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Information Impacts and Determinants of Information Selection: An Experimental Approach

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Laboratory experimentation was used to assess the impacts of information disclosure in imperfect markets. A dual oligopoly market structure was designed with contract information disclosed to subjects under three treatments: no, partial, and full disclosure. Regression analysis revealed some increase in selling price with full information disclosure, but no discernable effects on negotiated prices with partial disclosure. Alternative specifications showed large traders earning significantly lower profits, and information on large traders significantly beneficial to both buyers and sellers. Probit analysis of information selection determinants revealed no significant economic content in trader requests for information under partial disclosure.

Key words: experimental economics, grain transportation, imperfect markets, information impacts, transportation.

Historically economists have looked to neoclassical economic theory, to game theory, and to the structure–conduct–performance paradigm to evaluate the performance of particular markets. Unfortunately, only some of the more relevant and interesting questions regarding market performance are addressed by these methods. One question in particular where theory offers only modest insight concerns the impact of information on prices and market efficiency in imperfect markets. Carlton and Perloff suggested two strands of research that are related to information and imperfect markets. The first has focused on the cost of the information search. While neoclassical theory presumed that a market equilibrium with low search costs would be similar to an equilibrium with zero search costs, Diamond showed that with infinitesimal search costs and a large number of firms, the market equilibrium price is the monopoly price. However, if there are only a few sellers in the market, price-cutting may be profitable and the higher price equilibrium would be broken. Also, when free entry is allowed, monopoly profits are dissipated by excessive entry. Finally, if sellers cooperate and collectively lower prices, buyers may be induced to search for even lower prices, further lowering price below the monopolistic level. Thus, the reasoning by Diamond suggests a set of results very different from a market where buyers have full information.

The second strand of research has to do with asymmetrically held information. Salop and Stiglitz concluded that if there are many informed buyers, sellers will have little incentive to deviate from the competitive equilibrium, whereas if there are few informed buyers, a two-price equilibrium develops, with low-priced sellers charging a price equal to marginal cost and high-priced sellers selling at monopolistic prices. In addition, Salop showed that a monopolist may benefit by charging different prices to informed and uninformed buyers, since search costs would prevent uninformed consumers from buying at the low price. Perloff and Rausser effectively summarized the ambiguity surrounding the impacts of asymmetric information in imperfect markets when they concluded that

> . . . an increase in information known to the competitive fringe firms can increase or decrease the distortions in various agricultural markets. This ambiguous result . . . reflects the general principle that, in moving from one second-best world to another, there is no assurance that

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> society's welfare is enhanced. What at first may seem a paradox—improved information may be harmful—is a general result that should be expected. (pp. 371–72)

Because traditional economic theory offers little to assess the impacts of information on behavior in imperfect markets, economists increasingly have turned to laboratory experimentation (Plott; Smith). In particular, the impact of information disclosure in a dual oligopoly setting is uncertain. Depending upon prior history and the acceptance of certain behavioral assumptions, a number of theoretical outcomes are possible.[1] The intent of this article is to examine the effect of selective contract information disclosure on prices and profits in a dual oligopoly laboratory setting characteristic of the market for rail services in the Great Plains. An earlier empirical analysis showed rail rates in the region have edged upward since legislation requiring mandatory contract disclosure was authorized in 1986 (Fuller, Ruppel, and Bessler). However, other factors, such as dynamic negotiating relationships, the increased demand for U.S. wheat and coarse grain exports in the late 1980s, increases in rail input costs (labor, fuel, materials), and changing seasonal demands for grain transportation services, may have been responsible for this outcome. The advantage of the laboratory setting is to allow for control of the influence of these other elements.

Background

Both the rail carriers and the contracting grain shippers in the Plains states are characterized by high concentration ratios in their industries. The Staggers Rail Act of 1980 permitted railroads and grain shippers to enter into confidential contracts. Some shippers argued that the price confidentiality feature of rail contracts enhanced interrailroad competition (*Milling and Baking News*), while other shipper groups, such as the National Grain and Feed Association, argued that the high volume contract rates offered to large shippers discriminated against smaller shippers. Legislation passed in 1986 modified the Staggers Act by authorizing two levels of disclosure of confidential contract terms. First-tier disclosure, which we refer to as partial disclosure, included such items as shipper identity; origins, destinations, transit points, and movement types (single car, multiple car, unit trains, etc.); contract duration and implementation dates; volume requirements; commodities covered; and base rates which would apply in the absence of a contract. Second-tier disclosure, which we call full disclosure, included information on actual rates and charges in the contract. This information, which is typically the most important bit of information sought by a petitioning shipper, was not to be disclosed until a petitioning shipper (*a*) filed a petition for discovery of additional contract terms; (*b*) could show that it was ready, willing, and able to participate in the contract terms covered under first-tier disclosure; and (*c*) could show itself to be an "affected party" (*Federal Register*).

