1984

Monopoly Behaviour, Decentralized Regulation, and Contestable Markets: An Experimental Evaluation

Glenn W. Harrison

Michael McKee

7012

ECONOMICS AND LAW WORKSHOP

84-01

MONOPOLY BEHAVIOUR, DECENTRALIZED REGULATION, AND CONTESTABLE MARKETS: AN EXPERIMENTAL EVALUATION

Glenn W. Harrison
Michael McKee

January 12, 1984
4:00 p.m.
4032 SSC

Major funding for the Centre for Economic Analysis of Property Rights has been provided by the Academic Development Fund, The University of Western Ontario. Additional support has come from The Bureau of Policy Coordination, Consumer and Corporate Affairs. The views expressed by individuals associated with the Centre do not reflect official views of the Centre, The Bureau of Policy Coordination, or The University of Western Ontario.

MONOPOLY BEHAVIOUR, DECENTRALIZED REGULATION, AND CONTESTABLE MARKETS: AN EXPERIMENTAL EVALUATION

by

Glenn W. Harrison
Michael McKee*

January, 1984

*Department of Economics, University of Western Ontario.
We are grateful to the Centre for Economic Analysis of Property Rights for financial support.

CONTENTS

Tables

1. Introduction

In an important study Smith [1981] experimentally explored the effect of market organization on monopoly power. He found that a single increasing-cost posted-offer (PO) monopoly market favoured the seller relative to a number of alternative institutional environments.[1] This market converged rapidly to the theoretical monopoly equilibrium. A notable feature of buyer behaviour in this experiment was the total absence of any attempt to strategically withhold demand. Coursey, Isaac and Smith [1983] report the results of four decreasing-cost PO monopoly markets with less conclusive results. Specifically, average monopoly power is significantly less than in the earlier study using increasing costs. In the latter experiments strategic behaviour by buyers appears to have been important; Coursey, Isaac and Smith [1983; p. 20] note:

> Our observation was that a principal problem facing the monopolists was withholding of demand by buyers. Given the decreasing cost schedule of our monopolists, withholding of demand hits the seller at his most profitable units. Small amounts of withholding resulted in very large reductions in seller's profits. Buyer withholding occurred at a much higher rate in the monopoly experiments than in the duopoly experiments (9.14% vs. 1.16%). This tended to discipline the monopolists against attempts to increase price. This discipline appeared to weaken in 3 of the 4 experiments as the experiment progressed beyond about 15 periods. [footnote omitted]

One objective of the present study is to isolate the effect on monopoly behaviour in a PO market of changing cost conditions. We control for the extent of strategic buyer withholding by artificially simulating buyer behaviour in a computerized PO environment.[2] We also extend the experimental study of PO monopoly behaviour to a constant cost environment. A subsidiary

objective is also to simply increase the sample of PO increasing-cost experiments.[3]

The standard textbook treatment of monopoly regulation leaves the student facing the Scylla of efficiency loss with "average cost pricing" (or "rate of return regulation") or the Charybdis of the heavy informational requirements of "marginal cost pricing" (cf. Call and Holahan [1980; pp. 331 ff.] or Hirshleifer [1980; pp. 348 ff.]). Loeb and Magat [1979] proposed a method of decentralized regulation of monopoly which avoids the requirement that the regulatory agency have any information concerning cost curves. The basic method requires the agency to subsidize the monopoly by the amount of consumer's surplus generated at the price charged by the seller. The profit-maximizing choice of price and output is identical to that of MC pricing, with attendant attractive efficiency properties. Sharkey [1979] notes that the Loeb/Magat method represents "...an experiment in the design of social institutions... [that is]...undoubtedly worthy of more detailed examination on an industry-specific level." (p. 405). The second major objective of the present study is to undertake an experimental examination of the basic Loeb/Magat proposal under varying cost conditions.[4]

The final objective of the present study is to examine two further institutions in terms of their effectiveness in restraining monopoly power in a decreasing cost ("natural monopoly") environment. The major weakness of the basic Loeb/Magat proposal for decentralized regulation is the size of the subsidy required (cf. Sharkey [1979]). There are several ways to mitigate this expense without destroying the advantages of the scheme.

One obvious possibility, suggested by Loeb and Magat [1979; Section II], is to combine the subsidy with the initial sale of a franchise to serve the market as a sole supplier.[5] This hybrid institution therefore combines the rent-dissipating features of such franchise bidding arrangements (cf. Demsetz [1968]) with the attainment of efficiency in price and output decisions (cf. Telser [1969]). One feature of our experiments with the franchise bidding stage is the control for risk-neutrality in our subjects, using the experimental methods developed in Becker, DeGroot and Marschak [1964] and Harrison [1984(a)].

The other alternative institution we examine is to allow the market to be directly contestable by two or three potential sellers with zero entry costs (see Baumol [1982] for a review). Coursey, Isaac and Smith [1983], hereafter CIS, present experimental evidence that convincingly supports a "weak version" of the contestable markets hypothesis (that observed behaviour will be closer to competitive rather than monopoly predictions), but that is less convincing with respect to a "strong version" of the hypothesis (that observed behaviour converges to and attains competitive rather than monopoly predictions). Our results are intended to complement these in several respects. First, we control for strategic demand withholding as noted earlier. Second, we examine the effect of increasing the number of contestants from two to three. Third, we control for the aversion to risk of contestants matched with each other, ensuring that all subjects are approximately risk-neutral. Fourth, we allow "revalation of demand" and "collusion" as treatments in separate experiments.

In Section 2 we develop our experimental design and in Section 3 our theoretical predictions. The results are presented and evaluated in Section 4, and concluding remarks offered in Section 5.

2. Experimental Design

Twenty-nine PO monopoly experiments with "experienced" subjects[6] were conducted using computerized seller-input and simulated buyer behaviour. All subjects were honours undergraduates in economics at the University of Western Ontario. They were told that they would be paid a predetermined fraction of their earnings in these experiments; this fraction was set at one-tenth for all experiments, providing an expected monetary reward comfortably in excess of their likely opportunity cost for the time involved.[7] By all casual signs subject motivation was excellent.

Table 1 identifies the various experiments conducted by (i) the institution adopted, (ii) the cost conditions, (iii) the number of potential sellers, and (iv) the risk-neutrality of subjects. Note that at <u>least</u> 50% of the experimental subjects in any one design (e.g., UMI, UMC or UMD) were risk-neutral, and in the FM and CM series <u>all</u> subjects were risk-neutral. Two additional treatments were incorporated in the FM and CM series: (i) in FM5 and CM4 no attempt was made to forbid attempts at explicit collusion, and (ii) in CM2 and FM3 the demand curve was revealed to both subjects at the outset of the experiment and at the beginning of each period.

Appendix A (available on request) presents the complete set of experimental instructions for each design. All markets were conducted on a computerized posted-offer basis, corresponding in essentials with the institution studied by Ketcham, Smith and Williams [1983], CIS, Coursey, Isaac,

TABLE 1

Experimental Design

Institution	Experiment ID	Cost Condition	Shift Parameter	Number of Potential Sellers	Risk Neutral Seller(s)
Unregulated Monopoly	UMI1	Increasing	$1.76	1	Yes
	UMI2	Increasing	1.76	1	No
	UMI3	Increasing	1.76	1	Yes
	UMI4	Increasing	1.76	1	Yes
	UMC1	Constant	1.76	1	Yes
	UMC2	Constant	1.76	1	No
	UMD1	Decreasing	1.76	1	No
	UMD2	Decreasing	1.76	1	Yes
	UMD3	Decreasing	1.76	1	Yes
	UMD4	Decreasing	1.76	1	No
Regulated Monopoly	RMI1	Increasing	1.31	1	Yes
	RMI2	Increasing	1.31	1	No
	RMI3	Increasing	1.31	1	Yes
	RMI4	Increasing	1.31	1	Yes
	RMC1	Constant	1.31	1	Yes
	RMC2	Constant	1.31	1	No
	RMD1	Decreasing	1.31	1	No
	RMD2	Decreasing	1.31	1	Yes
	RMD3	Decreasing	1.31	1	Yes
	RMD4	Decreasing	1.31	1	No
Franchise Monopoly	FM1	Decreasing	3.64	2	Yes
	FM2	Decreasing	3.64	2	Yes
	FM3	Decreasing	3.64	2	Yes
	FM4	Decreasing	3.00	3	Yes
	FM5	Decreasing	3.00	3	Yes
Contested Monopoly	CM1	Decreasing	3.86	2	Yes
	CM2	Decreasing	3.86	2	Yes
	CM3	Decreasing	2.66	3	Yes
	CM4	Decreasing	2.66	3	Yes

Luke and Smith (CILS) and Harrison and Williams [1984].[8] We shall describe the procedural features of the UM design; each of the other designs are variants in a procedural sense.

Each subject is located at a computer terminal and the program executed. The number of periods to be conducted is initialized in full view of the subject. In each period the seller is shown the marginal cost of each of ten units (and knows that the implicit cost of further units is infinite). The seller is rewarded by the difference between the offer price of each unit (which is uniform for all units) and the unit costs for the quantity sold. These costs could, of course, be increasing, constant or decreasing. Inventories or carry-over of unfilled orders from buyers are not permitted (i.e., sales are "to order"); hence the given marginal cost schedule induces a theoretical flow supply schedule (cf. Smith [1976]).

After the display of cost conditions in each period, the seller is prompted for a price and quantity offer. Given the price offer, the quantity offer is restricted in a natural way.[9] The seller is informed of the potential trading profit if all units offered are sold, and then asked to confirm or revise the prevailing price/quantity offer. Offers may be revised any number of times before the seller faces buyers. When an offer is confirmed the seller is informed of the number of units purchased by buyers and the corresponding trading profit or loss (on a "per unit sold" and "total" basis). A trading commission of 5 cents per unit sold is also paid.

