Regulation of Monopolies
A Randomized Approach *)

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Abstract. Two formal models are proposed to describe the gains of randomizing the regulation and price control of monopolies. In the first model, a monopolist faces a non-zero probability of being regulated by the authorities due its pricing policy. This leads to a self-regulation. Threat of regulation induces monopoly to pay a risk premium to consumers in a form of reduced product price. The analytical solution of model leads to a form that may have some practical relevance in empirical research. Second model shows, if monopolies are allowed for, that the randomized non-competitive product price control implies a higher social welfare than without randomization. The used indirect utility function approach enables us to show that the social welfare function is non-concave in some region of monopoly prices. The implications of the models for competition policy are clear. In some cases the breaking up the monopolies is not the only alternative. A randomized price regulation policy can give results that are welfare and efficiency improving.

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I. Introduction

According to textbook economic theory, the main effects of monopoly are to misallocate resources, to reduce aggregate welfare and to redistribute income in favour of monopolists. The monopoly profit is merely a transfer of wealth from consumers to the monopolist producer. The 'welfare triangle' introduced by Harberger (1954) measures the net loss to society (for details, see Littlechild 1981). The first-best solution is to regulate price equal to the marginal cost and to provide, if necessary, a subsidy to the supplier equal to the fixed cost. This first best solution is based on a number of informational assumptions. Especially the assumption that the regulator has complete information about the cost of the firm is unnatural. The firm is expected to have better information about costs than the regulator. The firm may have an incentive to misreport its cost in order to obtain a more favorable price. The assumptions of non-existing regulatory and information gathering costs by the regulator are also unlikely to be met in reality. Posner (1975) argues that public regulation is probably a larger source of social costs than private monopoly.

In answering these problems the economic theory has provided alternative solutions. The application of agency theory is one alternative providing different screening mechanisms (e.g. Baron & Myerson 1982, Armstrong & Rochet 1999, Brighi & D'Amato 2002). Alternative, we can approach the issue with tariff policies augmented with measures of income and price risk (see Cowan 2003, and references there in). However, from empirical point of view it is difficult to know what are the practical merits of these models.

In the following we propose an alternative approach that relies on the idea of randomized regulation.[1)] Authorities impose a market and a price regulation partly in unanticipated fashion. In the first model the monopoly faces a credible threat of being regulated if the regulator observes a price level higher than assumed competitive price. No information concerning the cost structure of firm is needed for the regulation. The threat causes the monopoly to exercise self-regulating pricing policy that gives premium to the consumer.

The model gives a partial answer to the empirical fact that monopoly profits are not in general high as the pure theory predicts (Littlechild 1981, Slade 2004). It also shown that a hazard function, depending on the pricing policy, exists for the self-regulating monopolist. This may have some empirical relevance in the regulation planning. In the second model, the randomized approach is shown to increase social welfare as a case for a non-concave welfare function may exist for high price levels. The result depends on the second order conditions of the indirect utility function.

II. Model 1

Consider the case where monopoly faces following expected profits

$$V(q) = \pi(p(q))\overline{p}q + [1-\pi(p(q))]p(q)q - C(q) \tag{1}$$

where $\pi(p(q))$ is the probability that the monopoly will be regulated by the authorities because of monopolist's high pricing policy (i.e. $\pi' > 0,$ but demand curve is downward sloping, $p_q < 0$). In that case the monopoly faces a fixed regulated (market) price $\overline{p}$ for its demand. The expected revenue under market price is $\pi(p(q))\overline{p}q$. The second term $[1-\pi(p(q))]p(q)q$ gives the expected revenue of monopoly when it can continue to work unregulated. $C(q)$ is the cost function of output $(C_q > 0, C_{qq} > 0)$.