Similar issues have been analyzed using laboratory experiments. Hong and Plott employed a laboratory setting to explore the consequences of a proposed rate publication policy for the U.S. barge industry. The proposed policy required a carrier to file a rate change with the Interstate Commerce Commission (ICC) at least 15 days before the rate change was to become effective. In laboratory markets, Hong and Plott contrasted the proposed posted rate policy with negotiated rates and found that posting caused higher prices, lower volume, and reduced efficiency. Claims that rate filing would improve market operations were not supported by the experimental results. Grether and Plott examined the relationship between posted prices and certain industrial practices by an oligopoly of lead-based gasoline additive manufacturers. The Federal Trade Commission charged that an existing price posting policy was anticompetitive, while the manufacturers maintained that the pricing outcomes were simply the result of the highly concentrated market structure. Grether and Plott used laboratory experiments to refute the oligopolists' claim that concentration alone, unaided by certain practices, did not necessarily foster collusion-like prices. Further studies which are somewhat related to the proposed analysis include those by Plott and Smith and by Williams.

Methods

A laboratory experiment was constructed to represent a dual oligopoly market structure.[2] Twelve two-hour sessions were held. Each session consisted of eight training/trading periods (as described below). Six student volunteers per session were randomly assigned buyer or seller trading status. Each side of the market had one large trader, each controlling 50% of its respective market, and two smaller traders, each with one-quarter market shares. The subjects were instructed to buy (sell) units of a commodity from one of the three traders on the other side of the market. Buyers had demand schedules reflecting resale values and sellers had supply schedules reflecting costs of production. Three sets of market demand and supply

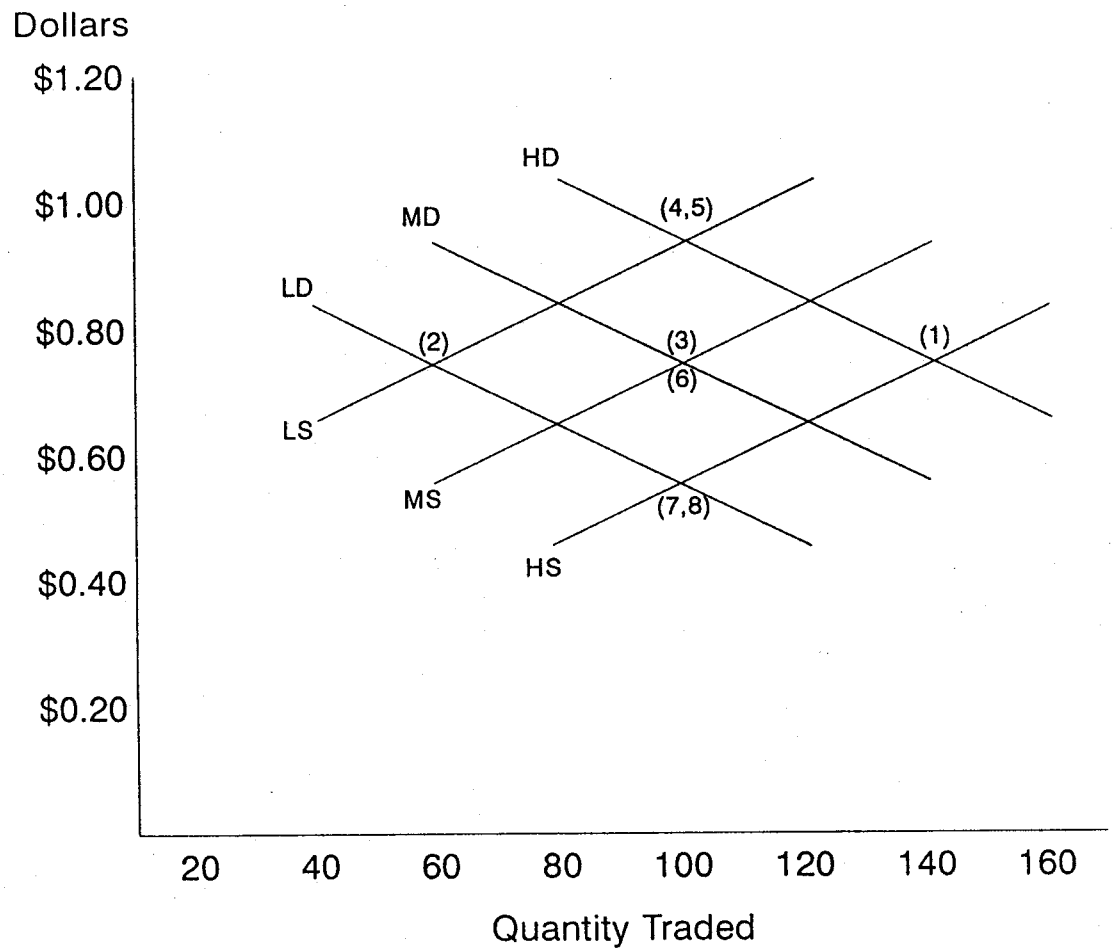

Figure 1. Supply and demand possibilities

Note: LD, MD, HD, LS, MS, HS refer to low, moderate, and high demand and supply, both respectively. Numbers in parentheses refer to experimental periods.

schedules (reflecting low, moderate, and high demand/supply conditions) generated nine possible equilibrium points (fig. 1). Each buyer (seller) was allowed to negotiate a maximum of three trades per trading period, one trade with each seller (buyer).[3] Prices and quantities traded were negotiable items. Buyers profited from purchasing units at a low price relative to their resale values. Sellers profited from selling units at a high price relative to their production costs.[4]

Subjects were placed in separate offices on one floor in the Department of Agricultural Economics at Texas A&M University. Each buyer (seller) had two phone lines available for his/her use, with two phone numbers listed for each of the sellers (buyers) but no communications available to competing buyers (sellers). Two 15-minute training periods were held, followed by six 10-minute trading periods. The training periods were designed to familiarize the subjects with the trading environment incrementally. The trading price was fixed during the first training period with the subjects allowed to conduct as many trades and to transact as many units as they desired. A maximum number of units to be traded was imposed during the second training period with prices negotiable. Training periods 1 and 2 were high demand–high supply (HDHS) and low demand–low supply (LDLS), respectively.