The RM series varies this procedure in one essential respect. Each seller is informed that he will receive a subsidy equal in value to the area under the demand curve and above the selling price in addition to the trading

profit or loss. The seller is informed of the actual subsidy only after the quantity sold is determined (also on a "per unit sold" and "total" basis).

The FM series adds a franchise bidding stage to the RM experiment at the beginning of each period. The potential sellers are informed that the preliminary auction for the right to be a monopolist in that period will be conducted as a Second-Price sealed-bid auction. The winner of this auction is the highest bidder, but the amount paid for the franchise is the second highest bid (tied high bids are resolved by a random mechanism). We discuss our choice of sealed-bid auction below. In all other respects the FM series was identical to the RM series once the seller had been determined in each period. The seller was allowed private access to the terminal to initialize his offer and discover his resulting total profit (composed of trading profit/loss plus subsidy minus franchise payment). At the end of trading in each period all subjects were informed of the price and quantity offer of the seller, and each component of his total profit.

The CM series is a simple variant on the UM series: each subject privately enters a price/quantity offer after privately being informed of the cost schedule for each period. When all offers have been initialized and "confirmed" every subject is informed of the price and quantity offers of all sellers, and the market is opened to buyers. Purchases are first made from the seller posting the lowest price, and then from the seller with the next highest price, and so on, until there is no further demand or the seller's maximum quantity offer is sold. Note that the first set of infra-marginal buyers will purchase from the lowest-price seller, leaving buyers with lower marginal valuations for the next lowest-price seller, and so on. Following

CIS and CILS, sellers are only informed of their own sales and trading profits.

Table 2 presents marginal revenue (MR) and cost schedules for several of the experiments. The MR schedules for the UM and RM series are shown in full. The MR schedules for the FM and CM series were obtained from the schedule for the UM series by varying a parameter-disguising shift parameter (see Table 1). Note that we induced a "kink" in the demand curve in the RM experiments in order to reduce the subsidy payout; this only affects the marginal valuations for the first five units. The three marginal cost (MC) schedules for a single shift parameter of $1.76 are shown in Table 2. The MC schedules for all experiments were obtained by simply varying the shift parameter. This use of a shift parameter follows CIS and CILS.[10]

3. Theoretical Predictions

Table 3 presents our theoretical predictions for all relevant variables. Our Monopoly predictions adopt the familiar MC = MR rule to determine quantity, and then defines price from the demand curve at that quantity. The Competitive predictions define price and quantity at the intersection of MC and the demand curve. Given the non-strategic demand behaviour that is assumed, we may focus attention on the alternative trading profit and/or total profit predictions. It is useful to decompose our predictions about monopoly behaviour into three possible components: the trading behaviour of the (ex post) seller, the degree of subsidy utilization, and the franchise bidding behaviour.

A convenient summary statistic for the trading behaviour of each (ex post) seller in all experiments is the Index of Monopoly Trading

TABLE 2

Marginal Revenue and Cost Schedules

	Demand Parameters						
	Price = AR		MR		Marginal Cost		
Unit	UM	RM	UM	RM	IC	CC	DC
1	$4.13	2.68	3.88	2.63	$0.63	2.13	2.88
2	3.88	2.63	3.38	2.53	0.88	2.13	2.63
3	3.63	2.58	2.88	2.43	1.13	2.13	2.63
4	3.38	2.53	2.38	2.33	1.38	2.13	2.13
5	3.13	2.48	1.88	2.23	1.63	2.13	1.88
6	2.88	2.43	1.38	1.43	1.88	2.13	1.63
7	2.63	2.18	0.88	0.43	2.13	2.13	1.38
8	2.38	1.93	0.38	-0.07	2.38	2.13	1.13
9	2.13	1.68	-0.12	-0.57	2.63	2.13	0.88
10	1.88	1.43	-0.62	-1.07	2.88	2.13	0.63
11	1.63	1.18	-1.12	-1.57	∞	∞	∞
12	1.38	0.93	-1.62	-2.07			
13	1.13	0.68	-2.12	-2.57			
14	0.88	0.43	-2.62	-3.07			
15	0.63	0.18	-3.12	-3.57			
Shift Parameter Assumed	1.76	1.31	1.76	1.31	1.76	1.76	1.76

Notation: AR = Average Revenue; MR = Marginal Revenue;
UM = Unregulated Monopoly; RM = Regulated Monopoly;
IC = Increasing Cost; CC = Constant Cost;
DC = Decreasing Cost.

TABLE 3

Theoretical Predictions

Experiment Series	Shift Parameter	Variable	Monopoly Predictions	Competitive Predictions
UMI	$1.76	Price	3.13	2.38
		Quantity	5	8
		Trading Profit	10.25	7.40
UMC	1.76	Price	3.38	2.13
		Quantity	4	9
		Trading Profit	5.20	0.45
UMD	1.76	Price	3.13	1.88
		Quantity	5	10
		Trading Profit	1.75	4.00
RMI	1.31	Price	2.43	1.93
		Quantity	6	8
		Trading Profit	8.88	7.40
		Subsidy	0.75	4.00
		Total Profit	9.33	11.40
RMC	1.31	Price	2.48	1.68
		Quantity	5	9
		Trading Profit	4.25	0.45
		Subsidy	0.50	6.00
		Total Profit	4.75	6.45
RMD	1.31	Price	2.43	1.43*
		Quantity	6	10
		Trading Profit	4.10	1.75
		Subsidy	0.75	8.25
		Total Profit	4.85	10.00
FM	3.64	Price	5.01	3.76*
		Quantity	5	10
		Trading Profit	4.00	1.75
		Subsidy	2.50	11.25
		Franchise Bid	6.50	13.00
		Total Profit	0.0	0.0
FM	3.00	Price	4.37	3.12*
		Quantity	5	10
		Trading Profit	4.00	1.75
		Subsidy	2.50	11.25
		Franchise Bid	6.50	13.00
		Total Profit	0.0	0.0
CM	3.86	Price	5.23	3.81
		Quantity	5	10
		Trading Profit	4.00	0.05
CM	2.66	Price	4.03	2.61
		Quantity	5	10
		Trading Profit	4.00	0.05

Note: An asterisk indicates that there is an interval of prices consistent with competitive profit maximization (see text).

Effectiveness (M) adopted by Smith and Williams [1982], CIS and CILS:

$$M = \frac{\pi - \pi_c}{\pi_m - \pi_c} ,$$

where π denotes the observed <u>trading</u> profit (in one or more periods), π_m denotes the theoretical monopoly trading profit, and π_c denotes the theoretical competitive trading profit.[11] The values of π_c and π_m for each experiment are shown in Table 2. Clearly $M \gtreqless$ as $\pi \gtreqless \pi_c$, and the maximum value of M (M=1) is attained if $\pi = \pi_m$.[12] The size of the subsidy required to induce competitive trading behaviour in the two Loeb/Magat decentralized regulation experimental series (RM and FM) may be measured by an Index of Subsidy Utilization (S):

$$S = \frac{\sigma}{\sigma_c} ,$$

where σ denotes the observed subsidy payment (in one or more periods) and σ_c denotes the subsidy entitlement at the theoretical competitive equilibrium (viz., the maximum possible entitlement). The predicted values of σ_c are shown in Table 3. Finally, we can define an Index of Rent Dissipation (R):

$$R = \frac{\rho}{\pi + \sigma} ,$$

where ρ denotes the observed amount <u>paid</u> (in one or more periods) at the franchising stage. Note that ρ is not the winning bid (i.e., recall that our franchise bid was conducted as a Second-Price sealed-bid auction).

A minor indeterminacy in our theoretical competitive predictions in the RMD and FM designs is indicated in Table 3 by an asterisk. In each

of these cases there is a range of prices supporting the competitive outcome and resulting in identical total profit. At prices lower than those indicated in Table 3 trading profit is reduced (or trading loss increased) but exactly offset by an increase in the subsidy received. Lower bounds on competitive price are well-defined, and define intervals for the competitive trading profit and subsidy.[13] We have no specific prediction as to behaviour within these intervals, but list in Table 3 the highest price supporting a competitive outcome.

We assume in Table 3 that the non-cooperative outcome of the franchise bidding stage will involve each subject bidding his expected rent from owning the franchise. The setting for our sealed-bid auction is akin to the "common value model" of Milgrom [1981] and Milgrom and Weber [1982], rather than the "independent private values model" of Vickrey [1961] and Cox, Roberson and Smith [1982]. Our presumption of full-value bidding behaviour is supported by Theorem 6 of Milgrom and Weber [1982; pp. 1100-1101] as well as the experiments reported in Harrison [1984(a)]. Revelation of the demand curve in FM3 was partly motivated by Theorem 8 of Milgrom and Weber [1982; pp. 1102-1103], which indicates that expected revenue from the franchise bidding stage will not decrease if such information is revealed (with certainty).

We do not distinguish the effect of varying the number of contestants from 2 to 3 on the theoretical predictions for the FM and CM designs. Theory is silent on the question of how many contestants are needed to achieve competitive results, although most economists would have a strong prior in favour of larger numbers (but see Smith and Williams [1982] on the

robustness of competitive theory with "small numbers" under the double-auction institution). Sherman and Willet [1967] discuss the competitive effect of uncertainty concerning the existence of potential entrants, but in our experiments the number of entrants is known with certainty. However, the number of effective contestants, in terms of their expected behaviour, is less certain, providing some support for our prior (also see Robson [1981]). There is some experimental evidence in Cox, Roberson and Smith [1982] that is consistent, along with other explanations, with cooperative bidding behaviour in Second-Price sealed-bid auctions when there are only three bidders. Again, however, this evidence is only suggestive, since the model appropriate to our franchising stage is different in a fundamental respect from the model employed in interpreting their evidence (as discussed earlier).