The monopoly sets its output on the level where the marginal expected profits are zero, i.e.

$$V'(q) = \pi' p_q \overline{p}q + \pi\overline{p} - \pi' p_q p(q)q + (1-\pi)[p_q q + p(q)] - C_q = 0 \tag{2}$$

$$\Rightarrow \quad \pi' p_q q[\overline{p} - p(q)] + \pi[\overline{p} - (p_q q + p(q))] = C_q - [p_q q + p(q)].$$

The result evokes some interesting observations. First, rearranging terms and noticing that $MC(q) = C_q$ we observe that optimal output decision by the monopolist is determined by

$$\pi' p_q q[\bar{p} - p(q)] + \pi[\bar{p} - p(q)(1 - \frac{1}{|\eta_q|})] = MC - p(q)(1 - \frac{1}{|\eta_q|}) . \tag{3}$$

When competitive pricing is conducted, $\bar{p} = MC(q) = p(q)$, one obtains naturally that $\pi = 1$. Second, when monopoly pricing is allowed for, the standard theory demands that $MR(q) = MC(q)$, i.e. $MC(q) = p(q)(1 - 1/|\eta_q|)$. Thus this can happen only when $\pi = 0$ and $\pi' = 0$. However, lastly, when $\pi \in (0,1)$, $\pi' > 0$ and $p_q < 0$,

$$\pi' p_q q[\bar{p} - p(q)] + \pi[\bar{p} - p(q)(1 - \frac{1}{|\eta_q|})] > 0 , \tag{4}$$

as the monopoly pricing rule demands that

$$\bar{p} - p(q) < 0 \text{ and } \bar{p} - p(q)(1 - \frac{1}{|\eta_q|}) = \bar{p} - MR(q) > 0 .$$

The result says that under the randomized price control the monopolist self-regulates its price at level that is lower than without the threat of regulation, and $MC > MR = p(q)(1 - 1/|\eta_q|)$. The randomized price control includes an extra (marginal) cost for the monopoly, a price premium for the consumers.

Thus monopoly reduces its price level and produces more under the threat of regulation. It sets its price on the level that is between the competitive and monopoly pricing (see Figure 1), i.e. $p(q_1)_R$ exists for which