Participant payouts were based on profits earned during periods 3 through 8. Periods 3 and 6 were "transition" periods with moderate demand and moderate supply (MDMS). Periods 4 and 7 were "baseline" periods, and were either high demand–low supply (HDLS) or low demand–high supply (LDHS) equilibria. If period 4 was HDLS, then period 7 was LDHS, and vice versa. Periods 5 and 8 were

Table 1. Summary Results on Quantities Traded, Prices, and Profits for Baseline and Disclosure Periods for Large and Small Buyers and Sellers

	Perfectly Efficient Solution (PES)[a]			
	Large Buyer	Small Buyers	Large Seller	Small Sellers
Quantity (units)[b]	49	24	49	24
Average Equilibrium Price (cents)	80	80	80	80

	Actual Outcomes for Baseline and Disclosure Periods			
	Large Buyer	Small Buyers (combined)	Large Seller	Small Sellers (combined)
Quantity (% of PES)	83.1	101.7	81.5	103.3
Price (cents)	81.1	77.4	76.6	80.6
Profits (% of PES)	90.5	99.8	81.6	94.7
Number of Trades	137	124.5	142	122
Maximum Number of Trades	144	144	144	144

[a] The PES is calculated at equilibrium prices and allocation quantities.
[b] The 50th and 25th units are inframarginal for the large and small traders, respectively. If traded at the equilibrium price, these units would bring neither profit nor loss to either buyers or sellers.

"disclosure" periods, and had the same equilibria as their preceding period. The baseline and disclosure periods had equilibrium prices of $1 and 60¢ for HDLS and LDHS, respectively, and equilibrium quantities of 100 throughout. Absolute values of the slopes of the schedules were identical between buyers and sellers, with the slopes for the small traders twice as steep as for the large traders. At the end of each session the subjects were paid pre-ordained fixed percentages of the sum of their six trading period profits for the evening. Percentages were set so that the anticipated payout of $18 was identical for each market participant.[5]

The experiment was designed to test the impact of selective information disclosure on buyer and seller profits, prices, and quantities. The 12 experimental sessions were equally divided into one of three information disclosure treatments: none (NO), partial (PT), and full (FL). Under the NO treatment, no information on previously traded quantities or prices was made available to the traders. Under FL, prior to trading in periods 5 and 8 all participants received a listing of all trades contracted during the prior trading period. Under PT, following periods 4 and 7 traders were allowed to request information on two trades from the prior period. Each of these requests specified (*a*) a particular buyer or seller involved in a trade and (*b*) a particular piece of information on the trade: either the first trade, the last trade, the largest quantity traded, the smallest quantity traded, the highest contract price, or the lowest contract price associated with the trader specified in (*a*). It was expected that full disclosure of prior-period trading information would reduce excessive trader profits by lowering excessively high seller prices and raising abnormally low buyer prices and by increasing the quantity traded for all traders. That is, positive signs were expected on full disclosure in explaining price, quantity, or profit differences between trading periods. On the other hand, it was expected that traders would use selected information (PT disclosure) to their benefit, raising seller prices and lowering buyer prices, and increasing profits and quantities traded for all traders.

Results

The experiment was conducted over a one-month period. Individual trades within each period were aggregated into period- and trader-specific quantities, quantity-weighted prices, and profits, resulting in 288 observations of baseline and disclosure periods (6 traders•4 periods•12 sessions).

Summary Results

Summary results on quantities, prices, and profits in the baseline and disclosure periods are presented in table 1. Following Plott and Smith, a perfectly efficient market standard was established in order to measure overall trader efficiency. This standard assigned period-specific equilibrium prices to all trades

Table 2. Summary of Information Requested under Partial Disclosure

	Information Requested on Trader				
	Large Buyer	Small Buyers (combined)	Small Sellers (combined)	Large Seller	Sum
By Buyers	2	4	26	16	48
By Sellers	17	24	7	0	48
Total	19	28	33	16	96

	Information Requested on Trade						
	First Trade	Last Trade	Large Quant	Small Quant	High Price	Low Price	Sum
By Buyers	2	3	9	0	3	31	48
By Sellers	14	8	7	0	16	3	48
Total	16	11	16	0	19	34	96

and quantity allocations (equal to the quantity supplied or demanded at the equilibrium price) to all traders. Given the inframarginal nature of the last unit, this perfectly efficient solution (PES) was 97 units traded per session (24 units for each of the smaller traders and 49 units for the larger traders). The mean of the actual units traded in the baseline and disclosure periods over all 12 sessions was 89.5 units per period, which amounted to 92.3% of the PES. On average, the small traders exceeded their allocations, while the large traders fell far short in their quantities traded. The smaller traders also engaged in fewer trades overall. The 386 contracts negotiated during the baseline and disclosure periods amounted to slightly more than eight trades per period, one less than the maximum potential number of trades per period. The large traders on both sides of the market averaged over 95% of their maximum number of trades, while the small buyers averaged only 86%.