4. Experimental Results

Tables 4, 5, 6 and 7 present the values for the three indices of monopoly behaviour for each period of each relevant experiment, along with pooled results. Appendix B lists the detailed results for each experiment.

4.1 Monopoly Behaviour

Consider the pooled trading effectiveness indices of the UM institution differentiated by cost conditions.

The UMI series leads to a pooled index over all periods of -0.10, indicating ineffective monopoly behaviour. However, some convergence towards an effective monopoly over time is apparent in the pooled results for each period. More importantly, all of the UMI experiments except UMI2 involved risk-neutral sellers. If we exclude UMI2 we obtain pooled indices of

TABLE 4

Indices of Monopoly Trading Effectiveness

Experiment Number	Period	Increasing Cost		Constant Cost		Decreasing Cost			
		UM	RM	UM	RM	UM	RM	FM	CM
1	1	-0.67	-6.72	0.45	-1.42	0.84	0.66	-5.60	0.23
	2	-0.04	-8.41	-0.09	0.0	0.37	0.52	-3.16	0.0
	3	0.77	-10.10	0.67	0.45	0.68	0.60	-1.16	0.08
	4	0.21	-12.80	0.81	-0.34	0.81	0.36	-1.16	0.33
	5	0.61	-3.68	0.87	-0.79	0.68	0.09	-1.16	0.23
	6	0.77	-2.32	0.98	-0.54	0.45	0.40	-5.60	0.20
	7	0.86	0.30	0.93	-1.95	0.41	0.29	-8.04	0.18
	8	0.91	-0.97	0.84	0.01	0.78	-0.09	-5.60	0.08
2	1	-1.48	-4.27	0.67	0.88	0.53	0.36	-0.04	0.43
	2	-1.42	-5.37	0.63	0.90	0.71	-0.29	-3.38	0.76
	3	-1.45	-4.70	0.60	0.76	0.71	-0.77	-4.49	0.41
	4	-1.24	-6.05	0.69	-0.09	0.71	-0.77	-4.49	0.51
	5	-1.60	-4.02	0.70	0.91	0.71	-0.77	-5.60	0.38
	6	-1.24	-4.02	0.72	0.92	0.71	-0.77	-4.49	0.23
	7	-1.24	-4.02	0.61	0.87	0.71	-0.77	-5.60	0.0
	8	-1.24	-4.03	0.85	0.85	0.71	-0.77	-5.60	0.35
3	1	-0.92	-4.95			0.71	-1.83	-16.67	0.10
	2	0.01	-1.98			0.53	-1.40	-16.67	0.12
	3	0.58	0.86			0.45	-0.98	-16.67	0.10
	4	-2.60	1.11			0.64	-0.98	-16.67	0.0
	5	0.86	-3.07			0.46	-0.98	-16.67	0.08
	6	0.62	-2.40			0.93	-0.98	-16.67	0.13
	7	0.48	-1.98			0.93	-0.98	-16.67	0.0
	8	0.95	-1.98			0.93	-0.98	-16.67	0.10
4	1	-1.15	-6.79			0.71	0.10	-5.87	0.12
	2	0.58	-6.72			0.68	0.52	-0.53	0.0
	3	0.75	-6.66			0.53	0.52	-0.06	0.0
	4	0.54	-7.40			0.64	0.80	-0.53	0.15
	5	0.91	-10.10			0.27	0.80	-0.53	0.10
	6	0.91	-6.79			0.82	0.66	-0.53	0.0
	7	0.91	-6.72			0.93	0.60	-7.20	-0.05
	8	0.91	-6.79			0.46	0.39	-0.53	0.73
5	1							-0.54	
	2							-9.47	
	3							-4.98	
	4							-4.67	
	5							-5.33	
	6							-5.51	
	7							-5.51	
	8							-13.82	

TABLE 5

Pooled Indices of Monopoly Trading Effectiveness

Experiment Number	Period	Increasing Cost		Constant Cost		Decreasing Cost			
		UM	RM	UM	RM	UM	RM	FM	CM
1	all	0.43	-5.59	0.68	-0.57	0.63	0.35	-3.93	0.16
2	all	-1.36	-4.56	0.68	0.75	0.69	-0.57	-4.21	0.38
3	all	-0.002	-1.80			0.70	-1.14	-16.67	0.08
4	all	0.55	-7.25			0.63	0.55	-2.03	0.13
5	all							-6.23	
all	1	-1.06	-5.68	0.56	-0.27	0.70	-0.18	-5.74	0.22
all	2	-0.72	-5.62	0.27	0.45	0.57	-0.16	-6.64	0.22
all	3	0.16	-5.15	0.63	0.60	0.59	-0.16	-5.47	0.15
all	4	-0.77	-6.28	0.75	-0.22	0.70	-0.15	-5.50	0.25
all	5	0.20	-5.22	0.76	0.06	0.53	-0.21	-5.86	0.20
all	6	0.27	-3.88	0.85	0.19	0.73	-0.17	-6.56	0.14
all	7	0.25	-3.11	0.77	-0.54	0.75	-0.21	-8.60	0.03
all	8	0.38	-3.44	0.84	0.43	0.72	-0.36	-8.44	0.31
all	all	-0.10	-4.80	0.68	0.09	0.66	-0.24	-6.60	0.19

TABLE 6

Indices of Subsidy Utilization

Experiment	Period 1	2	3	4	5	6	7	8	all
RMI1	3.14	3.76	4.39	5.39	2.36	1.86	0.88	1.36	2.89
RMI2	1.91	2.64	2.39	2.89	2.14	2.14	2.14	2.14	2.30
RMI3	0.62	1.58	0.53	0.18	1.73	1.48	1.58	1.58	1.16
RMI4	3.16	3.14	3.11	3.39	4.39	3.16	3.16	3.16	3.33
RMI (Pooled)	2.21	2.78	2.61	2.96	2.66	2.16	1.94	2.06	2.42
RMC1	2.09	1.00	0.59	1.27	1.59	1.39	2.51	0.99	1.43
RMC2	0.16	0.14	0.12	0.00	0.14	0.13	0.17	0.18	0.13
RMC (Pooled)	1.13	0.57	0.36	0.64	0.87	0.76	1.34	0.59	0.78
RMD1	0.34	0.22	0.51	0.43	0.66	0.73	0.76	0.87	0.57
RMD2	0.43	0.92	1.22	1.22	1.22	1.22	1.22	1.22	1.08
RMD3	1.53	1.40	1.28	1.28	1.28	1.28	1.28	1.28	1.33
RMD4	0.05	0.22	0.22	0.30	0.30	0.34	0.36	0.26	0.26
RMD (Pooled)	0.59	0.69	0.81	0.81	0.87	0.89	0.91	0.91	0.81
RM (Pooled)	1.34	1.05	1.44	1.64	1.58	1.37	1.41	1.30	1.44
FM1	2.12	1.63	1.23	1.23	1.23	2.12	2.61	2.12	1.79
FM2	1.01	1.68	1.09	1.09	2.12	1.09	2.12	2.12	1.84
FM3	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33
FM4	2.17	1.11	0.90	1.11	1.11	1.11	2.44	1.11	1.38
FM5	0.99	2.89	2.00	1.93	2.07	2.07	2.07	3.76	2.22
FM (Pooled)	2.12	2.33	2.07	2.10	2.17	2.31	2.71	2.65	2.31

TABLE 7

Indices of Rent Dissipation

Experiment	Period 1	2	3	4	5	6	7	8	all
FM1	0.88	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98
FM2	0.19	0.73	0.79	0.99	0.99	1.00	1.00	1.00	0.84
FM3	1.00	0.0	1.00	1.00	1.00	1.00	1.00	1.00	0.87
FM4	0.77	0.94	1.07	0.96	0.98	0.99	1.00	1.00	0.96
FM5	0.11	0.23	0.38	0.65	0.85	0.77	1.00	0.98	0.62
all	0.61	0.78	0.71	0.92	0.96	0.95	1.00	1.00	0.85

-0.92, 0.18, 0.70, -0.61, 0.79, 0.77, 0.75 and 0.92 in periods 1 through 8, respectively, giving an overall pooled index of 0.32. Moreover, the noticeable drop in effectiveness in period 4 is due solely to an exceptionally high price offer (leading to zero sales) in UMI3; immediately thereafter this seller returned to being an effective monopolist. The results for the UMC and UMD series (M = 0.68 and M = 0.66, respectively) indicate effective monopoly behaviour, with pooled indices closer to one than zero.

How do our results compare with the single increasing cost PO monopoly experiment in Smith [1981] and the four decreasing cost experiments in CIS? Recall that the major difference between our UM design and these previous studies is our control of buyer withholding (i.e., ruling it out), leading us to expect greater monopoly effectiveness in our experiments. A non-parametric Mann-Whitney (MW) statistic is used for these comparisons.[14] The probability that our UMD experiments have higher pooled values of M than the four CIS experiments is at least 0.876,[15] confirming our presumption about the effect of ruling out demand withholding in a decreasing cost environment. Comparisons with the experiment in Smith [1981][16] lead to the opposite result: the probability of our indices for UMI being greater than his, even excluding our UMI2, is a mere 0.003. It should be noted that in Smith's experiments

> ...the seller position was not a random assignment among the subjects. In each experiment an effort was made to preselect a subject to be the seller--someone who was thought not likely to be "easy on the buyers". [In the PO monopoly experiment there...]...was not a single instance of strategic behavior on the part of a buyer. [...] In postexperiment discussion, several buyers commented that they felt there was nothing else they effectively could do. In spite of the fact that strategic purchase behavior is possible, the buyers in this experiment

> perceived that they had no effective recourse but to accept a take-it-or-leave-it price. Consequently, the experiment was behaviorally mechanical, even boring. (Smith [1981; pp. 86, 92])

We conjecture that the behaviour of Smith's human buyers parallels our simulated buyers, and that his single experiment had a seller that was simply more aggressive (on average) than ours.

