Chapter 19

EXPERIMENTS IN DECENTRALIZED MONOPOLY RESTRAINT

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In this chapter, we report on laboratory experimental examinations of a particular class of institutions, policies or mechanisms of monopoly control. These are mechanisms which take the existence of a monopoly as a given and ask how might the "abuses" of monopoly be controlled in a decentralized manner. As such, we will be excluding from our analysis experiments in the discouragement or dismemberment of monopoly ("antitrust" experiments).

The most prevalent form of monopoly control in the United States for many decades was cost-based "rate of return" regulation. The academic and practitioner critics of rate of return regulation were numerous. In general, the arguments were that the incentives in the rate of return regulatory process itself led to distortions relative to standard measures of efficiency (for a more detailed discussion see Isaac, 1982). It is not surprising that there were many explorations for alternatives to rate of return regulation. We will focus exclusively on experiments that do more than simply reform centralized price regulation, that is, we examine *decentralized* forms of monopoly control.

1. Market Institutions for Monopoly Restraint

Smith (1981) conducted a series of laboratory market experiments designed to investigate whether the structure of some market trading institutions might discipline a monopolist. If some market institutions were to limit the exercise of monopoly power, then the charge to a regulatory body could be implementation of an appropriate design of the market itself rather than regulation of price or quantity. Smith looked at four market trading institutions: double auction, offer auction, posted bid, and posted offer. Two different measures of monopoly effectiveness for the eight Smith experiments are presented in Figure 1 (three double auction experiments, one posted offer experiment, one offer auction experiment, and three posted bid experiments, respectively). The yellow bars show the deviations of average prices in experiments from the quantity conditional monopoly prices (the demand prices for the actual average quantities traded). This measure, called "δ" in the paper, is a measure of the seller's effectiveness in obtaining high prices for the actual number of units sold. The second measure is overall market efficiency, which is inversely related to reductions in trading quantity below the competitive level. (These efficiency data are averaged across periods 5–10.)

Smith reported that some forms of market organization facilitated the disciplining of monopoly sellers by buyers. In one case, the offer auction, this conclusion is unam-

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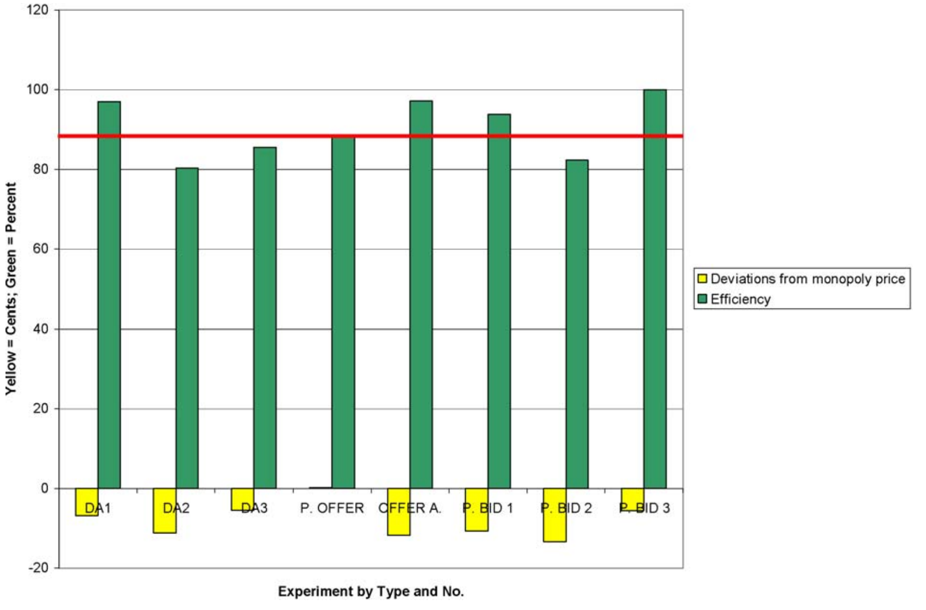

