

REGULATING AN INDUSTRY
WITH UNKNOWN COSTS AND DEMANDS

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I. INTRODUCTION

Uncontrolled monopoly is held to be inefficient. For this reason many economists have advocated the regulation of monopolies. Two forms of regulation have received considerable attention. First, a monopoly may be subject to restriction on the rate of return on its capital. Such regulation will not be investigated here since it can create serious distortions. This deficiency in rate of return regulation has led to the consideration of alternatives in which the right to provide the monopoly service is sold by the regulator at auction. The structure of the auction dictates the behavior of the monopolist. The purpose of this note is to expound a franchising scheme which will guarantee an efficient outcome and which requires no knowledge of demand or costs on the part of the regulator.

Demsetz (1968) was the first to propose an auction to decide who should be the monopolist. His proposal has the property that the regulator awards the right to the monopoly to the firm which will serve the market at the lowest price. Since the winning firm must break even, it is easy to see that competition among would-be monopolists will result in a winning price that is equal to average cost. This scheme is, therefore, inefficient. Nor is it easily implemented when market conditions are changing.¹ In response to these criticisms, Loeb and Magat (1979) suggested "a new institutional arrangement that mixes regulation and franchising and which eliminates many of the problems of both systems."²

In the Loeb-Magat scheme the regulator subsidizes the monopolist with a payment equal to the entire consumer surplus at the monopolist's chosen output. The monopolist must not price discriminate, and must let the market clear. Under these conditions the monopolist chooses output to maximize the

sum of producer and consumer surplus. Firms bid for the right to service the market on terms laid down by the regulator. That firm which offers the largest lump-sum payment to the regulator wins the right to be the monopolist. If several firms have equal access to the best production techniques then the outcome will be efficient, with price equal to marginal cost. With increasing marginal costs the winning firm makes a net payment to the regulator, while a net subsidy is paid by the regulator when marginal costs are decreasing.

Sharkey (1979) points out several problems that are not resolved by the Loeb-Magat scheme. One important problem left unresolved is the scheme's information requirements. Sharkey notes that "the L-M subsidy does require that a regulatory body be capable of independently measuring the demand facing the utility."³ Baron and Myerson (1982) present an analysis of a more complicated, but fundamentally similar, structure. They assume that an auction is infeasible, and place more weight on consumer surplus than on producer surplus in defining social welfare. A mixture of subsidies, penalties, and threats of closure, are shown to be enough for the regulator to limit the net subsidy to the monopolist.

An important difference between the regulatory scheme explained in the next section and that of Loeb and Magat (and that of Baron and Myerson) is the amount of knowledge available to the regulator. To use the Loeb-Magat scheme and award a subsidy equal to consumer surplus it is necessary that the demand curve be known to the regulator. This demand information must also be available to the firms if they are to calculate their bids correctly. But each firm need know only its own costs. There is no need for the regulator to have any knowledge of these. Since the subsidy is not dependent on the cost

structure there is no incentive for a firm to misrepresent its costs in preparing its bid. Thus, the Loeb-Magat regulatory plan is incentive compatible.

Incentive compatibility also holds for the plan which follows. However, this plan requires no prior knowledge by the regulator of demand or cost conditions for its implementation. Moreover, it applies when there are arbitrary numbers of potential buyers and sellers, and it determines which of these agents actually participate in the market.

II. REGULATING IN IGNORANCE

While the particular interest here is in the regulation of monopoly, it is convenient to begin by considering a more general problem. Suppose that there are a number of potential buyers (m) and sellers (n) of a commodity. The buyers and sellers know that they are so few that their actions influence price, but they are unable to collude. It is assumed that the regulator is able to act as a central purchasing agency, making all sales to buyers and purchasing all production from sellers. The regulator is required to buy and sell in a way that maximizes social welfare (conventionally defined as the sum of consumer and producer surplus).

It is assumed that the demand curves of all buyers are negatively sloped, and (for the present) that the marginal cost curves of all sellers are positively sloped. If the regulator knew all of these curves then they could be aggregated to give an excess demand function from which the equilibrium price could be computed. By buying and selling at this price the regulator would maximize social welfare. Unfortunately the demand and cost information is private. Even so, there is a way in which the regulator can elicit this

information and use it to determine an optimal allocation. To see this, it is helpful to discover where the obvious procedure breaks down.

The obvious procedure is for the regulator to ask all potential buyers and sellers to provide their demand or supply curves. If the agents know that these curves are to be used to determine a price at which the regulator will trade, then it is easy to show that less than the optimal quantity will be bought and sold. Each buyer will understate his demand to force the price down, while each seller will understate his supply to force the price up. As a result, the price calculated by the regulator may be above, equal to, or below that needed for efficiency, but it is certain that the quantity traded will be too small.