What effect did cost conditions have on monopoly trading effectiveness? A MW test indicates that UMC was more effective than UMI with 0.983 probability (0.815 excluding UMI2), and that UMD was also more effective than UMI with 0.989 probability (0.673 excluding UMI2). Finally, UMC was more effective than UMD with probability 0.723. These results indicate the following ordering of monopoly trading effectiveness: constant cost conditions are more favourable to monopoly behaviour than decreasing cost, with increasing cost conditions the least favourable.

4.2 Effect of Decentralized Regulation

In terms of trading behaviour, it is clear from Tables 4 and 5 that the Loeb/Magat scheme provides an extremely powerful incentive for competitive behaviour relative to the unregulated monopoly. The only RM series with an overall pooled index that is positive is the RMC design (M = 0.09), and in this case the experiment with a risk-neutral seller (RMC1) has a negative index over all periods (M = -0.57). Similarly, the results for the RMD design are even stronger if we exclude the two experiments that do not employ risk-neutral sellers (RMD1 and RMD4). Consistent with these results, we find in Table 6 that the subsidy entitlement is heavily used (i.e., negative values of M correspond to values of S exceeding unity).

A MW test supports the hypothesis that the RM design has a lower index of monopoly effectiveness than the corresponding UM design with probability 1.0 for increasing cost, 0.886 for constant cost (0.999 excluding UMC2), and 1.0 for decreasing cost. Similarly, the FM series has lower indices than the UMD design with probability of one.

Does the franchise bidding stage dissipate the rent generated by the basic Loeb/Magat scheme? The results in Table 7 indicate an overwhelmingly positive answer to this question. Convergence to full rent dissipation (R = 1) is rapid in all experiments except FM5, and in that case convergence is nonetheless sustained and complete by period 7.

Table 8 presents the sequence of franchise bids in each experiment, with an asterisk indicating the amount paid by the winner. The results from FM3, in comparison with FM1 and FM2, support Theorem 8 of Milgrom and Weber [1982]: revealing the demand curve, thereby improving each bidder's (subjectively stochastic) valuation of the value of the franchise, does increase the revenue of the auction. A MW test provides 80.4% confidence in this conclusion (92.9% confidence excluding the attempted collusive signalling by subject 1 in period 3 of FM3).

4.3 Effect of Direct Contestability

It is clear from the indices in Tables 4 and 5 that the CM design exhibits significantly lower monopoly effectiveness than the UMD design (MW test probability of 1.0). However, the CM design does not restrain monopoly power as powerfully as either the RMD design (MW test probability of 0.84, and a probability of 1.0 excluding RMD1, RMD4 and CM2) or the FM

TABLE 8

Sequence of Franchise Bids

Period	Subject	Experiment FM1	FM2	FM3	FM4	FM5
1	1	11.50*	2.50*	13.00*	10.00	2.95
	2	14.00	9.53	13.01	10.00*	1.00
	3				1.00	1.25*
2	1	13.00	12.92	13.00*	11.76	2.95*
	2	12.99*	9.53*	13.01	12.25*	10.00
	3					
3	1	13.01*	12.92	0.01*	12.01	5.00*
	2	13.02	10.25*	13.10	12.49*	2.95
	3				13.00	6.10
4	1	13.05*	12.92*	13.00*	12.01	8.50*
	2	13.06	13.01	14.01	12.50*	8.01
	3				12.50	10.05
5	1	13.10*	12.88*	13.00*	12.75*	10.01
	2	13.11	12.99	14.01	13.00	11.01*
	3				12.50	11.10
6	1	13.25	13.00	13.01*	12.90*	10.01
	2	13.04*	12.99*	14.01	13.00	10.04
	3				12.80	11.05
7	1	13.01*	12.95*	13.01*	13.02	18.57
	2	13.02	12.99	14.01	13.00*	13.00*
	3				12.95	12.10
8	1	13.02	12.97*	13.01*	12.99*	11.11
	2	13.00*	12.99	14.01	13.00	13.01
	3				12.99	12.75*

design (MW test probability of 1.0).

An artifact of our RMD and FM parameter choice, noted in Section 2, allows the seller to incur lower trading profits than we assume for π_c while still earning the same total π (the subsidy makes up the difference). As a consequence the RMD and FM indices of monopoly effectiveness may fall significantly below zero (and still be consistent with competitive behaviour) whereas the CM index of monopoly effectiveness is bounded below at zero by competitive behaviour.[17] However, even if all negative values of the index M for the UMD or FM design are set to zero, our conclusion with respect to their monopoly effectiveness relative to the CM design remains intact.

How do our results compare with the six decreasing-cost contestable markets of CIS? The differences are striking: our experiments exhibit uniformly lower monopoly trading effectiveness than the pooled CIS experiments. This conclusion is accepted with a MW test confidence of 100%, comparing the pooled results in both series for the initial eight periods; this confidence reduces slightly to 96.7% if all eighteen periods of the pooled CIS experiments are used, and is 98.1% if we only use our two-seller experiment (CM1) for comparison. We therefore conclude that prohibiting strategic demand withholding and controlling for risk-neutrality leads to even stronger support for the contestable markets hypothesis than in CIS.

4.4 Effects of Collusion, Demand Revelation, and the Number of Contestants

It appears that allowing collusion in FM5 and CM4 had little effect on their monopoly trading effectiveness (in comparison with FM4 and CM3, respectively). The only noticeable result in the CM design was a

capitulation of sellers 2 and 3 in the last period of CM4, when they posted suicidal price-offers of $10.00 and $12.00. We conjecture that such behaviour was due to "end period effects". In any case, a MW test is unable to distinguish if the indices of CM3 and CM4 arise from different populations.

Even setting the large negative trading effectiveness indices in FM5 to zero, we find that FM5 still has significantly lower values than FM4 (MW test probability of 0.982). From casual observation of the experiment it is apparent that the subjects had publicly discussed the set of profit-maximizing competitive trading strategies. In effect they had agreed to orient their cooperative activities to the franchise bidding stage. Indeed they were successful in periods 1 through 3 in generating significantly greater rent at the trading stage than was paid at the franchising stage (see Table 7). Note also from Table 8 that each subject was the monopolist in one period during the initial three periods. Non-cooperative behaviour took hold at the franchising stage in periods 4, 5 and 6, with subject 3 maintaining his hold over the monopoly.

Revealing the demand curve in FM3 (relative to FM1 and FM2) and CM2 (relative to CM1) did have clear effects on monopoly trading effectiveness. However, the effect was qualitatively opposite in the two institutions. In the FM design revelation led to near-perfect competitive behaviour, with the exception of the tacit collusive franchise bid signal of subject 1 in period 3 of FM3. In the CM design the effect of revelation was to encourage monopoly behaviour; a MW test supports this conclusion with 99.1% confidence.

Increasing the number of contestants from two to three in FM4 (relative to FM1 and FM2) and CM3 (relative to CM1) had some noticeable effects on behaviour. Monopoly trading effectiveness in FM4 is not significantly lower (recall that larger negative values in the FM design do not signify much), although the degree of rent dissipation in the franchising stage is somewhat lower (MW test confidence of 66.7%). These results serve as some caution to the prior belief that "larger numbers" automatically leads to more competitive behaviour, although our sample is obviously small. On the other hand, increasing the number of direct contestants in the CM design did significantly restrain monopoly trading effectiveness (MW test confidence of 92.9%).

5. Concluding Remarks

Our experimental results support the following broad conclusions: (i) in the absence of any threat of entry, an unregulated monopolist in varying cost conditions will tend to behave as predicted by standard monopoly theory; (ii) constant and decreasing cost conditions are more conducive to unregulated monopoly trading behaviour than increasing cost conditions; (iii) if the unregulated monopolist is aware that buyers will not strategically withhold demand, his monopoly effectiveness is generally greater, at least in a decreasing cost environment; (iv) the Loeb/Magat scheme to regulate monopolists provides a powerful incentive for competitive behaviour in decreasing cost conditions, whether or not any rent resulting from the monopoly is dissipated by a Demsetz franchise bidding stage; (v) a Vickrey Second-Price sealed-bid auction effectively dissipates any rent from the ownership of a decreasing cost monopoly with an entitlement

to consumer's surplus; (vi) allowing a decreasing cost market to be directly contested by two or three potential sellers significantly reduces monopoly effectiveness; (vii) direct contestability provides less restraint of monopoly power than a decentralized regulation scheme that assumes that the demand curve is known to the regulatory agency; (viii) prohibiting strategic buyer behaviour and ensuring risk-neutral sellers leads to contestable markets that exhibit significantly less monopoly behaviour; (ix) prohibiting explicit collusion among contestants, in a franchising institution or a directly contested market, does not significantly diminish competitive behaviour; (x) revealing the demand curve to contestants in a franchising institution reduces monopoly effectiveness and increases the revenue from the sealed-bid auction; (xi) revealing the demand curve in a directly contested market discourages competitive behaviour; (xii) increasing the number of contestants in a franchising institution has no noticeable effects on trading behaviour, although rent dissipation is slightly lower suggesting diminished competition at the franchising stage; and (xiii) increasing the number of direct contestants does significantly diminish monopoly trading effectiveness.