Prices in the aggregate also favored the small traders over the large traders, but also favored buyers over sellers. With a mean equilibrium price of 80¢ per unit for the baseline and disclosure periods, the mean of quantity-weighted contract prices per period was 79¢ per unit. Zero-sum games were in effect for nonequilibrium prices. That is, contract prices above or below the equilibrium price generated rents to the seller or buyer, respectively. Relative to the equilibrium price, the large buyer (on average) paid 1.1¢ too much, while the small buyers were under by 2.6¢ per unit. On the other hand, the large seller received 3.4¢ too little, while the small sellers were over, but only by .6¢. Overall, the buyer advantage amounted to just over 1¢ per unit.

The combined deviations from equilibrium prices and allocation quantities resulted in substantial differences in profits. Overall, small buyers achieved 99.8% of their PES profits, followed by small sellers at 94.7%, with the large buyer and seller at 90.5% and 81.6%, respectively. Although actual payout for all traders for the baseline and disclosure periods amounted to 96.7% of the expected level, profits were only at 91.7% of the standard. This discrepancy was the result of the small traders being more successful than the large traders and receiving higher payout percentages.

Partial Disclosure Information Selection

The information the traders could have selected can be classified into five categories: side of the market, size of the trader, order of the trade, trading price, and trading quantity. The first two of these categories pertain to a trader's request for information on other traders. As shown in table 2, both buyers and sellers overwhelmingly preferred information on traders from the opposite side of the market. Only six buyer requests and seven seller requests (out of a possible 48 requests on each side of the market) were for the same side of the market. Information requests on size were likewise fairly equally distributed, with buyers requesting information on a large trader 18 times and sellers requesting large trader information 17 times (again out of a possible 48).

The latter three categories pertain to the type of information requested. There were nine buyer and seven seller requests for the largest quantity traded (by a given buyer or seller), and no requests for smallest trade information. Again, these numbers are similar for buyers and sellers. However, dramatic differences appeared in requests for prices and order of trade information. Buyers requested price information 34 times versus 19 seller requests, while sellers made 22 order-of-trade requests compared to five for buyers.

Table 3. Variable Identification and Description

Variable Identification	Description
DPROFIT	Change in trader profits between a baseline period (4, 7) and a disclosure period (5, 8)
DPRI	Change in quantity-adjusted trading price between a baseline period (4, 7) and a disclosure period (5, 8)
DQTY	Change in quantity traded between a baseline period (4, 7) and a disclosure period (5, 8)
LPRI	Quantity-adjusted trading price lagged one period
LQTY	Quantity traded lagged one period
NTRDS	Number of trades in previous period
LRGE	0–1 variable denoting large trader (buyer or seller)
FULL	0–1 variable denoting full disclosure period
PART	0–1 variable denoting partial disclosure period
RLRGE	0–1 variable, request for information on large trader
RSAME	0–1 variable, request for information on trader on same side of market
RORD	0–1 variable, request for information on order of trade
RQTY	0–1 variable, request for information on quantity traded
RPRI	0–1 variable, request for information on trading price
SLR	0–1 variable denoting sellers
*EQ*60	0–1 variable denoting periods when equilibrium price was 60
*PD*8	0–1 variable denoting period 8
*SN*1	0–1 variable denoting session 1
*SN*2	0–1 variable denoting session 2
*SN*8	0–1 variable denoting session 8
SLPRI	0–1 variable, interaction between *LPRI* and *SLR*

The large seller was especially concerned with order, having requested order-of-trade information 11 times (out of a maximum of 16 requests). It is possible that the experimental design encouraged (or even forced!) market participants to lock in their trades early. This outcome may have contributed to the overall poor showing on the part of the large traders, especially the large seller, and may have been responsible for the overall downward pressure on prices. Certainly, the large traders in the aggregate did not exhibit the market power which the experimental design potentially offered them.

Information Impacts

The focus of this section is an econometric analysis of the impacts of information disclosure on profits, prices, and quantities traded between the baseline periods and the disclosure periods. Because these impacts are different for buyers and sellers, the two groups were analyzed separately. Trader behavior in any given period can be summarized as either a price-dependent or quantity-dependent (supply or demand) relationship:

$$P_t = f(Q_t, I_t, X_t) \tag{1}$$

and

$$Q_t = g(P_t, I_t, X_t), \tag{2}$$

where P_t and Q_t refer to prices and quantities traded, I_t is information provided to subjects, and X_t is a vector of other variables which may affect the estimated price–quantity relationship, all in time period t. Our focus is not in the recovery of the supply and demand functions, but in an assessment of information impacts. Accordingly, we rewrite (1) and (2) as two "time-specific" trading periods:

$$P_{t-1} = f_a(Q_{t-1}, I_{t-1}, X_{t-1}), \tag{1a}$$

$$Q_{t-1} = g_a(P_{t-1}, I_{t-1}, X_{t-1}), \tag{2a}$$

and

$$P_{t+1} = f_b(Q_{t+1}, I_{t+1}, X_{t+1}), \tag{1b}$$

$$Q_{t+1} = g_b(P_{t+1}, I_{t+1}, X_{t+1}), \tag{2b}$$

Table 4. Impacts of Information Disclosure on Changes in Profits, Price, and Quantities Traded for Split Sample of Buyers and Sellers

