritten as an ARMA (1, 1) process:

$$[1 - (1 - g)B]R_t = \mu_t - b\mu_{t-1}, \tag{8}$$

where μ_t is a white noise.[3]

The constraint for g, $0 < g < 2$, in Amihud–Mendelson's model is implicit in the associated ARMA (1, 1) process. If g is greater than 2 or less than 0, the absolute value of $(1 - g)$ is greater than 1, and the ARMA (1, 1) process is explosive [Granger and Newbold (1986, p. 39)]. In other words, the observed prices of grain futures will increasingly deviate from their underlying equilibrium, and never adjust or converge to equilibrium.

Eq. (8) will be employed to estimate the price adjustment factor for grain futures to consider the interaction among unobserved value returns, observed returns, and trading noise. Daily closing prices and intraday tick prices for all corn, wheat, oats, soybeans, soybean meal, and soybean oil futures contracts expiring in 1986 traded on the CBOT are analyzed. The intervals over which returns are considered are: daily return series generated from closing prices; and half-hour, 15-minute, five-minute, and tick return series generated from intraday prices. Daily futures returns are the differences of log closing prices.[4] The intraday return series exclude opening and/or closing prices ranges. No overnight changes are included in the intraday return series.

To examine whether the behavior of returns differs in contracts near and distant from maturity, two observation periods, one near and one distant, are analyzed for each contract. The length of the observation period for each return series is determined by the sample size (the number of observations). For tick and five-minute data, "near" is one month from maturity and "distant" is five months; for quarter-hour data, near is one to two months and distant is five to six months; for half-hour data, near is one to three months and distant is five to seven months; and for daily returns, near is one to four months and distant is five to 12 months from maturity. In the daily return series, observations from some of the contracts analyzed are from overlapping time periods.[5]

It is expected that the returns based on tick data, especially in the near maturity period, are more significantly affected by trading noise than by the price adjustment process because of heavy market-making activities of scalpers. The influence of

[3] For another example of this type of derivation of an ARMA (1, 1) model, see sections 1–8 of Granger and Newbold (1986).

[4] For intraday series, say the quarter-hour series, prices are recorded at each 15-minute interval from 9:45 AM to 1:00 PM for each trading day. Then, returns are computed. If no price is recorded exactly at the ending points of the time intervals, tick prices within a selected range and nearest to the ending points are used. If prices still cannot be found within the selected range of an ending point, a zero return is assigned to that point. The return for the next period is calculated from the ending point of the previous nonzero return.

[5] The amount of overlap in the near daily return series, which are four months in length, ranges between one and three months in adjacent series. For corn, wheat, and oats, only nearby adjacent series overlap (e.g., observations for the May contract taken between January and April of 1986 overlaps by two months, observations for the July contract taken between March and June of 1986). In the soybean complex, the amount of overlap in nearby contracts is more extensive, since several contracts mature in adjacent months (e.g., observations for the July, August, and September contracts are taken from four-month periods between March and August of 1986).

The amount of overlap in the distant daily return series, which are eight months in length, ranges between five and seven months in adjacent series. Because the series are longer, there is overlap across a number of series, particularly those from the soybean complex.

The overlap in the daily return series implies that these samples are not strictly independent. Thus, results from the daily return series may not be robust and should be interpreted with caution.

trading noise and the price adjustment process on return patterns of other time interval series, and the under-estimation or over-reaction of price adjustment, are empirical issues.

RESULTS

Eq. (8) suggests that the price adjustment estimate can be acquired from the coefficient estimate of the AR coefficient estimate of an ARMA (1, 1) process. If a_1 is the estimated AR coefficient of the process shown in eq. (8) for a return series, then the implied price adjustment estimate (g) for the series is $(1 - a_1)$, and the standard error of g is the standard error of a_1 in the series. Each return series will yield a price adjustment estimate under ARMA estimation, since an ARMA (1, 1) process can be built with every series. Significance of the estimated AR coefficients indicates a deviation of the price process from a frictionless instantaneous adjustment ($g = 1$). The price adjustment estimate is near 1 if its counterpart, a_1, is not significantly different from zero.