Clearly these conclusions require several qualifications, as presented in Section 4. Note that our results with respect to the FM and CM institutions only apply to a decreasing cost environment (conclusion (iv) also applies to increasing and constant cost environments in reference to the RM design). Moreover, many conclusions rest on a small sample (eight periods or one experiment, depending on one's definition of the "sample"). Several of our conclusions must therefore be subject to replication by other experimenters before they can be regarded as fully established.

Several directions for further experimental research are indicated. In Harrison and McKee [1984] we examine the effect of "experience" on the behaviour of the four alternative institutions considered in our decreasing cost design, interpreting the results with "inexperienced" subjects as the sort of evidence one might expect to accumulate during a transitional period (cf. Bailey and Panzar [1981] for a more conventional empirical study, with appropriately heavy qualifications concerning lack of "control" for certain critical variables). The natural question to ask is how reliable such evidence is in relation to results with experienced subjects. Direct extensions of our design to consider the FM and CM institutions in non-decreasing cost conditions have already been mentioned. Another variation would be to allow some explicit uncertainty with respect to cost and/or demand schedules, or with respect to the number of potential contestants in the FM and CM designs.

The effect of sunk (entry) costs on direct market contestability has been studied by CILS, and their design could be adapted to our franchising institution. This issue raises more general problems with possible entry equilibria and alternative franchising institutions, namely the treatment of durable or specific factors of production; see Williamson [1976] and Eaton and Lipsey [1980] [1981]. Although the experimental literature on the pricing of assets has grown rapidly, it provides little guidance in this case (cf. Friedman, Harrison and Salmon [1983] for a review). Given the difficulties of designing franchising institutions to deal satisfactorily with these and other features of observed monopolies, theorists have recently turned their attention to the design of optimal incentive compatible regulatory schemes (see Vogelsang and Finsanger [1979], Sappington [1980] and Baron and

Myerson [1982]). These schemes may be evaluated experimentally using variants of our design: see Harrison [1984(b)].

FOOTNOTES

[1] Specifically, this result holds for his comparisons with posted-offer duopoly, offer-auction monopoly, double-auction monopoly, and posted-bid monopoly. All experiments adopted increasing cost conditions.

[2] Coursey, Isaac, Luke and Smith [1983] and Harrison and Williams [1984] examine various PO markets in which non-strategic buyer behaviour is computer simulated. Harrison and Williams [1983; Section 3] evaluate the "realism" of this treatment of buyer behaviour. For present purposes, however, we defend our treatment on the simple grounds that no other way of controlling for strategic buyer withholding is so readily operationalized (viz., if we decide to allow α% withholding in each experiment, questions such as "should this apply to marginal or infra-marginal units offered?" or "should it be concentrated in earlier periods?" arise).

[3] Smith and Williams [1982] report the results of three increasing-cost PLATO double-auction monopoly experiments (these results support the findings of Smith [1981] from three oral double-auction monopoly experiments). We know of no other experimental studies of (unregulated and/or uncontested) monopoly behaviour with variable supply (see Plott [1982; pp. 1501 ff.] for an excellent review of the literature).

[4] Although Loeb and Magat [1979] only deal explicitly with the decreasing-cost case, it is clear that their argument applies to constant-cost and increasing-cost cases. Baron and Myerson [1982] present a general statement of the problem of designing decentralized regulatory schemes, and the Loeb/Magat method emerges as a special case of their optimal scheme.

[5] Loeb and Magat [1979; fn. 8 and Section II] also consider the use of a lump-sum tax on the monopoly (such a tax being calculated independently of the price chosen by the monopolist).

[6]"Experience" consisted of having participated in a previous PO monopoly experiment of at least 15 periods duration. The results with inexperienced subjects are discussed at length in Harrison and McKee [1984], and relate exclusively to a decreasing-cost environment. The monopolist in the single increasing-cost PO monopoly in Smith [1981] was apparently inexperienced (albeit quite an effective monopolist), and the sellers and buyers in the four decreasing-cost PO monopolies in Coursey, Isaac and Smith [1983] all had previous role experience.

[7]The fraction "one-tenth" was also chosen to avoid any difficulties with translating the financial amounts encountered during the experiment into a familiar numeraire currency.

[8]We did not, however, employ the PLATO computer system used in these studies (that system is unavailable to us). Instead, we developed interactive software requiring standard keyboard responses by subjects when prompted. Appendix A provides examples of typical sessions. Note that the UM and RM series did not require any interaction between subjects, only interaction between the computer and each subject (this feature follows from our simulation of buyer behaviour). The subject interaction in the FM and CM series was handled in a simple manner: the experimenter was in charge of the single terminal and controlled the physical access of subjects to the terminal. Although less elegant than having each subject at his own terminal (as in PLATO), this arrangement proved quite effective and fluid. On a technical note, the software to undertake these experiments (available from the first author on request) was in fact written to allow each subject

to be located at his own terminal. We were forced to adopt the "single terminal approach" when it was discovered that we were assigning physical devices (i.e., terminals) to logical units, despite the ferocity of the first author. Such assignments are widely prohibited on most university mainframe computers oriented for "open access".

[9]Specifically, there are four restrictions. First, the quantity offer must be an integer. Second, the quantity offer must be positive. Third, the maximum quantity offer corresponds to the last unit whose cost is less than or equal to the price offer. Fourth, the minimum quantity offer corresponds to the first unit whose cost is less than or equal to the price offer. The third and fourth restrictions did not apply to any experiments other than the UM series.

[10]CIS (footnote 15) were forced to slightly modify their stated parameters in certain (unusual) circumstances; this problem is peculiar to their PLATO software, and is not relevant to our experiments.

[11]All profit measures include commissions, a trivial and harmless departure from previous applications of this measure.

[12]We have defined π_m as the uniform-price theoretical monopoly profit. If price discrimination were allowed, as in the continuous double-auction monopolies of Smith [1981] and Smith and Williams [1982], observed profits could exceed π_m so defined.

[13]In the RMD series, the lower bounds are: Price = 0.18, Quantity = 10, Trading Profit = -10.75, Subsidy = 20.75, and Total Profit = 10.00. In the FM series with a shift parameter of 3.64 (3.00), the lower bounds are:

Price = 2.51 (1.87), Quantity = 10 (10), Trading Profit = -10.75 (-10.75), Subsidy = 23.75 (23.75), and Total Profit = 10.00 (10.00).

[14]We employ a (one-tail) MW test for the "slippage problem"; see Hoel [1971; pp. 310-318] for a formal discussion. We state the test outcomes in terms of the probability of the hypothesis that slippage has occurred in favour of the first-stated experiment (or series of experiments). The alternative hypothesis is that both samples arise from the same population.

[15]This probability compares the pooled results of our UMD series in Table 5 with the pooled results for the first eight periods of the CIS experiments (cf. Table 4 of CIS). Using all eighteen periods for the CIS experiments leads to a probability of 0.884, and comparing our UMD2 and UMD3 (the two experiments with risk-neutral sellers) with the pooled eight-period CIS results gives a probability of 0.965.

[16]One problem is an apparent inconsistency in the results reported by Smith: the price in periods 1 and 3 that is implied by the values of his statistic δ in his Table 2 ($1.25 and $1.00, respectively) do not agree with an "eyeball" of his Chart 5, the stated quantity sold (e.g., quantity in period 1 is stated as 7 units, but the resale value for the fourth through seventh units is less than $1.25), or the stated mean in Table 2 of the δ values for all periods (the stated mean is 0.0026, and the mean computed from the individual values listed is 0.01364). In our calculations prices of $0.95 and $1.00 are adopted for periods 1 and 3 (based on an examination of Chart 5 and a check for consistency with the resale value of the marginal unit sold, assuming correct "quantity sold" figures). The resulting seller profit, including commissions, is therefore $2.50, 2.70, 2.20, 2.25 and 2.70 in periods 1, 2, 3, 4 and 5-11 respectively. The theoretical values are

π_c = \$1.50 and π_m = \$2.70, giving values for M of 0.83, 1.0, 0.58, 0.63 and 1 in periods 1, 2, 3, 4 and 5-11 respectively.

[17]For this reason we do not draw any comparisons between the monopoly trading effectiveness of the RMD and FM series (given that both designs have generally negative indices for risk-neutral sellers). However, a comparison could be drawn if either design had exhibited positive indices. As such we are able to falsify certain (weak) hypotheses concerning relative monopoly effectiveness even in this case.

REFERENCES

Bailey, E. E. and Panzar, J. C., "The Contestability of Airline Markets During the Transition to Deregulation," Law and Contemporary Problems, v. 44, 1981, pp. 125-145.

Baron, D. P. and Myerson, R. B., "Regulating a Monopolist with Unknown Costs," Econometrica, v. 50, 1982, pp. 911-930.

Baumol, W. J., "Contestable Markets: An Uprising in the Theory of Industrial Structure," American Economic Review, v. 72, 1982, pp. 1-15.

Becker, G. M., DeGroot, M. H. and Marschak, J., "Measuring Utility by a Single-Response Sequential Method," Behavioural Science, v. 9, 1964, pp. 226-232.

Call, S. T. and Holahan, W. L., Microeconomics (Wadsworth, Belmont, 1980).

Coursey, D., Isaac, R. M. and Smith, V. L., "Natural Monopoly and Contested Markets: Some Experimental Results," Unpublished Manuscript, Department of Economics, University of Arizona, June 1983; forthcoming, Journal of Law and Economics.

Coursey, D., Isaac, R. M., Luke, M. and Smith, V. L., "Market Contestability in the Presence of Sunk (Entry) Costs," Unpublished Manuscript, Department of Economics, University of Arizona, 1983; forthcoming, Bell Journal of Economics.

Cox, J. C., Roberson, B. and Smith, V. L., "Theory and Behavior of Single Object Auctions," in V. L. Smith (ed.), Research in Experimental Economics (JAI Press, Greenwich, v. 2, 1982).