A. BUYERS:

	Dependent Variable					
	DPROFIT (OLS)		*DPRI* (2SLS)		*DQTY* (2SLS)	
Var. Name	(a) Est. Coeff.	(b) Est. Coeff.	(a) Est. Coeff.	(b) Est. Coeff.	(a) Est. Coeff.	(b) Est. Coeff.
Lagged Dep.	−0.68 (6.33)	−0.63 (5.90)	−0.57 (3.15)	−0.59 (3.27)	−0.38 (3.41)	−0.47 (4.07)
DQTY			−0.59 (1.46)	−0.26 (1.69)		
DPRI					−0.25 (1.96)	−0.30 (2.18)
LRGE	−0.33 (0.67)	−0.27 (0.52)	1.72 (0.79)	0.46 (0.20)	−2.10 (1.71)	−3.36 (2.47)
FULL	0.45 (0.74)	0.47 (0.84)	3.01 (1.28)	3.20 (1.40)	0.65 (0.46)	0.88 (0.63)
PART	0.57 (0.99)		−0.09 (0.04)		−0.96 (0.73)	
RLRGE		0.70 (0.72)		−8.70 (2.10)		−4.11 (1.42)
RSAME		−4.11 (3.12)		10.22 (1.60)		−3.41 (0.95)
RORD		3.14 (2.37)		−1.00 (0.17)		3.51 (1.04)
RQTY		0.04 (0.05)		−2.65 (0.76)		−1.73 (0.85)
RPRI		0.67 (0.73)		7.16 (1.87)		3.36 (1.32)
INTCPT	4.01 (5.63)	3.62 (5.09)	−3.19 (1.75)	−3.05 (1.71)	9.24 (2.93)	11.40 (3.59)
Efron's R^2	.39	.51	.30	.37	.30	.35
d.f.	67	63	66	62	66	62

Note: Absolute values of t-statistics are in parentheses. Critical values for the t-distribution for 60 d.f. are 2.00, 1.67, and 1.30 for 5%, 10%, and 20% significance levels (two-tailed test), respectively. Efron's R^2 is the square of the correlation coefficient between the observed and predicted values of the dependent variable. For explanation of variables, please see table 3.

where $t - 1$ refers to trading in a baseline period (4 or 7) and $t + 1$ refers to trading in the ensuing disclosure period (5 or 8). Period t is the time between periods when information on trading in $t - 1$ is disclosed to participants for use in $t + 1$. Thus, the impacts of information disclosure can be assessed by differencing the appropriate variables in the two sets of equations to yield:

$$P_{t+1} - P_{t-1} = f_c(Q_{t+1} - Q_{t-1}, I_{t+1} - I_{t-1}, X_{t+1}) \tag{1c}$$

and

$$Q_{t+1} - Q_{t-1} = g_c(P_{t+1} - P_{t-1}, I_{t+1} - I_{t-1}, X_{t+1}). \tag{2c}$$

Because there is no information provided in the baseline periods, I_{t-1} is zero, and he following equations can be estimated:

$$P_{t+1} - P_{t-1} = f_d(Q_{t+1} - Q_{t-1}, I_{t+1}, X_{t+1}) \tag{1d}$$

and

$$Q_{t+1} - Q_{t-1} = g_d(P_{t+1} - P_{t-1}, I_{t+1}, X_{t+1}). \tag{2d}$$

Table 4. Continued

B. SELLERS:

	Dependent Variable					
	DPROFIT (OLS)		*DPRI* (2SLS)		*DQTY* (2SLS)	
Var. Name	(a) Est. Coeff.	(b) Est. Coeff.	(a) Est. Coeff.	(b) Est. Coeff.	(a) Est. Coeff.	(b) Est. Coeff.
Lagged Dep.	−0.74 (9.53)	−0.74 (9.53)	−0.78 (5.15)	−0.82 (5.37)	−0.62 (6.00)	−0.72 (6.20)
DQTY			0.24 (0.86)	0.48 (1.77)		
DPRI					0.08 (0.76)	0.08 (0.83)
LRGE	−1.37 (3.61)	−1.50 (3.68)	−6.23 (3.11)	−7.18 (3.44)	−1.59 (1.15)	−3.42 (2.18)
FULL	−0.56 (1.22)	−0.52 (1.16)	3.61 (1.62)	3.41 (1.55)	0.36 (0.28)	0.67 (0.56)
PART	−0.86 (1.88)		1.72 (0.76)		−2.40 (1.91)	
RLRGE		1.51 (1.59)		9.02 (1.86)		3.58 (1.29)
RSAME		1.09 (0.88)		3.60 (0.57)		9.46 (2.66)
RORD		−1.67 (1.82)		−1.29 (0.28)		−6.68 (2.66)
RQTY		−0.04 (0.05)		−2.77 (0.77)		1.66 (0.86)
RPRI		−1.45 (2.36)		−4.89 (1.56)		−3.46 (1.81)
INTCPT	5.02 (7.84)	5.06 (7.97)	−0.34 (0.20)	0.05 (0.03)	15.41 (5.45)	17.89 (5.60)
Efron's R^2	.60	.62	.37	.43	.43	.52
d.f.	67	63	66	62	66	62

Finally, because profits are the result of price and quantity calculations, a profit relationship (π) also can be estimated in like fashion:

$$\pi_{t+1} - \pi_{t-1} = h(P_{t+1} - P_{t-1}, Q_{t+1} - Q_{t-1}, I_{t+1}, X_{t+1}). \tag{3}$$