To investigate the impact of the price adjustment process and noise trading on the first-order autocorrelation of grain futures returns, average first-order autocorrelation coefficients and price adjustment estimates for various time interval groups are matched in Table I along with average number of observations for each type of return series.[6] Price adjustment estimates and autocorrelation coefficients for each interval group are calculated separately for periods near and distant from maturity. Percentages of r_1 that are statistically significant within a time interval group are also presented in Table I. The percentages are calculated by dividing the number of significant coefficients by the number of near or distant series (i.e., the number of total contracts) within a time interval group. As another check on the representativeness of the average values of r_1 presented for each group in Table I, Fisher's combined test statistic is calculated for each average value of r_1. In all cases *except* the near five-minute and daily return series in wheat, the average values of r_1 are representative of the values of r_1 estimated for the individual return series in each group.[7] Moreover, in the majority of instances, when statistically significant, values of r_1 are negative. Exceptions to this general finding are noted in Table I.

The price adjustment estimates for each time interval return group presented in Table I are calculated by taking the mean of $g = (1 - a_1)$ from the ARMA estimates for each return series analyzed when a_1 is significant, and $g = 1$ when a_1 is insignificant in a series. A 95% confidence interval for each estimated g can be built by using the estimate, standard error of g [i.e., the standard error of the estimated AR (1) coefficient], and an appropriate t-value. The average confidence interval for a time interval group provides the upper and lower bound for the representative price adjustment estimate. These confidence intervals and their implications for pricing efficiency are discussed in Liu and Thompson (1990).

[6]Complete price adjustment estimates obtained from the ARMA (1, 1) process for each grain futures contract are not presented due to page constraints, but are available from the authors.

[7]Fisher's statistic is computed as follows:

$$X^2 = \sum_{i=1}^{k} \frac{(\text{difference between observed and expected values})^2}{\text{expected value}}$$

where k is the number of classes and $n(= k - 1)$ is the degrees of freedom. The expected value equals the average of all observed values. See Fisher (1970, pp. 78–85).

Table I
AVERAGE FIRST ORDER AUTOCORRELATION COEFFICIENTS AND PRICE ADJUSTMENT ESTIMATES FOR VARIOUS TIME INTERVAL GROUPS ACROSS GRAIN FUTURES MARKETS

	Tick Return	Five-Minute Intraday Return	Quarter-Hour Intraday Return	Half-Hour Intraday Return	Daily Return
Corn					
Distant period					
Ave. obs.	2568	835	546	379	173
r_1	−0.419	−0.055	−0.016	−0.034	0.049
	(100%)[a]	(20%)	(20%)	(0%)	(0%)
g	1.486	0.584	0.879	0.609	1.665
	(0.050)[b]	(0.212)	(0.518)	(0.320)	(0.224)
Near period					
Ave. obs.	3598	796	546	377	87
r_1	−0.572	−0.090	−0.104	−0.012	0.064
	(100%)	(80%)	(60%)	(0%)	(0%)
g	1.556	0.648	0.816	1.033	1.813
	(0.026)	(0.221)	(0.273)	(0.531)	(0.146)
Wheat					
Distant period					
Ave. obs.	2954	835	546	379	173
r_1	−0.134	0.067	0.025	−0.024	0.126
	(80%)	(20%)	(0%)	(20%)	(20%)
g	0.956	1.123	0.914	1.116	1.089
	(0.186)	(0.395)	(0.880)	(0.255)	(0.414)
Near period					
Ave. obs.	4173	796	546	377	87
r_1	−0.211	0.001[c]	−0.025	−0.029	0.004
	(100%)	(40%)	(20%)	(20%)	(0%)
g	1.251	0.785	0.947	0.984	1.096
	(0.079)	(0.130)	(0.471)	(0.409)	(0.247)
Oats					
Distant period					
Ave. obs.	187	819	536	353	149
r_1	0.014[d]	−0.018	−0.009	−0.039	0.131
	(40%)	(20%)	(0%)	(20%)	(40%)
g	1.031	1.192	0.434	0.817	1.242
	(0.232)	(0.516)	(0.300)	(0.326)	(0.140)
Near period					
Ave. obs.	484	788	543	376	87
r_1	−0.016[e]	0.028	0.014	0.019	0.080
	(60%)	(20%)	(0%)	(0%)	(0%)
g	0.741	0.813	1.010	1.426	1.353
	(0.436)	(0.550)	(0.363)	(0.242)	(19.1)
Soybeans					
Distant period					
Ave. obs.	3387	825	542	378	173