Demsetz, H., "Why Regulate Utilities?," Journal of Law and Economics, v. 11, 1968, pp. 55-65.

Eaton, B. C. and Lipsey, R. G., "Exit Barriers Are Entry Barriers: The Durability of Capital as a Barrier to Entry," Bell Journal of Economics, v. 10, 1980, pp. 721-729.

Eaton, B. C. and Lipsey, R. G., "Capital, Commitment, and Entry Equilibrium," Bell Journal of Economics, v. 12, 1981, pp. 593-604.

Friedman, D., Harrison, G. W. and Salmon, J. W., "The Informational Efficiency of Experimental Asset Markets," Research Report No. 8320, Department of Economics, University of Western Ontario, September 1983; forthcoming, Journal of Political Economy.

Harrison, G. W., "The Experimental Control of Risk Aversion," Unpublished Manuscript, Department of Economics, University of Western Ontario, 1984(a).

Harrison, G. W., "Incentive Compatible Regulation of Natural Monopoly," Unpublished Manuscript, Department of Economics, University of Western Ontario, 1984(b).

Harrison, G. W. and McKee, M. J., "How Reliable is Transitional Evidence on Alternative Institutions of Monopoly Restraint?," Unpublished Manuscript, Department of Economics, University of Western Ontario, 1984.

Harrison, G. W. and Williams, A. W., "The Effect of Market Organization on Convergence to Non-Stationary Competitive Equilibria," Unpublished Manuscript, Department of Economics, University of Western Ontario, January 1984.

Hirshleifer, J., Price Theory and Applications (Prentice Hall, Englewood Cliffs, Second Edition, 1980).

Hoel, P. G., Introduction to Mathematical Statistics (Wiley, New York, Fourth Edition, 1971).

Ketcham, J., Smith, F. L. and Williams, A. W., "A Comparison of Posted Offer and Double Auction Pricing Institutions," Unpublished Manuscript, Department of Economics, University of Arizona, January 1983; forthcoming, Review of Economic Studies.

Loeb, M. and Magat, W. A., "A Decentralized Method for Utility Regulation," Journal of Law and Economics, v. 22, 1979, pp. 399-404.

Milgrom, P. R., "Rational Expectations, Information Acquisition and Competitive Bidding," Econometrica, v. 49, 1981, pp. 921-943.

Milgrom, P. R. and Weber, R. J., "A Theory of Auctions and Competitive Bidding," Econometrica, v. 50, 1982, pp. 1089-1122.

Plott, C. R., "Industrial Organization Theory and Experimental Economics," Journal of Economic Literature, v. XX, 1982, pp. 1485-1527.

Robson, A. J., "Implicit Oligopolistic Collusion is Destroyed by Uncertainty," Economics Letters, v. 7, 1981, pp. 75-80.

Sappington, D., "Strategic Firm Behaviour Under a Dynamic Regulatory Adjustment Process," Bell Journal of Economics, v. 11, 1980, pp. 360-372.

Sharkey, W. W., "A Decentralized Method for Utility Regulation: A Comment," Journal of Law and Economics, v. 22, 1979, pp. 405-407.

Sherman, R. and Willet, T. D., "Potential Rivals Discourage Entry," Journal of Political Economy, v. 75, 1967, pp. 400-403.

Smith, V. L., "Experimental Economics: Induced Value Theory," American Economic Review (Papers and Proceedings), v. 66, 1976, pp. 274-279.

Smith, V. L., "An Empirical Study of Decentralized Institutions of Monopoly Restraint," in G. Horwich and J. Quirk (eds.), Essays in Contemporary Fields of Economics (Purdue University Press, West Lafayette, 1981).

Smith, V. L. and Williams, A. W., "The Boundaries of Competitive Price Theory: Convergence, Expectations and Transactions Costs," Unpublished Manuscript, Department of Economics, Indiana University (Bloomington), June 1982.

Telser, L. G., "On the Regulation of Industry: A Note," Journal of Political Economy, v. 77, 1969, pp. 937-952.

Vickrey, W., "Counterspeculation, Auctions and Competitive Sealed Tenders," Journal of Finance, v. 16, 1961, pp. 8-37.

Vogelsang, I. and Finsinger, J., "A Regulatory Adjustment Process for Optimal Pricing by Multiproduct Monopoly Firms," Bell Journal of Economics, v. 10, 1979, pp. 157-171.

Williamson, O. E., "Franchise Bidding for Natural Monopolies--In General and With Respect to CATV," Bell Journal of Economics, v. 7, 1976, pp. 73-104.

Appendix A

Experimental Instructions

Experiment 1 - UM

This experiment deals with the economics of market decision-making. Various research foundations have provided funds for this research. The instructions are simple, and if you follow them carefully and make good decisions you may earn a considerable amount of money.

In this experiment you will be the only seller in a market for a sequence of trading periods. The computer will simulate the behaviour of buyers in this market. At the beginning of each period you will be told the PRODUCTION COSTS to you of each of ten units of the commodity. Note that you must sell the first unit (and incur its production costs) before you sell the second unit and so on. You may offer to sell no more than ten units.

Once you have seen your PRODUCTION COSTS, you will be asked to enter a PRICE offer. You will then be asked to choose a corresponding QUANTITY to be made available at that offer price. All units that you sell will be sold for the same offer price.

There are three common-sense restrictions on the offer quantity you may choose:

(i) it must be positive and an integer (e.g., you cannot sell zero units or half a unit);

(ii) the maximum number of units you can offer corresponds to the number of the last unit whose cost is less than or equal to the offer price you selected; and

(iii) the minimum number of units you can offer corresponds to the number of the first unit whose cost is less than or equal to the offer price.

The computer will inform you of these maximum and minimum quantities after you select an offer price.

After you choose an offer quantity, the computer will inform you of the POTENTIAL PROFIT or LOSS that you would make IF ALL OFFERED UNITS are sold at the selected price. You may change the price and quantity offer as many times as you wish before facing the buyers.

Once you settle on a Price/Quantity offer, the computer will simulate buyer behaviour as mentioned earlier. There are five fictitious buyers, each with different valuations for the good. The computer will randomly order them in a buying sequence. Each buyer then decides, in the order selected, how many units to purchase at the price you offered. These buyers will each purchase

as many units as is profitable at the given price. After the first buyer has finished making purchases, the next buyer in random order may begin purchasing, and so on.

The trading period ends when the last buyer has had a chance to buy OR as soon as all of the units you offered to sell have been purchased. The computer will inform you of your profits in each period, and you will move on to the next period. There will be approximately twenty trading periods in this experiment. You will receive a small trading commission of five cents for each unit you sell.

PERIOD 1

Your production costs are:

Unit	Costs
1	$2.77
2	$2.52
3	$2.27
4	$2.02
5	$1.77
6	$1.52
7	$1.27
8	$1.02
9	$0.77
10	$0.52

Please input selling price in dollars and cents (e.g., enter $53.20 as 53.2 or $0.51 as 0.51).
Tentative selling price? 3.00
Maximum offer quantity is 10
Minimum offer quantity is 1

TENTATIVE QUANTITY OFFER? 10
Potential trading profit if you sell all 10 units is $14.05
Confirm this price/quantity offer or Revise (enter C or R)? R
Your production costs are:

Unit	Costs
1	$2.77
2	$2.52
3	$2.27
4	$2.02
5	$1.77
6	$1.52
7	$1.27
8	$1.02
9	$0.77
10	$0.52

Please input selling price in dollars and cents (e.g., enter $53.20 as 53.2 or $0.51 as 0.51).
Tentative selling price? 4.00
Maximum offer quantity is 10
Minimum offer quantity is 1

TENATIVE QUANTITY OFFER? 6
Potential trading profit if you sell all 6 units is $11.43
Confirm this price/quantity offer or Revise (enter C or R)? R
Your production costs are:

Unit	Costs
1	$2.77
2	$2.52
3	$2.27
4	$2.02
5	$1.77
6	$1.52
7	$1.27
8	$1.02
9	$0.77
10	$0.52

Please input selling price in dollars and cents (e.g., enter $53.20 as 53.2 or $0.51 as 0.51).
Tentative selling price? 3.25
Maximum offer quantity is 10
Minimum offer quantity is 1

TENTATIVE QUANTITY OFFER? 10
Potential trading profit if you sell all 10 units is $16.55
Confirm this price/quantity offer or Revise (enter C or R)? C
Price of $3.25 and quantity of 10 units confirmed.
Now open your price/quantity offer to buyers.
You have sold 4 units.
Your trading profit including commissions this period is $3.62 (or $0.91 per unit sold).

Experiment 2 - RM

This experiment is the same as the last one except for three changes:

(1) The cost and demand conditions have been changed.
(2) You will now receive a SUBSIDY on top of any TRADING profit or loss that you receive. The way this is computed is explained below.
(3) The minimum and maximum offer QUANTITY restrictions do not apply now although you may still offer no more than ten units.

The subsidy is determined by the difference between the price offer you choose and the demand price for each unit up to the potential demand (i.e. the area above your price and below the demand curve).

If you have any questions at this point, signal the person supervising the experiment.

PERIOD 1

Your production costs are:

Unit	Costs
1	$2.27
2	$2.02
3	$1.77
4	$1.52
5	$1.27
6	$1.02
7	$0.77
8	$0.52
9	$0.27
10	$0.02

Please input selling price in dollars and cents (e.g. enter $53.20 as 53.2 or $0.51 as 0.51).
Tentative selling price? 2.00
TENTATIVE QUANTITY OFFER? 10
Potential trading profit if you sell all 10 units is $9.05
Confirm this price/quantity offer or Revise (enter C or R)? C
Price of $2.00 and quantity of 10 units confirmed.
Now open your price/quantity offer to buyers.
You have sold 7 units.
Your trading profit including commissions this period is $3.71 (or $0.53 per unit sold).
You receive a subsidy of $2.39 (or $0.34 per unit sold).
Your total profit in this period is therefore $6.10 (or $0.87 per unit sold).

