

NON-CONVEXITIES, ECONOMIES OF SCALE, NATURAL MONOPOLY AND MONOPOLISTIC COMPETITION

CHARLES R. PLOTT

The behavior of markets characterized by non-convexities has been the subject of debate for almost a century. Marshall, for example, thought that the existence of large economies of scale in an industry would be a sufficient condition to guarantee that with any initial competition, the industry would ultimately result in monopoly. The great discussions between Joan Robinson and Edward Chamberlain were focused the principles that lie beneath the process of adaptation when non-convexities are present. A major question was whether monopoly or some constellation of oligopolies would evolve when competing firms had falling average costs throughout the range of demand. Much of industrial organization theory is built upon the principles of Cournot behavior. The theory predicts that Cournot prices will emerge from oligopolized markets and that such behavior will approach competitive behavior as the size of the economy grows large.

The classical discussion of the consequences of non-convexities took a new form as principles of game theory became joined with the structural features of large economies of scale. New models suggest that the threat of competition, as opposed to the existence of an actual competitor, serve to control monopolistic practices. The issues found in the literature explore and debate both the basic behavioral principles that might be at work as well as the application of those principles in particular situations.

The implications of these new models were first explored experimentally by [Coursey et al. \(1984\)](#) and by [Coursey, Isaac, and Smith \(1984\)](#). They studied markets with two potential competitors who were making decisions in a market with posted prices. (It is known that the textbook monopoly pricing model can predict the behavior of a single seller if the seller operates in a posted price institution.) The experiments produced the following results:

1. The existence of a single potential competitor has a clear influence on the pricing policies of a monopolist.
2. The prices that emerge are best modeled by contestable market theory. That is, monopoly emerges and the prices charged are close to the “limit price” that would make entry by the potential competitor unprofitable. The presence of sunk cost somewhat weakens this tendency.
3. While sales are monopolized, the industry is not. There is a tendency for the potential competitor to be a real competitor in that the competitor pays a price to expose its units to the market, even though it makes no sales.

A paper by [Plott, Sugiyama, and Elbaz \(1994\)](#) provides a replication and generalization of the earlier experiments. Agents had a choice between participation in a multiple

unit double auction market in which they could acquire rents with almost certainty, and a market in which each agent had economies of scale and a potential for being the only seller. The generalization of previous work involves (i) the number of markets (expanded to prevent the possibility that entry might occur due to boredom), and (ii) a choice of scale, which allows the theoretical possibility of several different forms of industrial organization.

Figure 1 shows the cost structure of a representative agent seller in the Plott, Sugiyama and Elbaz experiments, should the agent sell in the market in which economies of scale existed. The cost functions conform to the classical notion of economies of scale and the related non-convexity of the production function. As Figure 1 shows, the costs are characterized by a series of short run cost functions. The agent had a choice of twenty-four short run cost functions (given in tabular form), which can be interpreted as different possible scales of plant. The figure shows that “long run” average costs were falling throughout the range of the demand function. An approximate market demand function was public information for the sellers. (It was redemption values of buyers minus a small transactions cost.) Sellers could only participate in one of the two markets that existed in the experiment. Thus, if a seller chose to enter this market, an opportunity cost of profits foregone in the other market should be added to the cost function shown in Figure 1. The added cost is not shown but is included in the equilibrium calculations for the models that are applied.

Sellers made private decisions about which of the two markets to enter. If the market with scale economies was chosen, then the seller chose three variables: the scale of plant that would be operated, the price to be posted and the maximum quantity to be offered. All decisions were made public simultaneously. After decisions were made public, sellers had the option of reducing their maximum quantity sold to zero. This, in effect, took the seller out of the market and prevented the possibility of selling only a small quantity, which would be very costly because of the falling nature of average costs. Cancellation announcements were made simultaneously and the sellers who chose cancellation incurred no cost, other than the profits foregone by not participating in the competitive market.

Figure 2 illustrates the predictions of three of several competing models.

- (1) The monopoly model is shown with the lowest quantity and the highest prices.
- (2) Several oligopolistic and monopolistic competitive organizations are compatible with the parameters in the market. Shown in the figure is the market price predicted by the Cournot model if a symmetric duopoly evolved. The market could also support a monopolistically competitive configuration of either three or four symmetric competitors following Cournot price and quantity strategies. These are not shown in the figure but the prices are about the same as would be the case of duopoly. Each agent would simply choose a smaller scale of plant and offer less quantity on the market. The market cannot support five symmetric sellers that are following Cournot behavior.
- (3) The limit price of contested market theory is the case in which monopoly exists and charges a price equal to average cost of the optimal scale (given the market