Equations for profits, (quantity-weighted) contract prices, and quantities traded were estimated using OLS for the profits equation and 2SLS for the prices and quantities traded equations (due to the simultaneous determination of prices and quantities traded).[6] The dependent variables (*DPROFIT, DPRI,* and *DQTY*) were calculated as differences between their baseline values in periods 4 and 7 and their values in the disclosure periods, resulting in 72 observations each for buyers and sellers. Large trader quantities and profits were adjusted (approximately halved) to neutralize the effects of size. Lagged values for *DPRI* were calculated as percentages of mean values across all traders in the baseline periods (*LPRI*), while lagged values for *DPROFIT* and *DQTY* were simply values of profits and quantities traded in periods 4 and 7. Explanations for all variables used in the following analyses are found in table 3.

Results are presented in table 4. Markets were efficient in the sense that dependent variables and their lagged values were significantly negatively related (high profits, prices, and quantities were decreased and lower values were increased). The zero–one variable associated with large traders (*LRGE*) revealed a significant profit, price, and quantity disadvantage to the large seller, and a significant quantity disadvantage to the large buyer. The alternative specifications in columns (a) and (b) differ only in the manner in which the partial disclosure treatment is incorporated into the equation. In the column (a) equations, the full and partial disclosure impacts are evaluated using zero–one variables (*FULL, PART*) for the two treat-

ments. No significant differences were detected between no disclosure and full disclosure for any of the dependent variables (at the 10% significance level) in this specification. Seller profits were hurt, however, by partial disclosure, due largely to quantity decreases.

The specific information requests obtained under partial disclosure are modeled explicitly in the column (b) equations. The information selection variables (*RLRGE, RSAME, RORD, RQTY,* and *RPRI*) are zero–one variables. Each of these variables was assigned a value of one when it had been selected as one of the two choices in the preceding partial disclosure selection process. Since choosing any particular trader–trade set of information on the first choice neither necessitated nor precluded selection of any information as a second choice, there was no problem of multicollinearity or interdependence.

For the buyers, information requests for order of trades (*RORD*) were the most helpful, due to a combination of lower prices and increased quantities traded. Requests for information on traders from the same side of the market (*RSAME*), on the other hand, were significantly negatively related to changes in buyer profits, due to higher purchase prices and decreased quantities traded. Information requests for large traders (*RLRGE*) significantly decreased buyer prices, but decreases in quantities traded neutralized impacts on profits. Price information requests (*RPRI*) paradoxically resulted in higher buyer prices. Requests for quantity information (*RQTY*) were insignificant throughout for both buyers and sellers. For the sellers, information requests for large traders enhanced both the selling price and the quantity traded, with a marginally significant positive impact on profits. Price information requests decreased profits, due to lower selling prices and fewer units sold. Order requests also decreased profits due to a significant reduction in the quantity sold. Information requests for traders on the same side of the market increased the quantity sold, but had no significant impact on profits.

Determinants of Information Selection

An analysis of the determinants of information selection under partial disclosure is presented in table 5. Probit analysis was applied to the 96 observations of requests for information (2 requests per trader•6 traders•2 periods per session•4 sessions) over five categories of requests: *RLRGE, RSAME, RORD, RQTY,* and *RPRI,* all as defined above. Coefficients are presented in table 5 together with their associated *t*-statistics (absolute values) in parentheses and changes in probabilities in brackets. The coefficients are interpreted as the direction and magnitude of change along the horizontal axis of the normal probability density function given a one-unit change in the right-hand-side variable.[7]

Explanatory variables include "economic" variables (price and quantity information from the previous period), market indicator variables (size and side of the market), and period- and session-specific indicator variables. The economic variables include *LPRI* and *LQTY* (the trader's percentages of mean price and quantity from the previous period), *NTRDS* (the number of trades in the previous period), and *SLPRI,* an interactive term calculated as *LPRI* multiplied by a zero–one seller variable (*SLR*) and designed to capture the differential price impacts facing sellers as opposed to buyers. Market indicator variables included *SLR* and a zero–one indicator for large traders (*LRGE*). Other indicator variables reflected low price equilibrium periods (*EQ*60), period 8 (*PD*8), and three of the four partial disclosure sessions (*SN*1, *SN*2, and *SN*8). Most of these period- and session-specific indicator variables were insignificant throughout. This result is the desired outcome, since it implies that the experimental design was not seriously flawed (i.e., that there were no differences in session or period outcomes not accounted for by other right-hand-side variables).

The coefficients and summary statistics in table 5 reveal three equations (*RSAME, RORD,* and *RQTY*) with a number of significant explanatory variables and reasonably strong goodness-of-fit measures (as reflected in R^2 values and percentage of correct predictions) and two equations (*RLRGE* and *RPRI*) with only a few significant explanatory variables and weaker goodness-of-fit measures. The *RLRGE* equation has the lowest percentage of correct predictions and the lowest R^2 (both McFadden's and Efron's), and is the only equation besides *RQTY* where the chi-square statistic for the likelihood ratio test (that all slope coefficients are zero) is not significant at the 10% level. The only meaningful significant explanatory variable in the *RLRGE* equation indicates that large traders tended not to select information on the other large trader. *RPRI,* the equation with the second lowest percentage of correct predictions, was the only equation with no significant economic or market indicator explanatory variables.