Experiment 3 - FM

This experiment deals with the economics of market decision-making. Various research foundations have provided funds for this research. The instructions are simple and if you follow them carefully and make good decisions you may earn considerable amounts of money.

In this experiment you will be one of one of 3 POTENTIAL SELLERS in a market for a sequence of 8 trading periods. In each trading period the computer will simulate the behaviour of buyers in the market. You may assume that this simulated buyer behaviour does not involve any collusive withholding of demand (i.e., deliberate, strategic, under-revelation of demand). At the beginning of each period you will be told the PRODUCTION COST to you of each of ten units of the commodity. Note that you must sell the first unit (and incur its production cost) before you sell the second unit and so on. You may offer to sell no more than ten units.

Once you have seen your PRODUCTION COSTS, you will be asked to BID for the right to serve the market in that trading period. If you win this preliminary auction you will be the SOLE SUPPLIER to the market for that trading period. The winner of the preliminary auction will be the potential seller who bids the HIGHEST amount. The amount that the winner must PAY, however, is the SECOND HIGHEST AMOUNT BID. This will, of course, be less than the amount of the winning bid (unless two or more people bid exactly the same amount AND that bid is the highest received). In the event of tied bids that are the highest received, the winner will be determined by the flip of a coin.

If YOU WIN THE PRELIMINARY AUCTION conducted before each trading period, you will be asked to enter a PRICE offer. You will then be asked to choose a corresponding QUANTITY to be made available at that offer price. There is only one restriction on the offer quantity you may choose: it must be positive and an integer (i.e., you cannot offer to sell zero units or half a unit).

After you choose an offer quantity, the computer will inform you of the POTENTIAL TRADING PROFIT or LOSS that you would make IF ALL OFFERED UNITS ARE SOLD AT THE PRICE YOU SELECTED. You may revise the price and quantity you offer as many times as you wish BEFORE facing the buyers. Once you settle on a price/quantity offer, the computer will simulate buyer behaviour as mentioned earlier. There are five fictitious buyers, each with different valuations for the good. The computer will randomly order them in a buying sequence. Each buyer then decides, in the order selected, how many units to purchase at the price you offered. These buyers will each purchase as many units as is profitable to them at the going price. After the first buyer has finished making purchases, the next buyer in random order may begin purchasing, and so on. At the beginning of each period you will be told EXACTLY what the market demand schedule is for that period. When you are choosing your price to offer to the market, the computer will also inform you of the potential demand at that price.

The trading period ends when the last buyer has had a chance to buy OR as soon as all of the units you offered to sell have been purchased. You will receive a trading commission of 5 cents for each unit you sell. The computer will then inform you of your TRADING PROFITS in that period. In addition to trading profits, you will receive a SUBSIDY determined by the difference between the price offer you choose and the demand price for each unit up to the potential demand (i.e., the area above your price and below the demand curve).

Summarizing, then, your TOTAL PROFIT OR LOSS is composed of three items:

(1) the amount you have to pay for the right to serve the market as a sole supplier;
(2) your TRADING PROFIT; and
(3) the SUBSIDY you receive.

Note that item (1) is DEDUCTED from items (2) and (3) to arrive at your TOTAL profit or loss. If you incur a TOTAL LOSS in any one period it will be deducted from your accumulated total profit over all of the periods of the experiment (remember there are 8 periods).

At the end of trading in each period, all POTENTIAL SUPPLIERS will be informed of the PAYMENT for the right to serve the market, the price/quantity OFFER of the winning supplier, and the SUBSIDY paid. Note that ONLY the winning supplier in each period will know his/her TRADING PROFIT for that period.

If you have any questions at this point, ask the person who is supervising the experiment to clarify them.

Experiment 4 - CM

In this experiment there are 2 or 3 potential sellers with a homogeneous product and ALL POTENTIAL SELLERS may directly make price/quantity offers to buyers. Buyers will then decide who they want to buy from, based on the price/quantity offers of each potential seller.

At the end of each trading period all PRICE OFFERS will be made public, but the QUANTITIES OFFERED and the QUANTITIES SOLD by each seller will remain private.

If you have any questions at this point, ask the person supervising the experiment to clarify them.

Appendix B

Detailed Experimental Results

RESULTS FOR UNREGULATED MONOPOLY **UMI1**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	PROFIT
1	2.12	6	6	5.49
2	2.37	7	7	7.28
3	3.00	6	5	9.60
4	3.50	4	3	8.01
5	3.24	5	4	9.14
6	3.00	5	5	9.60
7	3.05	5	5	9.85
8	3.08	5	5	10.00

RESULTS FOR REGULATED MONOPOLY **RMI1**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	1.00	10	10	-2.55	12.55	10.00
2	0.75	10	10	-5.05	15.05	10.00
3	0.50	10	10	-7.55	17.55	10.00
4	0.10	10	10	-11.55	21.55	10.00
5	1.25	8	8	1.96	9.44	11.40
6	1.50	8	8	3.96	7.44	11.40
7	2.00	8	7	7.84	3.51	11.35
8	1.75	8	8	5.96	5.44	11.40

RESULTS FOR UNREGULATED MONOPOLY **UMI2**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	PROFIT
1	3.25	6	4	3.18
2	3.00	6	5	3.35
3	2.75	7	6	3.27
4	2.85	6	6	3.87
5	2.90	6	6	3.85
6	2.85	6	6	3.87
7	2.85	6	6	3.87
8	2.85	6	6	3.87

RESULTS FOR REGULATED MONOPOLY **RMI2**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	1.50	10	9	1.08	7.62	8.70
2	1.20	10	10	-0.55	10.55	10.00
3	1.30	10	10	0.45	9.55	10.00
4	1.10	10	10	-1.55	11.55	10.00
5	1.40	10	10	1.45	8.55	10.00
6	1.40	10	10	1.45	8.55	10.00
7	1.40	10	10	1.45	8.55	10.00
8	1.40	10	10	1.45	8.55	10.00

RESULTS FOR UNREGULATED MONOPOLY **UMI3**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	PROFIT
1	2.00	6	6	4.77
2	2.39	8	7	7.42
3	2.89	10	5	9.05
4	9.15	10	0	0.00
5	3.05	5	5	9.85
6	3.25	5	4	9.18
7	3.15	5	4	8.78
8	3.10	5	5	10.10

RESULTS FOR REGULATED MONOPOLY **RMI3**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	0.20	1	1	0.07	2.48	2.55
2	1.50	6	6	4.47	6.33	10.80
3	2.20	9	6	8.67	2.13	10.80
4	2.44	10	5	9.05	0.70	9.75
5	1.20	5	5	2.85	6.90	9.75
6	1.40	5	5	3.85	5.90	9.75
7	1.50	6	6	4.47	6.33	10.80
8	1.50	6	6	4.47	6.33	10.80

RESULTS FOR UNREGULATED MONOPOLY **UMI4**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	PROFIT
1	1.89	6	6	4.11
2	2.89	10	5	9.05
3	2.99	10	5	9.55
4	3.19	10	4	8.94
5	3.08	5	5	10.00
6	3.08	5	5	10.00
7	3.08	5	5	10.00
8	3.08	5	5	10.00

RESULTS FOR REGULATED MONOPOLY **RMI4**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	0.99	10	10	-2.65	12.65	10.00
2	1.00	10	10	-2.55	12.55	10.00
3	1.01	10	10	-2.45	12.45	10.00
4	0.90	10	10	-3.55	13.55	10.00
5	0.50	10	10	-7.55	17.55	10.00
6	0.99	10	10	-2.65	12.65	10.00
7	1.00	10	10	-2.55	12.55	10.00
8	0.99	10	10	-2.65	12.65	10.00

RESULTS FOR UNREGULATED MONOPOLY **UMC1**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	PROFIT
1	2.45	10	7	2.59
2	4.26	10	0	0.00
3	3.60	10	7	3.64
4	3.80	10	6	4.32
5	3.00	10	5	4.60
6	3.10	10	5	5.10
7	3.30	10	4	4.88
8	3.18	10	4	4.40

RESULTS FOR REGULATED MONOPOLY **RMC1**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	1.00	10	10	-6.30	12.55	6.25
2	1.68	10	9	0.45	6.00	6.45
3	2.00	10	7	2.59	3.51	6.10
4	1.50	10	9	-1.17	7.62	6.45
5	1.30	10	10	-3.30	9.55	6.25
6	1.42	10	10	-2.10	8.35	6.25
7	0.75	10	10	-8.80	15.05	6.25
8	1.69	10	8	0.48	5.92	6.40

RESULTS FOR UNREGULATED MONOPOLY **UMC2**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	PROFIT
1	2.60	10	7	3.64
2	2.85	7	6	3.42
3	2.55	9	7	3.29
4	2.61	8	7	3.71
5	2.62	7	7	3.78
6	2.63	7	7	3.85
7	2.64	7	6	3.36
8	3.20	4	4	4.48

RESULTS FOR REGULATED MONOPOLY **RMC2**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	2.40	8	6	4.62	0.93	5.55
2	2.42	6	6	4.74	0.81	5.55
3	2.44	7	5	4.05	0.70	4.75
4	2.80	5	0	0.00	0.00	0.00
5	2.42	8	6	4.74	0.81	5.55
6	2.43	6	6	4.80	0.75	5.55
7	2.39	10	6	4.56	0.99	5.55
8	2.38	10	6	4.50	1.05	5.55