Table I (continued)

	Tick Return	Five-Minute Intraday Return	Quarter-Hour Intraday Return	Half-Hour Intraday Return	Daily Return
r_1	−0.036[f]	0.028	−0.042	−0.025	−0.042
	(71%)	(29%)	(14%)	(29%)	(0%)
g	0.915	0.743	1.113	1.088	0.827
	(0.198)	(0.670)	(0.746)	(0.392)	(0.266)
Near period					
Ave. obs.	7317	830	550	381	88
r_1	−0.265	−0.025[g]	−0.086	−0.065	−0.060
	(86%)	(43%)	(29%)	(29%)	(0%)
g	1.355	0.951	0.640	1.138	0.282
	(0.057)	(0.355)	(0.236)	(0.663)	(0.273)
Soybean meal					
Distant period					
Ave. obs.	1242	829	546	377	170
r_1	−0.102	−0.018	−0.040	−0.035	−0.041
	(63%)	(13%)	(13%)	(13%)	(13%)
g	0.922	1.374	0.839	1.225	1.174
	(0.229)	(0.938)	(0.227)	(0.679)	(0.661)
Near period					
Ave. obs.	2936	809	546	380	87
r_1	−0.235	−0.041	−0.090	−0.043	−0.028
	(100%)	(38%)	(50%)	(0%)	(0%)
g	1.145	0.626	0.539	0.643	0.859
	(0.085)	(0.223)	(0.221)	(0.192)	(1.83)
Soybean oil					
Distant period					
Ave. obs.	1267	829	546	377	168
r_1	−0.009	−0.023	0.003	−0.011	−0.046
	(38%)	(0%)	(0%)	(25%)	(0%)
g	1.208	1.369	0.533	0.986	0.280
	(0.352)	(0.408)	(0.416)	(0.345)	(0.382)
Near period					
Ave. obs.	3965	809	546	380	87
r_1	−0.084	0.010	−0.006	−0.013	−0.027
	(100%)	(13%)	(0%)	(0%)	(0%)
g	1.197	1.251	0.884	0.856	1.123
	(0.188)	(0.502)	(4.27)	(0.529)	(0.564)

[a]Percentage of significant first-order autocorrelation coefficients within the time interval group.
[b]Standard error for the price adjustment estimate g. It is calculated by averaging standard errors of AR (1) coefficients within the time interval group.
[c]One of two significant coefficients is negative.
[d]One of two significant coefficients is negative.
[e]Two of three significant coefficients are negative.
[f]Three of five significant coefficients are negative.
[g]Two of three significant coefficients are negative.

Several observations may be made regarding the comparison of average values of r_1 and g coefficients. As explained in the discussion of eq. (4), the sign of r_1 is determined by the relative magnitudes of $(1 - g)v^2$ and σ^2. As shown in Table I, a negative value of r_1 is, at times, associated with over-reaction of prices ($g > 1$), especially in nearby tick series. In these cases, it is not possible to distinguish between the relative impact on returns of trading noise and over-reaction of prices, since both negatively influence r_1. In instances where both $r_1 < 0$ and $g < 1$, the influence of liquidity trading, as manifested in the contribution of the noise variance to r_1, surpasses that of partial price adjustment. When $r_1 > 0$, the impact of the price adjustment process exceeds that of noise trading because $r_1 > 0$ implies $g < 1$. When r_1 is not different from zero, trading noise is of small relative importance since the noise variance in this instance is only a fraction $(1 - g)$ of the value return variance.[8] In cases where g is near 1, the covariance of returns is determined largely by trading noise, which may be small if r_1 is also close to zero.[9] Since it is not theoretically possible to observe $r_1 > 0$ and $g \geq 1$, there is no clear interpretation for these combinations of r_1 and g.

Previous findings suggest that return series of shorter time intervals (e.g., the tick return series) have more negative and significant first-order autocorrelation coefficients (r_1), because the effect of market making is more pronounced in these series. This phenomenon is observed here also. The most negative and significant values of r_1 are found in the tick return series of grain futures, except in oats, where values of r_1 are often positive or not significantly negative.