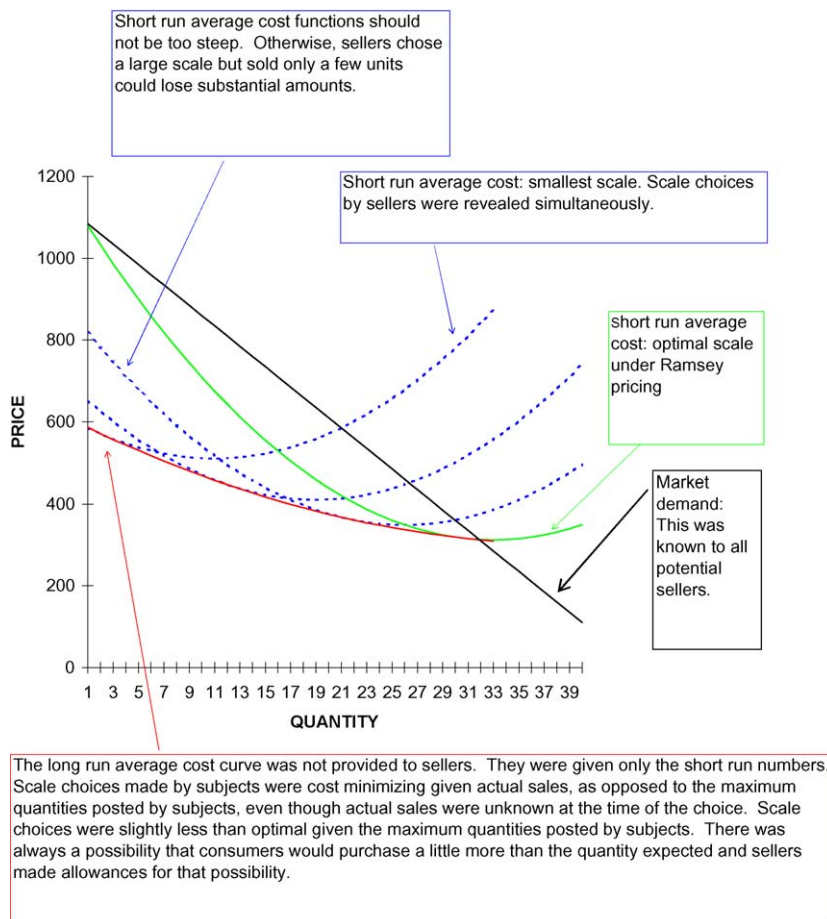


Figure 1. Identical average costs: subjects were given tables with the average cost and marginal cost associated with each of twenty four scales of plant. Each potential seller chose whether or not to leave a competitive market and enter this market, and if entry was chosen then a scale of plant and a maximum quantity offered and a (posed) price were also chosen.

demand and including the opportunity cost of foregone profits from the competitive market).

- (4) A model of market collapse would predict that the threat of uncoordinated competition and resulting losses might prevent anyone from entering.
- (5) A model of collusion would predict that some subset of firms would enter and through a coordination of strategies over time manage to hold prices at a monopoly level. Each, knowing that the benefits of collusion would disappear if

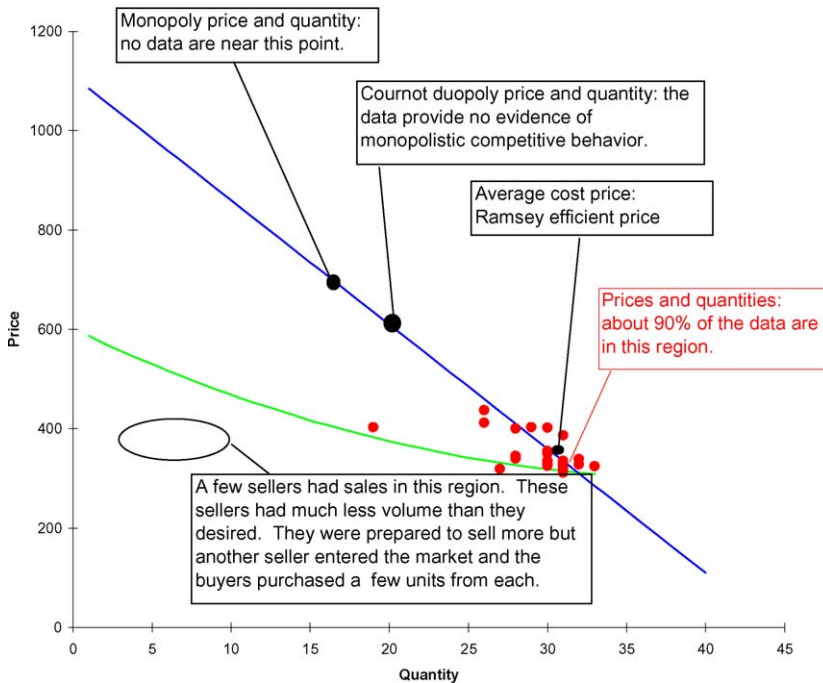


Figure 2. Model predictions and data: Almost all outcomes are near the prediction of the contestable markets model. Monopoly almost always emerges. Prices of the monopolist are always near average cost. There is no evidence of market collapse. There is no evidence of collusion. There is no evidence of monopolistic competition. The policing of the monopoly is done by entrants that stand ready to undercut the single seller should it attempt to charge monopoly level prices. This “contingent entry” is costly and can be viewed as a loss of efficiency due to the policing of the single seller.

any deviation from cooperation was detected by others, would hold to the implicit collusion and thereby render the organization stable.