Figure 1. Smith (1981) asked whether some market institutions are decentralized mechanisms that enable buyers to effectively constrain the market power of monopolists. This figure presents results from Smith's experiments with the double auction (DA), posted offer (P. OFFER), offer auction (OFFER A.), and posted bid (P. BID) market institutions. The yellow bars show the deviations of average prices in experiments from the quantity conditional monopoly prices (the demand prices for the actual average quantities traded). This is a measure of the seller's effectiveness in obtaining high prices for the actual number of units sold. Note that sellers were highly monopoly price effective in the posted offer experiment, less effective in the posted bid experiments, even less effective in the double auction experiments, and least monopoly price effective in the in the offer auction experiment. Thus the posted offer market is the least effective institution for constraining the ability of a monopolist to charge high prices and the offer auction is the most effective. The green bars show the efficiency of the experimental market allocations, measured as the realized sum of consumer and producer surplus, divided by the surplus that would result from the competitive equilibrium allocation, multiplied by 100. The horizontal red line indicates the efficiency of the theoretical monopoly allocation, 88.5 percent. Note that the offer auction allocation is highly efficient, the average posted bid allocation less efficient, the posted offer allocation even less efficient, and the average double auction allocation the least efficient. Thus the offer auction allowed the buyers to effectively constrain the ability of a monopolist to charge high prices without sacrificing much market surplus from witheld demand.

biguous – this market had high efficiency and prices were well below the monopoly prediction. In other cases, the conclusions are more ambiguous. The double auction, for example, allowed buyers to keep prices well below theoretical monopoly prices but at the cost of greatly reduced trade and hence low market efficiency. The market institution that was most conducive to the seller obtaining the theoretical monopoly price and quantity was the posted offer market, arguably the one closest to what may be the "natural" organization of most retail markets of concern to regulators.

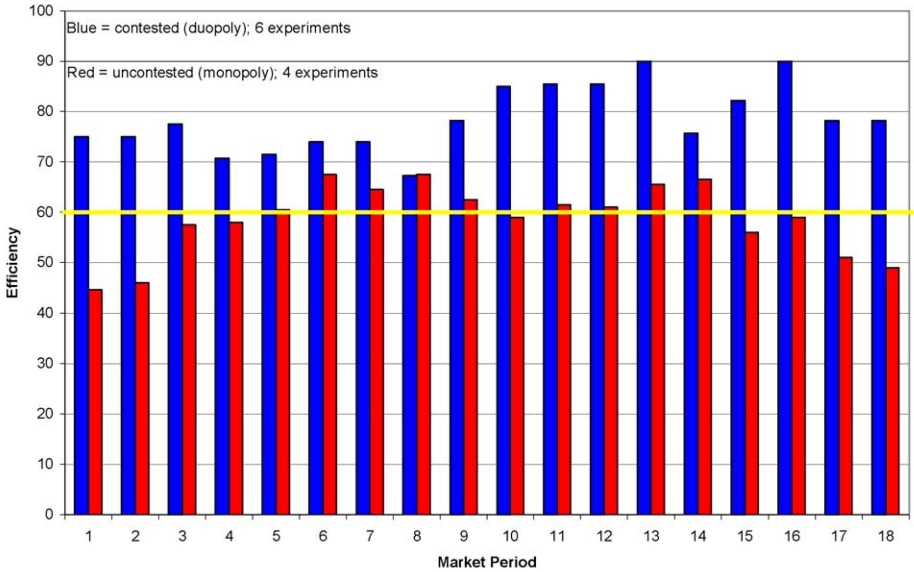

Figure 2. Coursey, Isaac, and Smith (1984) reported results from experiments with contested and uncontested markets for sellers with decreasing marginal costs and zero sunk costs. The red bars show the average allocative efficiencies in each of the 18 periods of four experiments with uncontested markets. The blue bars show the average allocative efficiencies in six experiments with the same decreasing costs but with markets contested by a second firm. The theoretical monopoly allocation has an efficiency of 60 percent, denoted by the yellow line. Market efficiency is increased notably by the contesting actions of the second firm.