In corn futures, r_1 is more strongly negative in near contracts than in distant contracts for the tick, five-minute, and quarter-hour series. Negative values of r_1 are associated with $g \approx 1.5$ in the tick return series. Therefore, it is not possible to distinguish between the effects of liquidity trading and price adjustment in both near and distant tick return series. However, it is likely that the market-making activities of scalpers, which results in trading noise, also contributes to the over-reaction of prices evident in tick returns. Trading noise is evident in the five-minute and the quarter-hour nearby return series in corn. In all other corn series, noise appears relatively unimportant. Partial price adjustment is evident in the five-minute near and distant series and in the half-hour distant series is corn as judged by values of g less than 1. However, in both near and distant daily return series, over-reaction of price adjustment appears more prevalent. It is perplexing that over-reaction is suggested in both daily series, but average values of r_1 are not negative.

For wheat futures contracts, it is not possible to distinguish between the effects of trading noise and over-reaction of prices in explaining the tick return pattern in near contracts. Noise appears to be most important in the distant tick return series where the price adjustment coefficient is very close to 1, and most average values of r_1 are significantly negative. In all other wheat series, noise appears to be relatively unimportant. In these series, g is close to one (except in the nearby five-minute series) and most values of r_1 are not significantly different from zero.[10]

The results for oats are different than those for corn or wheat and provide little evidence of market-making in oats futures. Most noteworthy, the average value of r_1 in both the near and distant tick series in oats is close to zero. Moreover, while several

[8] Average values of r_1 are considered to be different from zero if more than one-half of the values of r_1 for a time interval group are significantly different from zero.

[9] Average values of g are considered here to be near one if they lie within one standard error above or below one.

[10] Recall that the nearby five-minute and daily series in wheat are the only series where average values of r_1 are not representative of all the values in the series according to Fisher's test statistic. However, for both of these series, the majority of values of r_1 are not different from zero.

of the values of r_1 for the tick series are significantly different from zero, fewer than half are significantly negative. Also in contrast to corn and wheat, values of g are close to 1 in both the nearby and distant tick series in oats. In most of the other oats return series, values of r_1 are not significantly different from zero suggesting that noise is also of minor importance in these intervals. The average value of g in the distant quarter-hour series suggests partial price adjustment. On the other hand, the average values of g suggest over-reaction of prices in the nearby half-hour series, the distant daily series, and the nearby daily series (although here the standard error of g is enormous). The distant daily return series in oats is noteworthy for having 40% of values of r_1 significant, a large positive average value of r_1 (0.131), and an average value of g which suggests over-reaction. These findings are paradoxical since over-reaction of prices should be associated with negative values of r_1.

For soybeans, as in corn, r_1 is more strongly negative in near contracts than in distant contracts. However, the majority of values of r_1 are significantly negative in only the nearby tick return series where the average value of g suggests over-reaction of prices. Thus, trading noise is important, along with over-reaction, in explaining the behavior of futures returns only in the nearby tick series in soybeans. In all distant series in soybeans, g is near 1, suggesting that the price adjustment process is efficient. Partial price adjustment appears evident in the nearby quarter-hour and daily series.

In soybean meal futures, all average values of r_1 are negative and, except for the daily series, greater in magnitude in the nearby series than in the distant series. Trading noise is important in explaining the behavior of returns in both the nearby and distant tick return series where the majority of values of r_1 are significantly negative. The nearby tick series also displays characteristic over-reaction of prices, so it is not possible to determine the relative impact of trading noise versus price adjustment on returns. As in soybeans, g is near 1 in all distant return series. Partial price adjustment is evident in the nearby five-minute, quarter-hour, and half-hour return series. Trading noise also appears important in the nearby quarter-hour return series.

In soybean oil, noise trading appears to be important only in the nearby tick series where all r_1 are significantly negative. Over-reaction of prices is also characteristically indicated in the nearby tick series. However, the average r_1 is small in the nearby tick series as compared to the values in all other grain futures (except oats), which suggests that market-making is less dominant in soybean oil futures than in most other grain futures. Average values of g are close to 1 in all other nearby series in soybean oil. Partial price adjustment is suggested in the distant quarter-hour and daily return series.