Figure 1 illustrates the response of a seller when asked to reveal his supply curve. The i th seller regards market demand (D_m) and the supply of the remaining sellers (S_{n-i}) to be independent of his actions. If nothing is supplied by seller i the equilibrium quantity is Q_0 and price is P_0 . Let S_n be the supply curve including the true supply of the i th seller: Then the equilibrium quantity is Q_1 . The price P_1 is, of course, lower when supply from seller i is included than when it is not. By withholding supply this seller is able to raise the price. Provided that D_m and S_{n-i} are known to the seller the extent to which supply is understated can be found. Confronting seller i is a marginal revenue curve MR_i derived from the residual demand curve (which is the difference between D_m and S_{n-i}). By equating this with his marginal cost the profit maximizing price and quantity can be calculated by the seller, who need then only reveal as his supply curve any positively sloped curve containing this price and quantity. The curve S_F , passing through (p_2, Q_2) might be the market supply curve

calculated on the basis of the information provided by seller i . Notice that the seller would not care about any aspect of his revealed 'supply curve' except that it ensures that his preferred price P_2 prevails. Of course, the exact extent of the understatement by the seller is more complex to calculate than the previous argument suggests. This is because D_m and S_{n-i} are not likely to be known to the seller. As a consequence, the marginal revenue curve is not simply determined. It will depend on the beliefs held by the seller about the residual demand curve. What is certain, regardless of these beliefs, is that the seller will understate his supply.

For an individual buyer the case is symmetrical, and self-interest will result in an understatement of demand. All buyers and sellers can work out that demand and supply will be misrepresented, and they will take this into account. Thus, seller i will take D_m as the misrepresented demand curve and S_{n-i} as the misrepresented aggregate supply curve of all other sellers. Even so, his best strategy is to understate supply.

The reason why buyers and sellers do not reveal their true demand or supply curves is that they are not motivated to do so in the procedure just outlined. The Loeb-Magat scheme suggests how the regulator can induce each seller to correctly reveal his supply (that is, marginal cost) curve. If the regulator promises to pay the consumer surplus generated by the production of seller i , then the objective of that seller becomes the maximization of producer plus consumer surplus. This provides no incentive for the seller to misrepresent his costs. Payment of the subsidy requires that the demand curve be known to the regulator. This information can be obtained from buyers by suitably rewarding them. To achieve this, the Loeb-Magat scheme can be stood on its head. If the regulator promises to pay the individual buyer the

producer surplus generated by his demand, then the buyer's objective becomes the maximization of producer plus consumer surplus, with the consequence that there is no incentive to misrepresent demand. The regulator receives correct cost and demand information which can be used to find that price which will result in the socially optimal level of output, and its allocation among the buyers. The number of buyers and sellers is also determined.

The natural monopoly case, in which the potential sellers have decreasing marginal cost curves, is now considered.⁴ Each seller will reveal his correct marginal cost curve if the consumer surplus will be paid to him by the regulator. Each buyer will reveal his demand curve if he is taxed an amount sufficient to offset the negative producer surplus that his demand creates. From this information the regulator can decide which seller should be the monopolist, what subsidy should be paid, and what taxes should be levied on buyers. Social welfare is maximized by the regulatory scheme, which requires no knowledge on the part of the regulator of demand or cost conditions (unlike the Loeb-Magat scheme).

While the Loeb-Magat scheme has been used in the exposition of the regulatory procedure above, it would be wrong to infer that a generalization of a recent result has been made. In fact, the procedure described here is essentially that found in Section I ("The Exclusive Public Marketing Agency") of the famous article of Vickrey (1961). This part of Vickrey's seminal paper details perhaps the first incentive-compatible regulatory plan. It seems to have been ignored⁵ by readers too ready to accept Vickrey's own evaluation:

"Considering the fact that public funds [used to pay the subsidies to market participants] are obtainable only at a significant cost in terms of over head expenses of collection as well as misallocation of resources at

other points, it is highly doubtful whether the carrying-out of such a scheme in full could ever be justified."⁶ Although Vickrey did not consider the case of natural monopoly, it is appropriate that the regulatory plan presented in this section be called the Vickrey scheme.

III. FRANCHISING AND THE VICKREY SCHEME

As stated, Vickrey's scheme requires the payment of subsidies to sellers and buyers when marginal costs are increasing. The total subsidy required might be substantial. Yet Vickrey's pessimism about funding the subsidies is, with hindsight, seen to be unjustified. The essential point underlying the proposal of Demsetz (1968), and subsequent regulatory schemes based on auctions, is that participants in a market earn a return in excess of their opportunity cost. That raises the possibility that the regulator might extract some, or all, of this excess return in exchange for the right to be in the market. These payments to the regulator provide a fund out of which subsidies may be paid. The maximum potential size of this fund is, of course, the sum of total consumer and producer surplus; in other words, the total gains from trade put an upper limit on the subsidies paid by the regulator if no outside finance is available. In the case of the Vickrey scheme with increasing marginal costs, the total subsidy is less than the sum of producer plus consumer surplus.⁷ It is therefore possible for the Vickrey scheme to be self-financing (and indeed make a profit) if market participants are franchised. The problem for the regulator is to devise a franchising method which is compatible with the incentives offered to buyers and sellers to induce them to reveal their private demand and cost information. Leaving this difficulty aside, it is instructive to consider the range of possible ways of

paying for the subsidies.