2. Contestable Markets

Another regulatory approach which would also not require centralized price regulation is the promotion of contestable markets. The idea of what became known as the "contestable markets" hypothesis (see, for example, Baumol, Panzar, and Willig, 1982) is that even a market with a cost structure which satisfies the conditions of a "natural monopoly" may be lacking in traditional definitions of "market power" if there is a second firm with access to identical technology ready to contest the market. Thus the power to charge monopoly prices can be constrained in a market that is contested even if only one firm is observed to be serving the entire market.

There have been several experimental market tests of the contestable markets hypothesis (e.g., Coursey, Isaac, and Smith, 1984; Harrison and McKee, 1985; Brown-Kruse, 1991). The results generally support the conclusion that laboratory markets with conditions required for contestability perform reasonably like the predictions of the contestable markets hypothesis. Figure 2 summarizes the results from Coursey, Isaac, and Smith (1984).

Much of the debate in the regulatory arena was not over the contestable markets hypothesis, *per se*, but rather over the applicability of the conditions of the theory to field

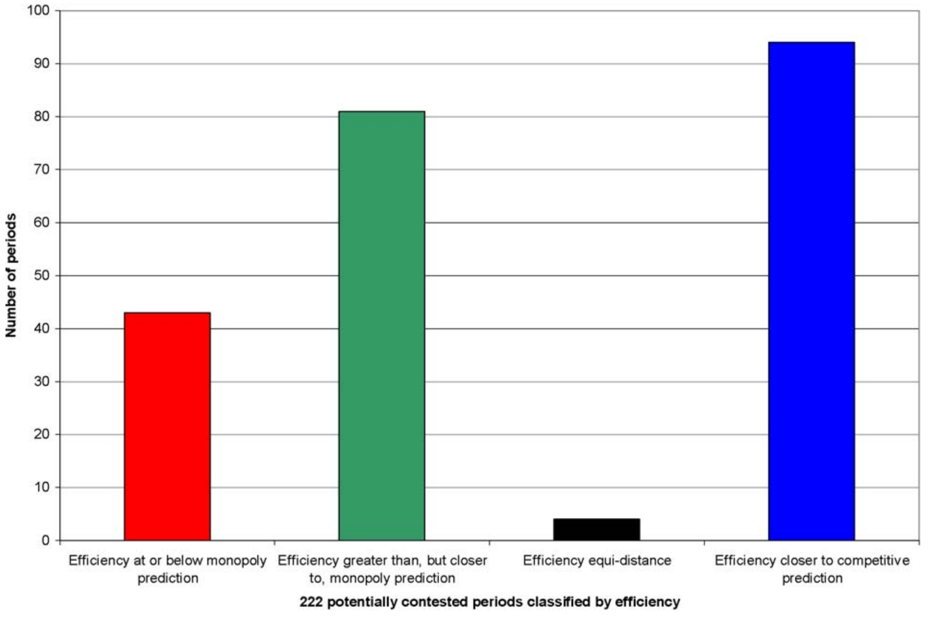

Figure 3. Coursey et al. (1984) added small sunk costs to the design in Coursey, Isaac, and Smith (1984) to ascertain whether the greater efficiency of the contested markets with decreasing cost firms was robust. The bars in this figure report the number of experimental market periods out of 222 with efficiencies closer to monopoly or competitive predictions. Contestable market efficiency is greater than the theoretical monopoly efficiency in 179 out of the 222 periods and in 94 of those periods it is closer to the competitive market prediction than to the monopoly prediction.

environments. One limiting condition of the pure form of the contestable markets hypothesis is the assumption of zero sunk costs. Coursey et al. (1984) provided additional empirical information by adding small sunk costs to their previous design. They found that the results of contestability were not "brittle"; that is, adding a small amount of sunk costs caused only a modest amount of deviation from the predictions of the contestability theory. Market performance did not suddenly "jump" to the monopoly outcomes. Figure 3 illustrates this conclusion.