RSAME, RORD, and *RQTY* each had at least four significant explanatory variables, with *SLR,* its interactive price term (*SLPRI*), and *LRGE* all significantly different from zero (at the 10% level) in all three equations. The previous period percentage deviation from quantity (*LQTY*) was important in information requests on order and quantity (*RORD* and *RQTY*), while the number of trades (*NTRDS*) and the previous period percentage deviation from price (*LPRI*) were significant only in the *RQTY* equation. The largest changes in probability occurred with the noncontinuous variables in the *RORD* equation. The probability of order information being selected increased 42% and 38% when the requestor

Table 5. Probit Maximum Likelihood Estimates and Summary Statistics for Information Selection Equations

ESTIMATES:

Var. Name	Dependent Variable				
	RLRGE	*RSAME*	*RORD*	*RQTY*	*RPRI*
LPRI	−0.0133[a]	0.0362	0.0681	−0.0568*	−0.0040
	(0.62)[b]	(0.77)	(1.64)	(1.89)	(0.19)
	[0.0040][c]	[−0.0010]	[0.0077]	[−0.0018]	[0.0001]
SLPRI	0.0482	−0.1293*	−0.0813*	0.0941*	0.0085
	(1.56)	(1.89)	(1.70)	(1.86)	(0.28)
	[0.0178]	[−0.0045]	[−0.0229]	[0.0171]	[0.0034]
LQTY	−0.0051	0.0056	0.0174**	−0.0334**	−0.0017
	(0.83)	(0.51)	(2.46)	(2.36)	(0.28)
	[−0.0019]	[0.0002]	[0.0049]	[−0.0061]	[−0.0007]
NTRDS	0.1675	0.0340	−0.5413	1.0327*	0.1222
	(0.48)	(0.04)	(1.38)	(1.82)	(0.35)
	[0.0620]	[0.0012]	[−0.1526]	[0.1876]	[0.0482]
SLR	−4.9035[a]	12.761*	9.6090*	−9.6336*	−1.7225
	(1.56)	(1.88)	(1.95)	(1.88)	(0.57)
	[−0.0291]	[−0.0059]	[0.4171]	[−0.0399]	[−0.3428]
LRGE	−0.7113*	1.4447**	1.3389**	−1.2960**	−0.4406
	(1.75)	(2.54)	(2.85)	(2.10)	(1.13)
	[−0.2631]	[0.0498]	[0.3775]	[−0.2355]	[−0.1740]
EQ60	0.1422	−1.1777**	−0.5467	0.1631	0.3188
	(0.52)	(2.03)	(1.63)	(0.46)	(1.16)
	[0.0526]	[−0.0406]	[−0.1542]	[0.0296]	[0.1259]
PD8	−0.0916	0.3679	0.5416	−0.3039	−0.2164
	(0.33)	(0.77)	(1.64)	(0.85)	(0.78)
	[−0.0339]	[0.0127]	[0.1527]	[−0.0552]	[−0.0854]
SN1	0.3473	−3.2041	−0.6405	−0.6066	0.9159**
	(0.85)	(0.95)	(1.36)	(1.21)	(2.19)
	[0.1284]	[−0.1105]	[−0.1806]	[−0.1102]	[0.3616]
SN2	0.6910*	0.2222	−0.5888	−0.1029	0.3900
	(1.70)	(0.31)	(1.22)	(0.21)	(0.97)
	[0.2556]	[0.0077]	[−0.1660]	[−0.0187]	[0.1540]
SN8	0.0175	0.1405	−0.1798	−0.4992	0.3718
	(0.04)	(0.22)	(0.39)	(1.04)	(0.95)
	[0.0065]	[0.0048]	[−0.0507]	[−0.0907]	[0.1468]
CONSTANT	0.9995	−5.7682	−8.8006**	5.9770	0.5028
	(0.45)	(1.28)	(2.00)	(1.85)	(0.23)

SUMMARY STATISTICS:

	Dependent Variable				
	RLRGE	*RSAME*	*RORD*	*RQTY*	*RPRI*
Number of iterations	3	6	5	5	3
Log of likelihood function	−57.81	−24.56	−40.82	−36.64	−57.10
Likelihood ratio test	10.34	27.02	32.43	13.23	17.85
d.f.	11	11	11	11	11
McFadden's R^2	.08	.35	.28	.15	.14
Efron's R^2	.09	.34	.33	.13	.18
Percent correct predictions	65.6	90.6	78.1	83.3	71.9

Note: A single asterisk indicates significance at the 10% level; double asterisks indicate significance at the 5% level (two-tailed test). For explanation of variables, please see table 3.

[a] Coefficients on *LPRI* and *SLR* are estimated, not adjusted (see text).

[b] Absolute values of asymptotic *t*-statistics are in parentheses.

[c] Changes in probability of information selection given a one-unit change in the associated variable (calculated at variable means) are in brackets.

was a seller or a large trader, respectively, and decreased 15% with an increase in the number of trades. In general, these three variables accounted for greater changes in probability than either the remaining indicator variables or the continuous variables.