(5) $$\bar{p} = p_0(q_0) < p(q_1)_R < p_2(q_2) \quad \text{and}$$

(6) $$q_0 > q_1 > q_2.$$

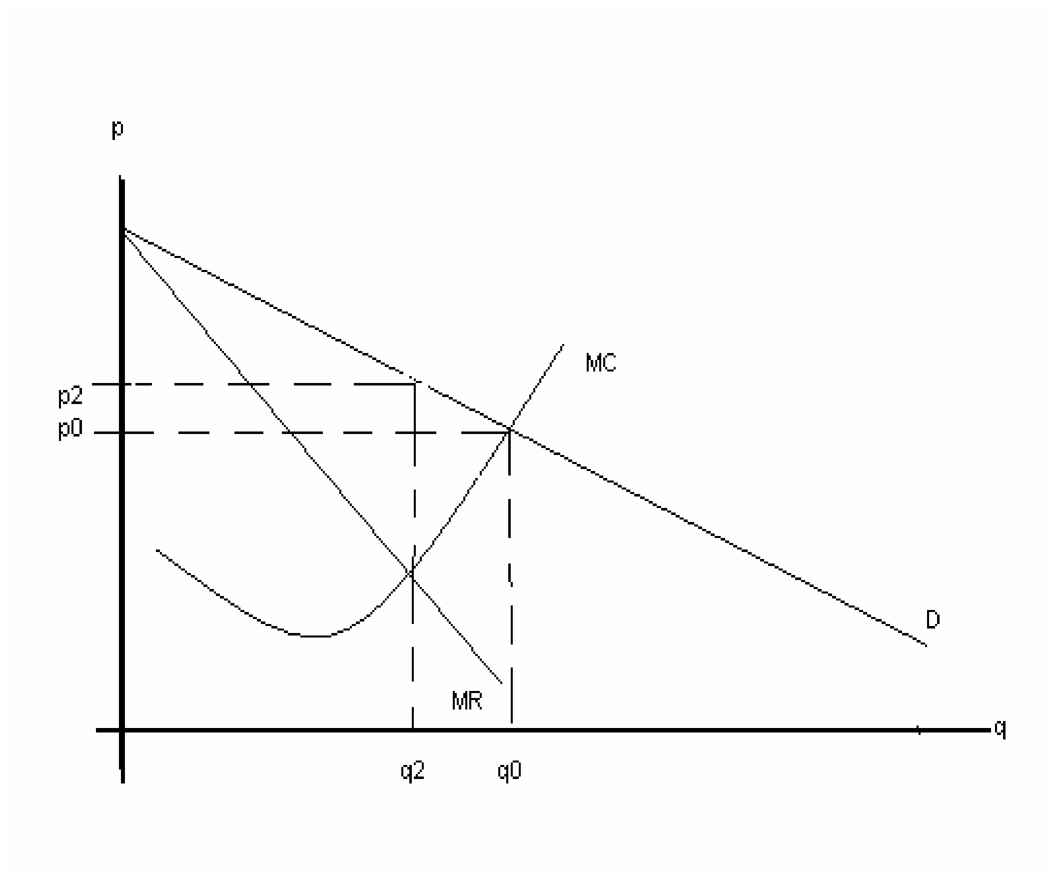

Figure 1. Monopoly price setting (p_2) and competitive price (p_0)

The randomized approach has the advantage that it operates as a threat for the monopoly. There exists always a non-zero probability that the monopoly is regulated depending on its output decision. However before the regulation can take place the authorities and the monopoly must assume that $\bar{p} < p(q)$ exists.[2)] Assume next also that regulation threat is "strong" giving result like $\bar{p} \approx MC(q)$. Now we have

(7) $$\pi' p_q q[\bar{p} - p(q)] + \pi[\bar{p} - p(q)(1 - \frac{1}{|\eta_q|})] \approx \bar{p} - p(q)(1 - \frac{1}{|\eta_q|})$$

$\Rightarrow$

$$\pi' p_q q[\bar{p} - p(q)] \approx [1-\pi][\bar{p} - p(q)(1 - \frac{1}{|\eta_q|})]. \quad (8)$$

Basically rule (8) states that the strategic price setting for the monopoly is a complicated function of output and failure rate or hazard rate of monopoly, i.e.

$$p(q) = G(q, R(q)) \quad (9)$$

where $R(q) = \frac{\pi'}{1-\pi} = \frac{f(p(q))}{1-F(p(q))}$ is the hazard function. $F(p(q))$ is the probability distribution function of possible regulatory policy depending on the monopoly's output decision.

The importance of equations (8) and (9) lies in the fact that they relate control policy to the pricing decisions and Eq. (9) is a highly non-linear function in output, i.e. many equilibrium points may exist.

III. Model 2

Next assume that all consumers have an indirect utility function of price and income $I(p, y)$ and $y = pq - C(q)$ (for more details, see Newbery 1978). Now $-I_p / I_y = q(p)$ with $I_y > 0$ and $I_p < 0$. The social welfare function W has a form of

$$W(p) = I(p, y(p)). \quad (7)$$

Social optimum is determined by

(8)

$$\frac{dW}{dp} = \frac{\partial I}{\partial p} + \frac{\partial I}{\partial y}\frac{dy}{dp} = -I_y q(p) + I_y[q(p) + (p - \frac{dC}{dq})\frac{dq}{dp}]$$

$$= I_y (p - \frac{dC}{dq})\frac{dq}{dp} = 0 \quad \Leftrightarrow \quad p = \frac{dC}{dq}.$$