3. The Loeb–Magat Mechanism

In some markets, perhaps those in which the cost conditions are significantly different from those specified by the contestable markets hypothesis, it may be that some form of explicit regulatory process is inevitable. [We ignore alterations in centralized price regulations, such as the "price cap" scheme discussed in Isaac (1991).] A theoretically optimal regulatory mechanism was offered by Loeb and Magat (1979). It is a reformulation of the Groves (1973) and the Groves and Loeb (1975) demand revealing process.

In the Loeb–Magat process [as described in Cox and Isaac (1987)], total profits of the firm are represented as:

$$pQ(p) - C\big(Q(p)\big) + S^{\mathrm{LM}}(p) + A, \tag{1}$$

where $C(\bullet)$ is the firm's cost function, $Q(\bullet)$ is the demand function, $S^{\mathrm{LM}}(\bullet)$ is a subsidy function that depends on p, and A is a lump-sum transfer that does *not* depend on p. The subsidy function is defined as:

$$S^{\mathrm{LM}}(p) = \int_0^{Q(p)} \rho(x)\,\mathrm{d}x - pQ(p), \tag{2}$$

where $\rho(\bullet)$ is the inverse demand function. That is, net of some lump-sum transfer A, the regulated firm receives as a subsidy all of the consumers' surplus at its chosen price. The dominant strategy of a profit-maximizing firm that is regulated by the Loeb–Magat mechanism is to set price equal to marginal cost.

There are two possible objections to the Loeb–Magat process. First, the subsidy function may pose a political barrier to acceptance of the process. Several remedies have been proposed to address this problem (see Cox and Isaac, 1986). The second problem is that the regulators would have to know the demand function for the monopolist's product in order to implement the Loeb–Magat mechanism's subsidy formula. But the regulators would only have observations of market demand within the sample of historical prices, not over the domain of the demand function.

Harrison and McKee (1985) report on five experimental sessions combining the Loeb–Magat mechanism with a franchise auction to dissipate expected monopoly rents back to the regulator. One of the sessions allows collusion, and in only one of the remaining four experiments do the firms know their own demands (although the regulatory operation of the Loeb–Magat mechanism necessarily incorporates demand information). Harrison and McKee report that by a standard measure of "monopoly effectiveness," their implementation of the Loeb–Magat mechanism approaches full dissipation of economic rents. Cox and Isaac (1986) conducted four L–M experiments, half with and half without the firm knowing its own demand. Like Harrison and McKee, Cox and Isaac found that the Loeb–Magat mechanism worked largely as advertised. Figure 4 presents the price and quantity path from two of these experiments.

4. The Finsinger–Vogelsang Mechanism

Regardless of the implementation of the information condition regarding the firm's knowledge of demand, the problem of the *regulators'* need to know the demand function is present in any case. This implementation problem is not alleviated by the presence or absence of a franchise auction to reduce the net transfers. Finsinger and Vogelsang (1981) reported an iterative alternative to the Loeb–Magat subsidy formula with much weaker information requirements. Let p_r be the price of the monopolist's product upon introduction of the F–V mechanism. The firm is free to choose price in each subsequent