The results of three experiments with seven agents are contained in [Figure 2](#):

1. Under the conditions of non-convexities – and in particular the conditions of economies of scale and no institutional barriers to entry – the organizational form that emerged was monopoly; all sales were made by a single seller.
2. No evidence exists for any form of organization other than monopoly. No oligopolies or monopolistically competitive agents emerged. No conspiracies developed although some of the pricing might have represented attempts to collude or signal a willingness to collude.
3. There was an instance of market collapse in which no seller entered the market or all sellers canceled their decision after observing the choices of other sellers. This occurred only one time out of all periods.
4. Prices were near the limit price predicted by contestable market theory.

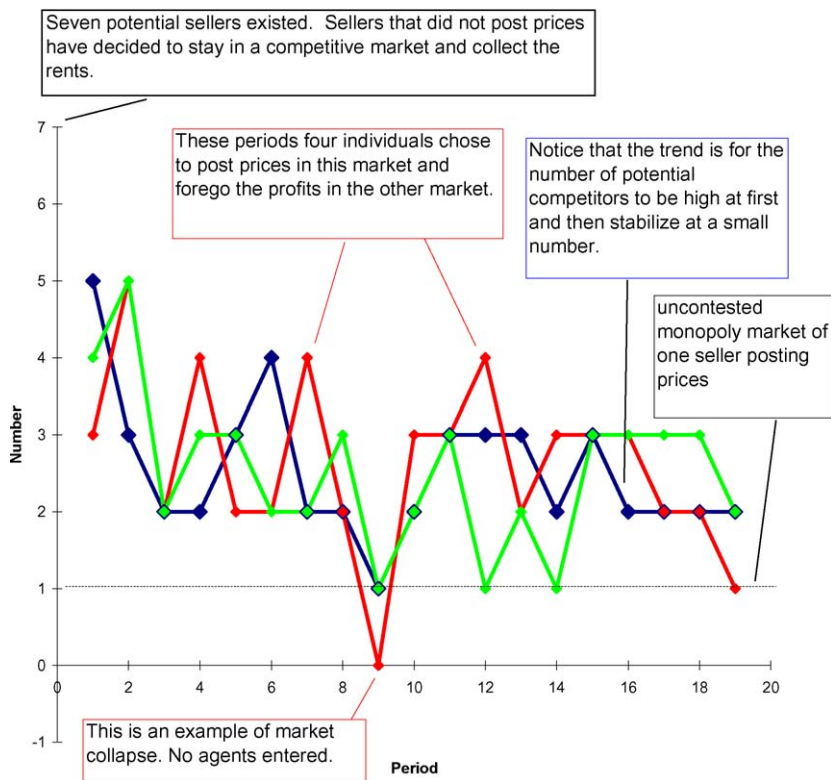


Figure 3. Number of agents posting prices each period for three different market experiments. This number provides a measure of both potential competition and the resources used to police monopoly pricing. If more than one seller posts price then the monopolist might be the single seller but there are other agents that have invested to become a seller should the monopolist post price that is sufficiently high to give them sales.

That is, prices were near the Ramsey optimal average cost.

5. Scale choices and quantity choices reflected the expectation of sellers that they would be the only seller and that they planned to sell at prices near average cost. Scale choices were near the optimal given market demand.

Figure 3 provides an insight about the process through which the contestable markets work. The figure shows the number of sellers that posted prices in the contested market for each period of each experiment. As shown, in almost all periods of all experiments there existed more than one agent that paid the opportunity cost to compete in the contested market and was prepared to sell. That is, the contested market was actually contested. The prices prepared by the potential entrants ranged from near average cost to substantially above average cost, perhaps reflecting the hope that the monopolist would get “greedy” and charge prices substantially above cost. This phenomenon leads the conclusion that follows.

6. The cost of policing the monopoly decreases with time. The fact that entrants always existed in the market indicates an efficiency cost of policing the monopolized market in terms of product foregone in the competitive market. As the number of posting firms decreases, the efficiency loss decreases.

The results of the Plott, Sugiyama and Elbaz experiments illustrated in the figures are consistent with the earlier experiments. Of course how these results might change if the scale decisions were made and announced before the pricing decision was made is unknown. Other variables of interest might involve longer term investment decisions and/or no ability to cancel quantity decisions, etc. but to date, these have not been studied.

References

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