One method of franchising to finance the Vickrey scheme is to charge all sellers an entry fee just less than the producer surplus plus the subsidy they will receive. Since the subsidy to buyers is less than total producer surplus this method of franchising will earn the regulator a profit. All the gains from trade then accrue to the buyers. An alternative is to franchise the buyers. Each buyer can be charged an entry fee not exceeding his consumer surplus plus subsidy. This will provide more than enough income to fund the subsidies. The regulator will make a profit, and all of the gains from trade will accrue to the sellers. Between these extremes lies a continuum of franchising arrangements. Participation fees can be levied on buyers and sellers, at rates that can be adjusted to exactly cover the subsidies that are paid. If differential fees are allowed, then they can be set so that there is no distributional effect.

One problem with the incentive mechanisms discussed above is that the entry fee is tied to the producer and consumer surplus. Of course, there is no incentive compatible mechanism which will induce sellers or buyers to reveal their own (respective) surplus if it will be used to set an entry fee applicable to them. An alternative to the mechanism discussed above is to specify the entry fee for active sellers (buyers) as the bid of the first inactive seller (buyer). In a manner analogous to the second price auction, each seller (buyer) would then have no incentives to misrepresent their own supply (demand). It is, however, not at all clear that entry fees set in this manner would be sufficient to finance the required subsidies.

In the case of a natural monopoly, matters are not quite so straightforward. The only seller allowed in the market receives a subsidy

which exceeds the total gains from trade. This occurs because the seller's producer surplus is negative. However, the regulator receives tax revenue from the buyers which somewhat offsets the subsidy. There is scope for the regulator to extract payments from the market participants sufficient to fund the Vickrey scheme. Unlike the case with increasing marginal costs, in the present case this cannot be done by levying the seller alone. Even if all the gains to the monopolist are extracted there is still a deficit equal to the difference between producer surplus and the taxes paid by the buyers. On the other hand, if all of the consumer surplus is extracted from the buyers (partly as market participation fees, and partly as the tax they pay), then the subsidy is exactly covered. All of the gains from trade go to the seller. The regulator will break even, and all of the gains from trade go to the buyers, if all the seller's gains are extracted by an entry fee and buyers pay an entry fee equal to the difference between producer surplus and their taxes. Combinations of these extreme arrangements are also feasible.

The principle is now established that franchising buyers and seller(s) to participate in the market can provide sufficient revenue to fund the Vickrey scheme, and result in any of a range of distributional outcomes. The difficulty confronting the regulator is to obtain the franchise fees without affecting the incentive for the agents to be truthful.

When the regulator is deciding which of a group of firms with equal access to the best-practice technology should be granted a monopoly the value to the winner can be discovered by a suitable auction. If marginal costs are increasing then the winning bid is more than enough to run the Vickrey scheme.⁸ Indeed, the regulator could require that the winner pay a stipulated fraction of his bid, and still afford to subsidize the consumers.

In the case of a natural monopoly, an auction may again be used to find the successful firm, and to extract (almost) all of its gains from participating in the Vickrey scheme. (In the same circumstances, the Loeb-Magat scheme will generate the same income from the sellers, and leave a larger deficit to the regulator⁹ than does the Vickrey scheme because the latter yields taxes from the buyers). Unless the buyers also contribute the regulator in this case makes a loss.

A simple auction will only yield the sellers' evaluations of participating in the regulated market if a monopoly is to be granted. What is needed is a preference-revelation mechanism to find the values placed on market participation by buyers and sellers in the general case. No obvious scheme suggests itself. In practice the best that might be done is to levy a lump sum tax on all would-be market participants. This would extract some of the gains from the buyers and seller, but may exclude some agents who would increase social welfare if admitted.

IV. CONCLUDING REMARKS

This note has resurrected the Vickrey scheme, which persuades buyers and sellers to reveal their true demand and supply curves, and has applied it to a natural monopoly. The Loeb-Magat scheme of monopoly regulation operates to obtain cost information in the same way as does the Vickrey scheme, but it assumes that demand information is available to the regulator. From the point of view of the information required to implement the two schemes that of Vickrey is less demanding than that of Loeb-Magat.