Discussion and Conclusions

The surprising outcome from this analysis of experimental data is the impacts of size. The table 5 results suggest that large traders had the greatest impacts on information selection, both in terms of significant coefficients and changes in probability. In table 4, the significant negative sign on *LRGE* in the sellers' price and profits equations and the significant enhancements provided by *RLRGE* to both buyers' and sellers' prices seem to indicate that, *ceteris paribus,* a perception of size as being important actually resulted in size hurting a trader. Furthermore, *RLRGE* was the only information variable in table 4 with a positive impact on profits for both sellers and buyers. Clearly the impacts of the large traders were being felt by the other traders. It almost seems as if their very presence and the fear they may have generated gave them market liability instead of market power. Other traders may have "ganged-up" on them and exploited their cumbersome size from the very beginning.

As a quality check, mean profits were calculated for all 12 sessions over only the early trading periods 3 and 4 (with the large traders' profits adjusted as suggested earlier). In period 3 the large traders averaged \$5.21, with \$5.13 going to the large buyers and \$5.29 to the large sellers. The four small traders averaged \$6.18, ranging from \$4.59 to \$7.55 per period. The period 4 results showed an even more pronounced bias against the large traders, who averaged only \$4.94 compared to the small traders at \$6.28. The large seller's profit of \$5.01 was the larger of the two large traders' profits, but was less than the lowest of the small traders' individual profits of \$5.68. Thus, both periods 3 and 4 seemed to reflect early diminished profits for the large traders. Some researchers maintain that a concentrated industry characterized by large firms is inherently inefficient, since large firms are slow and awkward adjusters to changes in market conditions. These results provide support for this conjecture.

A second observation is that the economic content of market information may be less helpful than the source of the information disclosure. Requests for price information (*RPRI*) were hurtful in table 4 for both buyers and sellers, while requests for quantity information were insignificant in all equations on both sides of the market. In addition, except for a few cases, it is hard to find significant economic content in the determinants of information selection in table 5. On the other hand, information on large traders was helpful throughout (as noted above), while information on traders from the same side of the market enhanced the sellers' quantity sold and information on the order of trades significantly increased buyer profits. The implication is that, in this information processing age, the higher value information may be any information which can be obtained from the larger competitors, with the content of the information inherently less valuable. One further surprise with respect to information selection was the tendency for sellers not to request information on prices. The new two-tiered rail contract disclosure regime places a very high value on rate information, but with all bits of information equally costly and accessible in the experimental setting, sellers chose order-of-trade information more often than price information.

Straightforward extension of these results to the potential impact of information disclosure on rail rates between grain shippers and railroads in the Central/South Plains is difficult, although certain inferences can be drawn. The first is that although there appears to have been no early bias to the advantage of either side of the market, sellers were quickly taken down as trading progressed through the six trading periods. Period 3 profits saw sellers averaging \$6.52 and buyers averaging \$5.20 per trader. In period 4 profit gaps narrowed and profit patterns reversed, with buyers averaging \$6.10 and sellers averaging \$5.57 per trader, in spite of no information dissemination between periods 3 and 4. The gap continued to narrow through the remaining periods and the buyer dominance continued, as buyers averaged \$5.93 over periods 5 through 8, with sellers averaging \$5.72 per trader. The table 4 results revealed some price advantage to the sellers with full information disclosure, implying that either time or partial information disclosure was to the benefit of the buyers. This leads to the second inference we can draw, that when sellers have no information on competitors' prices, they may be more aggressive and more "willing to deal." Full disclosure may allow for some price coordination, removing a measure of competition from among the sellers and resulting in price increases. The full disclosure results do support Hong and Plott, and Grether and Plott, who found that posted prices led to higher prices.

These results also are consistent with recent econometric evidence based on an analysis of geographic price spreads which shows that real rail rates over the study region's major transportation corridors have edged upward since the implementation of the information disclosure policy (Fuller, Ruppel, and Bessler). Furthermore, rate disclosure may be responsible for the reduced use of grain transport contracts. In 1986 an estimated 63% of rail grain moved under contract, whereas by 1988 the share had dropped to 40% (Association of American Railroads). If increased contracting was in fact responsible for lower rates during

the early Staggers years, the fear of information disclosure requirements may be directly or inadvertently linked to the decreased number of contracts, thereby contributing to higher rates.

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Notes

[1] That is, prices may increase, decrease, or remain relatively unchanged and market efficiency may be enhanced or impeded.

[2] Data generated by the experiment were also used in an assessment of market efficiency (Ruppel, Fuller, and McKnight). That study, which used analysis of variance techniques, contains greater detail on the study region under consideration.

[3] In pilot runs, a tendency had been observed for second and third trades between identical subjects at "distorted" prices or involving only a few units traded. The intent behind placing the limitation on the number of trades was to diminish the likelihood of these "meaningless" transactions.

[4] See the appendices in Ruppel, Fuller, and McKnight for sample low demand–low supply resale and cost schedules and for detailed participant instructions.

[5] No prior information was given to participants about minimum payouts, but when earnings were low, subjects were paid a minimum of $10 per session. The highest payout for an individual participant was $27. Over all 12 sessions, the total payout was 97.4% of the expected payout.

[6] Either prices or quantities could be estimated in a system, but not both. These 2SLS equations are separate estimates of the same system, but reflect how the information variables affect the dependent variables differently.

[7] Modified coefficients are relevant for the two variables which constitute an interaction term (*SLR* and *LPRI*). These modified coefficients were used in calculating changes in probabilities for these two variables, although the actual estimated coefficients are reported in table 5.

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