Table II summarizes the impact of market forces on the return behavior of grain futures. In all nearby tick return series except oats, and in the distant tick return series in corn, trading noise accompanied with over-reaction of prices are important in explaining return behavior. As stated earlier, it is likely that the market-making activities of scalpers, which results in trading noise, also contributes to the over-reaction of prices evident in nearby tick returns. Trading noise *without* evidence of over-reaction of prices is important in the distant tick return series in wheat and soybean meal. Market-makers appear to be scarce in oats futures contracts with little evidence of trading noise even in the tick return series. Trading noise is of less importance in most other return series intervals with the exceptions of the five-minute and quarter-hour nearby series in corn and the quarter-hour nearby series in soybean meal. Finally, over intervals longer than tick-to-tick, partial price adjustment appears more prevalent than over-reaction of prices. The evidence of over-reaction of prices over longer intervals (both daily series in corn, the nearby half-hour series in oats, and the distant daily series in oats) is suspect given that the estimated values of g are inconsistent with average values of r_1 close to zero.

CONCLUSIONS

This study applies Amihud–Mendelson's price adjustment model to the analysis of the relative importance of trading noise and price adjustment in explaining return behavior in grain futures markets. In the model, the sign of the first-order autocorrelation coefficient is determined by both trading noise and the price adjustment process [eq. (4)]. Contracts both distant and near maturity are separately analyzed to investigate whether there are differences in market forces between the two periods.

The results of the study indicate that, except in oats, trading noise together with over-reaction of prices are important in explaining the behavior of returns on a tick return basis in nearby contracts. Trading noise is also important on a tick return basis in some distant contracts. Thus, the effects of market-makers on tick-to-tick price behavior is significant in all grain futures contracts except in oats where market-makers appear scarce. Trading noise is less evident over longer time intervals. Except in corn and soybean meal, noise appears of lesser importance in explaining return behavior across all time intervals longer than tick-to-tick. In corn, noise appears to affect significantly the behavior of returns in nearby contracts across five-minute and quarter-hour intervals in addition to tick returns. In soybean meal, noise also appears significant in nearby contracts across quarter-hour intervals. A lack of trading noise is

Table II
SUMMARY OF THE IMPACT OF TRADING NOISE AND THE PRICE ADJUSTMENT PROCESS ON THE RETURN BEHAVIOR OF GRAIN FUTURES

	Tick Return		Five-Minute Intraday Return		Quarter-Hour Intraday Return		Half-Hour Intraday Return		Daily Return	
	Dist.	Near	Dist.	Near	Dist.	Near	Dist.	Near	Dist.	Near
Corn	I/O	I/O	V/P	N/P	V	N	V/P	V	V/O	V/O
Wheat	N	I/O	V	V/P	V	V	V	V	V	V
Oats	V	V	V	V	V/P	V	V	V/O	V/O	V
Soybeans	V	I/O	V	V	V	V/P	V	V	V	V/P
Soybean meal	N	I/O	V	V/P	V	N/P	V	V/P	V	V
Soybean oil	V	I/O	V	V	V/P	V	V	V	V/P	V

N—majority of values of r_1 significantly negative and g less than or equal to one. Trading noise is important in explaining return behavior; strong evidence of market-making.

V—$r_1 \approx 0$, or majority of values of r_1 not significantly different from zero. Trading noise or market-making is of lesser importance in explaining return behavior.

P—$g < 1$ as judged by average value of g smaller than one standard error below one. A partial price adjustment process is implied by return patterns.

O—$g > 1$ as judged by average value of g greater than one standard error above one. Over-reaction of prices is implied by return patterns.

I—majority of values of r_1 significantly negative and g greater than one. The relative impact on returns of trading noise and over-reaction of prices cannot be clearly distinguished.

desirable over longer time intervals where liquidity issues are less salient and where errors in the analysis and interpretation of information should be less common. However, a lack of trading noise may indicate performance problems in oats and in distant contracts, particularly on a tick basis, because it may reflect a lack of liquidity in these contracts.

Finally, evidence of both over and partial adjustment is found over intervals longer than tick-to-tick. However, the evidence of over-reaction cannot be interpreted within the context of Amihud–Mendelson's model. Therefore, evidence of partial price adjustment appears more compelling than evidence of over-reaction over these intervals. Hence, prices in grain futures may have a tendency to display partial adjustment to their equilibrium values over longer time intervals.

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