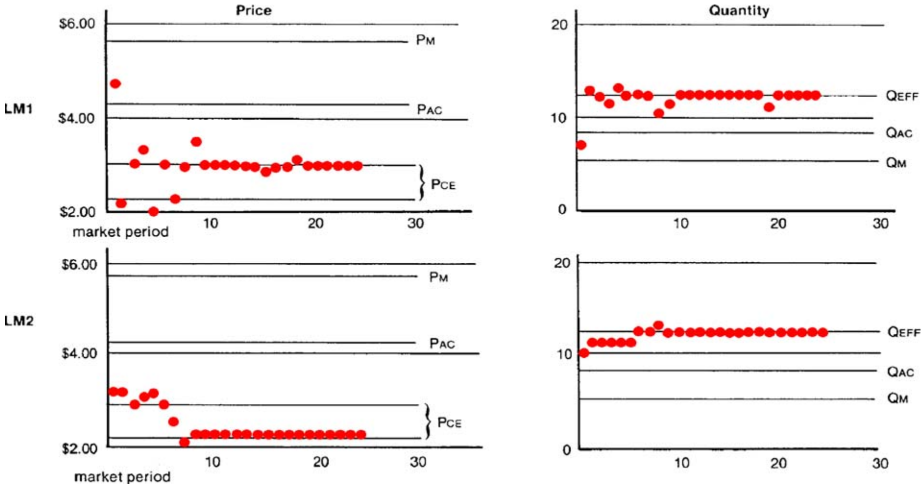

Figure 4. Cox and Isaac (1986) reported experiments with the Loeb–Magat subsidy mechanism applied to monopoly sellers with decreasing marginal costs. The size of the subsidy under this mechanism is equal to the area under the seller's demand curve plus a (positive or negative) lump sum. Implementation of the subsidy requires the regulator to know the demand function for the seller's product. This subsidy formula makes the fully-efficient ("competitive") outcome profit-maximizing for the same reason that the perfectly-discriminating monopoly outcome is fully efficient. Price and quantity outcomes from two representative experiments (LM1 and LM2) are shown. Prices converge quickly to be within the range of competitive market-clearing prices. Quantities converge to the efficient quantity.

period $0, 1, \ldots, t \ldots$. The general formula of the Finsinger–Vogelsang subsidy is

$$S_t^{\mathrm{FV}} = \sum_{\tau=0}^{t} Q_{\tau-1}[p_{\tau-1} - p_\tau]. \tag{3}$$

Since Equation (3) contains only observed prices and quantities, it is clear that the regulator need not have any *a priori* knowledge of the demand function in order to implement the Finsinger–Vogelsang subsidy. This is the great practical advantage of the Finsinger–Vogelsang (hereafter, F–V) subsidy mechanism over the Loeb–Magat (hereafter, L–M) mechanism.

The critical empirical question is whether the F–V mechanism can actually induce efficient allocation by a monopolist. The F-V theory states that the optimal price path for the regulated firm will converge to the social optimum. However, note from Equation (3) above that, if a firm ever raises its price, it is penalized in the current period and *in all* future periods. This suggests the importance of the question of what happens if the firm errs and raises price. Even if the firm realizes it has made a mistake and lowers price, the firm has permanently lowered its potential subsidy. The possible deleterious effect of price cycles on the performance of the F–V mechanism was first noticed by Seagraves (1984). Cox and Isaac (1986) presented the results of four laboratory experiments with