Second order conditions reveal some interesting results

(9)

$$\frac{d^2W}{dp^2} = (I_{yp} + I_{yy}\frac{dy}{dp})p\frac{dq}{dp} + I_y p\frac{d^2q}{dp^2} + I_y\frac{dq}{dp}$$

$$-(I_{yp} + I_{yy}\frac{dy}{dp})\frac{dC}{dq}\frac{dq}{dp} - I_y\frac{d^2C}{dq^2}(\frac{dq}{dp})^2 - I_y\frac{dC}{dq}\frac{d^2q}{dp^2}$$

$$= [I_y p\frac{dq}{dp} - I_y\frac{dC}{dq}\frac{dq}{dp}][\frac{(I_{yp} + I_{yy}\frac{dy}{dp})}{I_y} + \frac{d^2q/dp^2}{dq/dp}] + I_y\frac{dq}{dp} - I_y\frac{d^2C}{dq^2}(\frac{dq}{dp})^2$$

$$= \frac{dW}{dp}[[\frac{(I_{yp} + I_{yy}\frac{dy}{dp})}{I_y} + \frac{d^2q/dp^2}{dq/dp}] + I_y[1 - \frac{d^2C}{dq^2}\frac{dq}{dp}]\frac{dq}{dp}$$

$$= I_y[1 - \frac{d^2C}{dq^2}\frac{dq}{dp}]\frac{dq}{dp} < 0, \text{ since } \frac{dW}{dp} = 0,\ I_y > 0,\ \frac{d^2C}{dq^2} > 0, \text{ and } \frac{dq}{dp} < 0.$$

Note that for monopoly case we have

$$\frac{dW}{dp} = I_y (p - \frac{dC}{dq})\frac{dq}{dp} < 0 \quad \text{when } p > \frac{dC}{dq}.$$

Now the sign of

$$\frac{d^2W}{dp^2} = \frac{dW}{dp}[[\frac{(I_{yp} + I_{yy}\frac{dy}{dp})}{I_y} + \frac{d^2q/dp^2}{dq/dp}] + I_y[1 - \frac{d^2C}{dq^2}\frac{dq}{dp}]\frac{dq}{dp}$$

depends on sign of $[\frac{(I_{yp} + I_{yy}\frac{dy}{dp})}{I_y} + \frac{d^2q/dp^2}{dq/dp}]$. That is typically negative.

This means that sign of d^2W/dp^2 can be positive especially when income elasticity I_y is small. Then the social welfare function will be non-concave for some high (monopoly) values of p. This gives room for randomized control policy with values $p_1 < p_{MONOP} < p_2$ leading to higher expected social welfare than with mean value of p_1 and p_2 $\bar{p} \approx p_{MONOP}$.

III. Conclusions

The regulation of monopolies is a classical case of pure and applied economic theory. Monopolies are regarded as socially harmful, both terms equality and economic efficiency. The target of this note was to show that the randomized regulation and pricing policy have socially desirable effects. Two models were presented.

The first proposed model assumed that the incidence of regulation is an increasing function of monopoly price. It was also assumed that the regulator can identify the monopoly without knowing its cost structure and regulation threat imposes an implicit or explicit competitive price that deviates from observed (monopoly) supply price. Under the credible threat of regulation monopolist self-regulates its price on the level that is between the competitive and monopoly price. The risk of being regulated causes the monopoly to pay price premium to the consumers.

The second model assumed the existence of continuous indirect social welfare function. It was shown that harmful effects of monopolies can be reduced with randomized price control even without the threat of price regulation or breaking up the monopolies. The result depended on the second order conditions of the welfare function.

The implications of the models for practical competition policy are clear. The authorities need not run extensive and costly regulation program. Some randomly chosen regulation cases and credible regulation threat may be more effective in cost-benefit terms.

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1) In this context we mean by monopoly regulation and control cases where the authorities monitor directly the monopoly, use legal methods to control price setting, open the market to competition, or finally break the monopoly into separate new firms.

2) Note that it is not necessary for the authorities to know the exact value of $\overline{p}$. We can also interpretate $\overline{p}$ as the internal reference value for the monopoly that is valid for it under regulation. In this sense $\overline{p}$ is "private information" for the monopoly. We only assume that $\overline{p} < p(q)$. Actual competitive price can neither be simulated nor calculated, in the end it is only competition itself that can be determine it.

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