RESULTS FOR UNREGULATED MONOPOLY **UMD1**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	PROFIT
1	2.60	10	7	3.64
2	2.45	10	7	2.59
3	2.75	10	6	3.27
4	2.80	10	6	3.57
5	2.55	10	7	3.29
6	2.30	10	8	2.76
7	2.65	8	6	2.67
8	2.58	10	7	3.50

RESULTS FOR REGULATED MONOPOLY **RMD1**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	2.10	10	7	3.29	2.81	6.10
2	2.25	10	6	2.97	1.83	4.80
3	1.90	10	8	3.16	4.24	7.40
4	2.00	10	7	2.59	3.51	6.10
5	1.75	10	8	1.96	5.44	7.40
6	1.60	10	9	2.70	6.00	8.70
7	1.65	10	9	2.43	6.27	8.70
8	1.55	10	9	1.53	7.17	8.70

RESULTS FOR UNREGULATED MONOPOLY **UMD2**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	PROFIT
1	2.50	10	7	2.94
2	3.00	10	5	1.35
3	3.00	6	5	1.35
4	3.00	6	5	1.35
5	3.00	6	5	1.35
6	3.00	6	5	1.35
7	3.00	6	5	1.35
8	3.00	6	5	1.35

RESULTS FOR REGULATED MONOPOLY **RMD2**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	2.00	10	7	2.59	3.51	6.10
2	1.50	10	9	1.08	7.62	8.70
3	1.25	10	10	-0.05	10.05	10.00
4	1.25	10	10	-0.05	10.05	10.00
5	1.25	10	10	-0.05	10.05	10.00
6	1.25	10	10	-0.05	10.05	10.00
7	1.25	10	10	-0.05	10.05	10.00
8	1.25	10	10	-0.05	10.05	10.00

RESULTS FOR UNREGULATED MONOPOLY **UMD3**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	PROFIT
1	3.00	10	5	3.35
2	2.50	10	7	2.94
3	3.50	10	3	1.76
4	3.25	10	4	3.18
5	3.15	10	4	2.78
6	3.10	10	5	3.85
7	3.10	10	5	3.85
8	3.10	10	5	3.85

RESULTS FOR REGULATED MONOPOLY **RMD3**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	1.00	10	10	-2.55	12.55	10.00
2	1.10	10	10	-1.55	11.55	10.00
3	1.20	10	10	-0.55	10.55	10.00
4	1.20	10	10	-0.55	10.55	10.00
5	1.20	10	10	-0.55	10.55	10.00
6	1.20	10	10	-0.55	10.55	10.00
7	1.20	10	10	-0.55	10.55	10.00
8	1.20	10	10	-0.55	10.55	10.00

RESULTS FOR UNREGULATED MONOPOLY **UMD4**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	PROFIT
1	3.00	8	5	3.35
2	2.75	8	6	3.27
3	2.50	8	7	2.94
4	3.25	4	4	3.18
5	2.95	10	8	2.36
6	3.05	10	5	3.60
7	3.10	10	5	3.85
8	3.15	10	4	2.78

RESULTS FOR REGULATED MONOPOLY **RMD4**

PERIOD	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	2.50	10	4	1.98	0.42	2.40
2	2.25	10	6	2.97	1.83	4.80
3	2.25	10	6	2.97	1.83	4.80
4	2.15	10	7	3.64	2.46	6.10
5	2.15	10	7	3.64	2.46	6.10
6	2.10	10	7	3.29	2.81	6.10
7	2.08	10	7	3.15	2.95	6.10
8	2.20	10	6	2.67	2.13	4.80

RESULTS OF CONTESTING - CM1

PERIOD	SELLER ID	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	PROFIT
1	1	4	10	0	0
1	2	3.9	10	10	.95
2	1	3.81	10	10	.05
2	2	3.85	10	0	0
3	1	4	10	0	0
3	2	3.84	10	10	.35
4	1	4	10	0	0
4	2	3.94	10	10	1.35
5	1	3.98	10	0	0
5	2	3.9	10	10	.95
6	1	4	10	0	0
6	2	3.89	10	10	.85
7	1	3.88	10	10	.75
7	2	3.93	10	0	0
8	1	3.84	10	10	.35
8	2	3.99	10	0	0

RESULTS OF CONTESTING - CM2

PERIOD	SELLER ID	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	PROFIT
1	1	5.95	3	0	0
1	2	3.98	10	10	1.75
2	1	4.48	8	8	3.40
2	2	5.95	3	0	0
3	1	5.95	3	0	0
3	2	3.97	10	10	1.65
4	1	4.48	8	0	0
4	2	4.23	9	9	2.70
5	1	4.48	8	0	0
5	2	3.96	10	10	1.55
6	1	3.9	10	10	.95
6	2	3.91	10	0	0
7	1	5.95	3	0	0
7	2	3.81	10	10	.05
8	1	3.95	10	10	1.45
8	2	4.47	8	0	0

RESULTS OF CONTESTING - CM3

PERIOD	SELLER ID	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	PROFIT
1	1	2.7	10	10	0.45
1	2	2.8	10	0	0
1	3	3.5	10	0	0
2	1	2.79	10	9	.54
2	2	2.9	10	0	0
2	3	3.25	10	0	0
3	1	2.69	10	0	0
3	2	2.65	10	10	.45
3	3	2.75	10	0	0
4	1	2.67	10	0	0
4	2	2.61	10	10	.05
4	3	2.67	10	0	0
5	1	2.64	10	0	0
5	2	2.66	10	0	0
5	3	2.64	10	10	.35
6	1	2.63	10	0	
6	2	2.62	10	10	.55
6	3	2.63	10	0	0
7	1	2.62	10	0	0
7	2	2.61	10	10	.05
7	3	999	10	0	0
8	1	2.65	10	10	.45
8	2	3	10	0	0
8	3	3.00	10	0	0

RESULTS OF CONTESTING - CM4

PERIOD	SELLER ID	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	PROFIT
1	1	3.5	10	0	.54
1	2	4	6	0	0
1	3	999	10	0	0
2	1	3.29	10	10	.05
2	2	3.29	10	0	0
2	3	3.4	10	0	0
3	1	3.4	10	0	0
3	2	3.29	10	10	.05
3	3	3.5	10	0	0
4	1	4	6	0	0
4	2	3.35	10	10	.65
4	3	3.43	10	0	0
5	1	3.4	10	0	0
5	2	3.33	10	10	.45
5	3	3.35	10	0	0
6	1	3.29	10	10	.05
6	2	3.31	10	0	0
6	3	3.43	9	0	0
7	1	3.32	10	10	-0.15
7	2	3.32	10	0	0
7	3	3.43	10	0	0
8	1	3.9	10	8	2.92
8	2	10	10	0	0.0
8	3	12	10	0	0

RESULTS OF MONOPOLY TRADING STAGE - FM1

PERIOD	SELLER ID	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	2	2.5	10	10	-10.85	23.85	0
2	1	3.05	10	10	-5.35	18.35	0
3	2	3.5	10	10	- .85	13.85	0
4	2	3.5	10	10	- .85	13.85	0
5	2	3.5	10	10	- .85	13.85	0
6	1	2.5	10	10	-10.85	23.85	0
7	2	1.95	10	10	-16.35	29.35	0
8	1	2.5	10	10	-10.85	23.85	0

RESULTS OF MONOPOLY TRADING STAGE - FM2

PERIOD	SELLER ID	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	2	3.75	10	10	1.65	11.35	10.50
2	1	3	10	10	-5.85	18.85	3.47
3	1	2.75	10	10	-8.35	21.35	2.75
4	2	2.75	10	10	-8.35	21.35	.08
5	2	2.5	10	10	-10.85	23.85	.12
6	2	2.75	10	10	-8.35	21.35	.01
7	1	2.5	10	10	-10.85	23.85	.05
8	2	2.5	10	10	-10.85	23.85	.03

RESULTS OF MONOPOLY TRADING STAGE - FM3

PERIOD	SELLER ID	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	2	.01	10	10	-35.75	48.75	0
2	2	.01	10	10	-35.75	48.75	0
3	2	.01	10	10	-35.75	48.75	12.99
4	2	.01	10	10	-35.75	48.75	0
5	2	.01	10	10	-35.75	48.75	0
6	2	.01	10	10	-35.75	48.75	-.01
7	2	.01	10	10	-35.75	48.75	-.01
8	2	.01	10	10	-35.75	48.75	-.01

RESULTS OF MONOPOLY TRADING STAGE - FM4

PERIOD	SELLER ID	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	1	1.80	10	10	-11.45	24.45	3.00
2	3	3.00	10	10	.55	12.45	.75
3	3	3.25	10	9	1.62	10.08	-.79
4	3	3.00	10	10	.55	12.45	.50
5	2	3.00	10	10	.55	12.45	.25
6	2	3.00	10	10	.55	12.45	.10
7	1	1.50	10	10	-14.45	27.45	0
8	2	3.00	10	10	.55	12.45	.01

RESULTS OF MONOPOLY TRADING STAGE - FM5

PERIOD	SELLER ID	PRICE OFFER	QUANTITY OFFER	QUANTITY SOLD	TRADING PROFIT	SUBSIDY	TOTAL PROFIT
1	1	3.13	10	9	.54	11.16	10.45
2	2	.99	10	10	-19.55	32.55	10.05
3	3	2.00	10	10	-9.45	22.45	8.00
4	3	2.07	10	10	-8.75	21.75	4.50
5	3	1.92	10	10	-10.25	23.25	1.99
6	3	1.88	10	10	-10.65	23.65	2.96
7	1	1.88	10	10	-10.65	23.65	0
8	2	.01	10	10	-29.35	42.35	.25