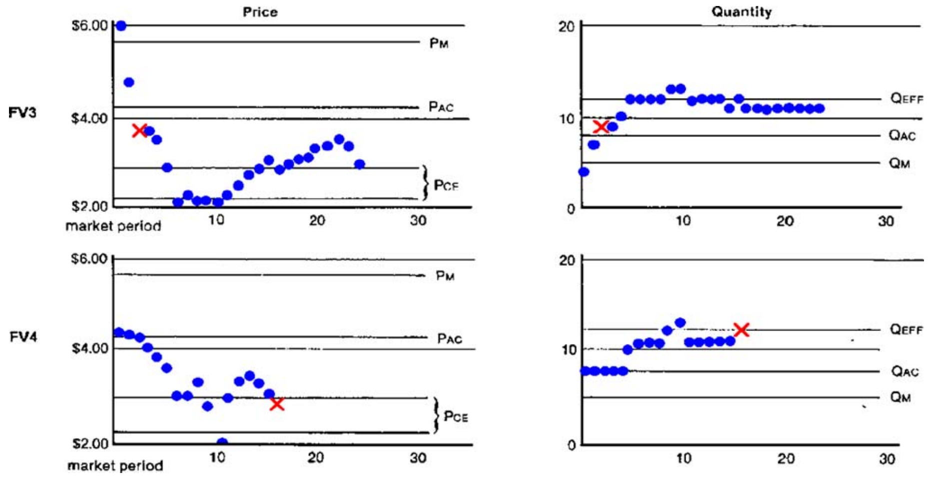

Figure 5. Cox and Isaac (1986) reported experiments with the Finsinger–Vogelsang subsidy mechanism applied to monopoly sellers with decreasing marginal costs. The size of the subsidy under this mechanism is calculated from observed quantities and price changes; thus the regulator does not need prior knowledge of the seller's demand function. The theory for this mechanism predicts that, starting from any price greater than marginal cost, the profit-maximizing prices and quantities will monotonically converge to the fully-efficient, competitive price and quantity. But the subsidy formula permanently penalizes any price increase in all subsequent periods. Thus the actual performance of this mechanism can be vulnerable to deviations from optimal monotonic price decreases. The figure shows results from two representative experiments. In experiment FV3, the seller decreased price too quickly and would have been bankrupt in the third period (with prices and quantities marked with a red ×). In this experiment, the seller's losses were forgiven and the experiment was restarted. The further results were that the seller's prices and quantities did not converge to efficient outcomes before the experiment ended in period 25. Prices and quantities in experiment FV4 did not converge to efficient levels before the subject went bankrupt in period 17 from the penalty for the non-monotonic price path.

the F–V mechanism and found that, indeed, these profit-destroying cycles were a robust occurrence. Results from two of these experiments are presented in Figure 5.

5. The Cox–Isaac Mechanism

Cox and Isaac (1987) reported an alternative subsidy formula that is similar to F–V in its information requirements but offers superior incentives to converge to the social optimum. The subsidy function is based on a revealed measure of surplus, and the penalty for raising price in the Cox and Isaac (hereafter, C–I) subsidy formula is "forgiving," unlike the F–V formula. The C–I subsidy formula is defined as:

$$\begin{aligned} S_t^{\mathrm{CI}}(p_r, p_0, p_1, \ldots, p_t) &= [p_r - p_t]Q_r, \quad \text{for } p_t \geqslant p_r \\ &= \int_0^{Q(p_t)} M_t(q \mid p_r, p_0, p_1, \ldots, p_t)\,\mathrm{d}q - p_t Q(p_t), \quad \text{for } p_t < p_r, \end{aligned} \tag{4}$$