It has also been pointed out that there is sufficient potential revenue available from would-be market participants that the regulator can break even

while paying the subsidies required by the Vickrey scheme for the truthful revelation of private information. It has not been explained how to tap this potential revenue. However, for the case of a natural monopoly, the right to be the monopolist can be auctioned, as occurs in the Loeb-Magat scheme. While this does not generate enough revenue for the Vickrey scheme to be self-financing, the taxes collected from buyers mean that the net subsidy required is generally less than that needed to run the Loeb-Magat scheme. (As the number of buyers increases the amount of tax collected from each tends to zero, reflecting the decreasing importance of each buyer. In the limit the tax is zero, and the Vickrey scheme, with auctioning, requires the same net subsidy as does the Loeb-Magat scheme).

However ideal it is theoretically, in execution any regulatory plan creates problems. For instance, the costs of administering the scheme must be compared with its benefits.¹⁰ Despite this caveat, the Vickrey scheme, coupled with an auction, adds to the possible ways of regulating an industry.

FOOTNOTES

1. Baumol, Panzar and Willig (1982, Chapter 14) extend Demsetz' model to successive auctions of the monopoly franchise, and discuss some of the problems that then arise, for example "...if minimization of cost requires construction of sunk plants at two different dates." (Baumol et al. (1982, p. 414).
2. Loeb and Magat (1979, p. 400).
3. Sharkey (1979, p. 406).
4. See Sharkey (1982, Chapter 2) for an account of the history of natural monopoly theory. He highlights the weak foundations, and the lack of consensus about the interpretation and application, of the theory.
5. But see the introductory remarks of Smith (1981) and Smith (1979) for exceptions.
6. Vickrey (1961, p. 13).
7. See Figures 1 and 2 of Vickrey (1961, pp. 11, 12). Note that under the Vickrey scheme firms have an incentive to merge. As Vickrey himself implies, the merger of all firms will result in the subsidy to sellers being total consumer surplus.
8. Of course, granting a monopoly is inconsistent with maximizing social welfare when firms have identical, increasing, marginal costs. The point is that an auction is able to elicit the seller's gain from taking part in the market under the regulator's rules.
9. One of the main objections raised against the Loeb-Magat scheme by Sharkey (1979, p. 406) was precisely this net subsidy.
10. As Coase (1970) argues, the cost includes the possibility that the regulator ceases to fulfill the purpose it was designed for.

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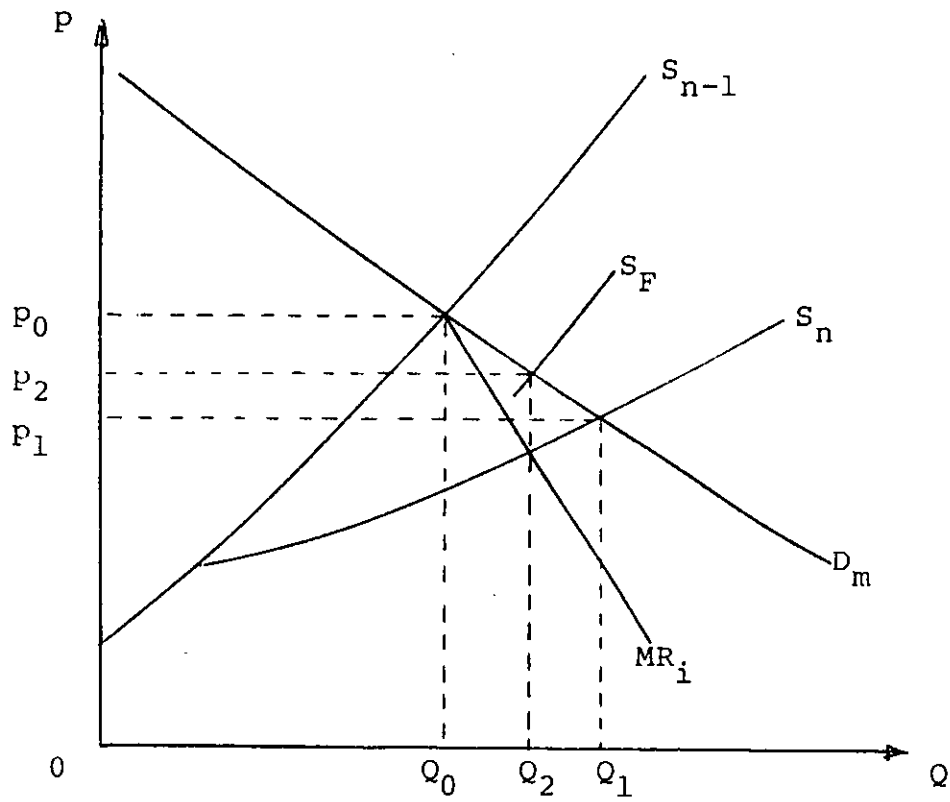


Figure 1: An Individual Seller Will Understate Supply to Raise the Price Calculated by the Regulator