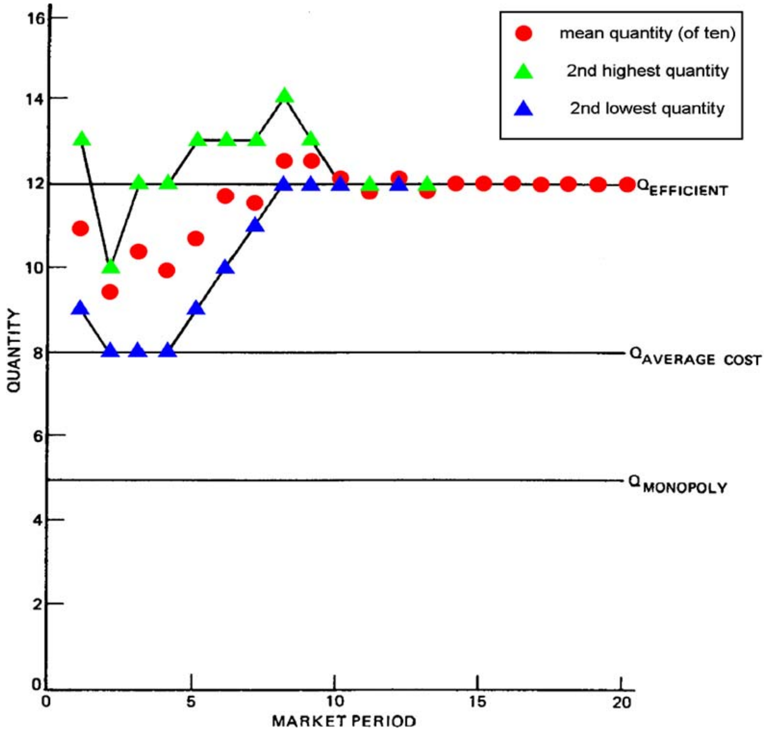

Figure 6. Cox and Isaac (1987) reported experiments with a new subsidy mechanism applied to monopoly sellers with the same decreasing marginal costs as in their other experiments. The size of the subsidy under this mechanism is also calculated from observed quantities and prices and theory predicts monotonic convergence to the fully-efficient, competitive price and quantity. But this subsidy formula is forgiving of non-monotonic price cycles. The figure shows quantity results from ten experiments. Mean quantities are denoted by red circles. Second-highest quantities are represented by green triangles and second-lowest quantities are denoted by blue triangles. As shown, quantities converge to the efficient quantity.

where p_r is the extant price and Q_r the extant quantity before the subsidy is first implemented and the function $M(\bullet)$ is defined as

$$M_t(q \mid p_r, p_0, p_1, \ldots, p_t) = \min\Big\{p_r, \max_{p_\tau, \tau \leqslant t}\big[p_\tau \mid Q(p_\tau) \geqslant q\big]\Big\}. \tag{5}$$

Cox and Isaac (1987) prove that the optimal path for a firm with subsidy formula (4) is convergence to the social optimum.

Cox and Isaac (1987) conducted laboratory tests with the new subsidy formula and reported that it did induce efficient allocations by monopoly sellers. They reported ten laboratory sessions, and all ten of the laboratory monopolists regulated with the C–I mechanism converged to the social optimum. Figure 6 reports the mean and dispersion of prices in the ten experiments; Figure 7 reports the same for quantities. In a later

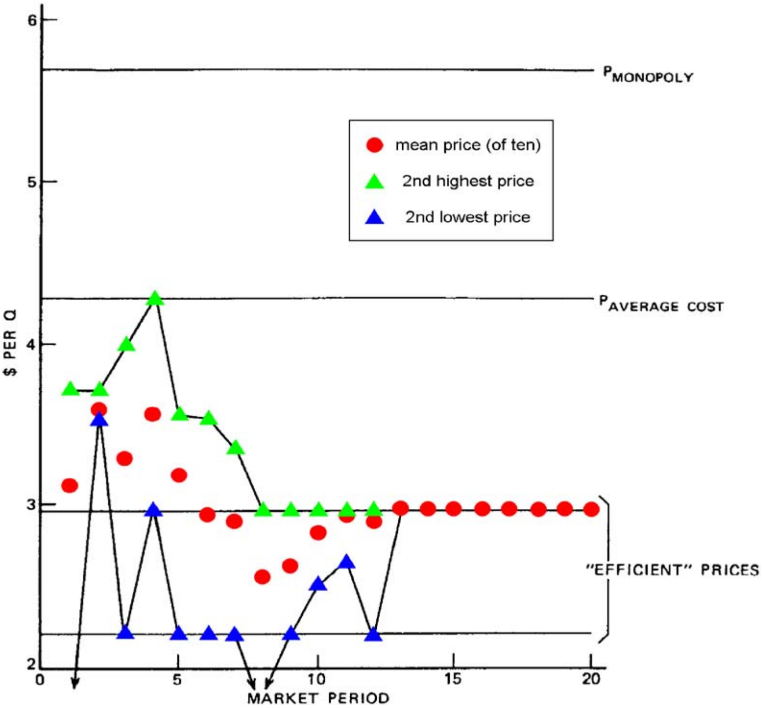

Figure 7. Mean, second-highest, and second-lowest prices in the Cox and Isaac (1987) experiments with the new subsidy formula are reported in this figure. Prices converge to the efficient price.

paper, Cox and Isaac (1992) found similarly robust results when there was an (uncertain) opportunity for cost reduction.

Acknowledgement

Toby Isaac provided valuable assistance by preparing the figures. Figures 4 and 5 are a modified representation of the same data as they appeared in Cox and Isaac (1986). Figures 6 and 7 are a modified representation of the same data as they appeared in Cox and Isaac (1987).

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