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Threat-based Regulation and Endogenously Determined Punishments

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ABSTRACT

We present a theoretical model to show that through the adoption of simple regulatory rules, the threat of regulation as well as regulation itself impacts upon a firm's pricing strategy. The model is relevant to general antitrust policy, as well as the regulation of individual utility industries. While the paper focuses on the threat of revenue regulation, the principal results may also hold when regulation takes the form of penalties on prices charged. In the model the probability of regulatory intervention increases with the level of price charged, as does the toughness of any regulation imposed. This form of regulation, although not optimal, has the advantage of being relatively simple to apply. The proposed regulatory rules offer a form of transparent regulation that could circumvent fears of regulatory capture.

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1. INTRODUCTION

Efforts are ongoing across many countries to create greater contestability in many industries, including utility industries that, often due to technological advances, are no longer necessarily regarded as naturally monopolistic.[1] For example, telecommunications is often cited as an example of an industry that has experienced dramatic technological developments in recent years giving rise to greater opportunities for competition. Similarly, in many countries, advances such as sophisticated metering systems and the development of pool markets have contributed to increasing competition in the gas and electricity industries. Nevertheless, when hit and run entry is believed to be a non-credible threat, for example, due to the presence of barriers to entry, potential entry into a market may not constrain incumbent firms' pricing and production decisions.

This paper argues that when hit and run entry is (or is believed to be) a non-credible threat, a regulator can affect a firm's behavior by the credible threat of regulation, as well as by regulation itself. The credible threat of regulation can take the advantageous form of simple regulatory rules, such as potential revenue or price penalties, which can impact upon a firm's pricing strategy.

The notion of regulatory threats impacting upon firms' behavior has wide applicability. The model presented below is equally applicable to the potential

[1] See, for example, Baumol, Panzar and Willig (1982) for a detailed discussion of the theory of contestable markets.

regulation of a firm by an industry specific regulator, or the more general threat of intervention by antitrust authorities.[2] Below, we concentrate on regulation that takes the form of a penalty on revenue. This is comparable to fines imposed under US antitrust law and EU competition policy; the provision of the 1998 UK Competition Act that allows for firms to be fined up to 10% of turnover for three years, and the French scheme whereby fines of up to 5% of firms' sales can be imposed for competition law violations, Souam (2001).

Existing theoretical research, including papers by Klevorick (1973), Bawa and Sibley (1980) and Logan *et al.* (1989) confirms that the threat of regulation can impinge upon a firm's behavior. These models focus on the regulation (and threat of regulation) in monopolistic industries, where regulation is used to achieve a 'fair rate-of-return', reflecting rate-of-return regulation traditionally adopted in the US. Meanwhile, Glazer and McMillan (1992) examine the threat of a price selected by the regulator being imposed on a monopolist. As in this paper, the threat of regulation is endogenously determined by price charged. However, the form of regulation potentially adopted is very different below as the size of the penalty is also endogenously determined in relation to the price initially charged by a firm.

The theoretical model presented here focuses on a firm with substantial market power, and can be contrasted with previous research in that the focus here is on the implications of the adoption of arguably more straightforward regulatory rules.[3] Regulation takes the form of penalties on firm revenue although penalties on price charged are also briefly explored. These revenue and price penalties can be

[2] See Acutt and Elliott (2001) for key requirements for the efficacy of threat based antitrust policy.
[3] Alternatively, joint profit maximising oligopolists can be assumed in the analysis below.

contrasted with the standard forms of regulation usually considered in the literature, namely rate-of-return and price regulation. The regulation is not intended to be optimal and hence does not reflect the maximization of a regulator's objective function. Nevertheless, because regulatory bodies do not need to monitor and potentially regulate firms continuously, it is hoped that the form of (threatened) regulation envisaged will be cheaper and easier to implement.

We show that through the adoption of simple regulatory rules, the threat of regulation, including threatened punishment by antitrust authorities, impacts upon a firm's pricing strategy. Our results hold when regulation takes the form of penalties on firm price as well as revenue. It is assumed that the probability of regulatory intervention and the extent of regulation is endogenously determined by the firm's behavior in the first period of a two-period game. While Souam (2001) also considers revenue regulation, he focuses on optimal regulation in a one period model in which a fine is a fixed proportion of revenue.

The UK Cabinet Office's Better Regulation Task Force (1998) identifies five key principles of good regulation: transparency; accountability; targeting; consistency and proportionality. The regulation modeled in this paper performs well against these principles. It would be transparent if the relevant regulatory authorities announce the rules in advance. As both the probability and extent of intervention are determined by the firm's behavior, features of the rules modeled are that they are by their nature proportional and targeted. Accountability and consistency depend on the process identified by the regulator for the application of the rules described here. However, there is no reason *a priori* why the rules modeled here would not be consistent with these two criteria. Further, through the use of simple regulatory rules, it is hoped that fears of regulatory capture could be minimized.

A limited number of empirical studies have also been published that explore the threat of regulation on firms' behavior, for example, Zweifel and Crivelli (1996), Taylor and Zona (1997), and Acutt *et al.* (2001). Taylor and Zona (1997) conclude that both regulation and the threat of regulation have impacted upon AT&T's pricing strategy, while Zweifel and Crivelli (1996) conclude that the threat of introducing reference prices restrained prices in the German pharmaceutical industry. Acutt *et al.* (2001) use intervention analysis to show how the temporary imposition of price regulation and the threat of further regulation impacted upon prices in the England and Wales electricity pool market.

Section 2 sets out the assumptions underlying the theoretical analysis. Section 3 describes the results of a regulator threatening to impose revenue penalties for abuse of a dominant market position, while the results of the potential imposition of price penalties are discussed in Section 4. Section 5 concludes, highlighting potential advantages of the regulatory rules described.

2. THEORETICAL ANALYSIS - ASSUMPTIONS

Assume that a firm with sufficient market power to be considered a monopolist (or joint profit maximizing oligopolists) wishes to set price to maximize profits over both periods of a two-period game.[4] However, a regulator can monitor the price charged in the first period and can choose to impose a punishment in the second period. The

[4] This model abstracts from what would in reality be a continually repeated, overlapping, two-period game.

punishment is assumed to be enforceable and takes the form of a penalty on revenue (or price). Partly to reflect the imperfect and costly nature of regulation and regulatory monitoring, intervention by the regulator may not necessarily be certain, even when price is high. Rather, it is positively related to the price charged in the first period of the model. Throughout the paper it will be assumed that:

$$\gamma = f(P) \in [0,1] \tag{1}$$

$$\gamma(P) \geq 0 \qquad \gamma'(P) > 0 \qquad \gamma''(P) \lesseqgtr 0$$

where:

γ = probability of regulatory intervention;

P = price charged by the firm.

Alternative specific functional forms for this relationship will be illustrated below.

A potential penalty on revenue is denoted $R(P)$, it being assumed that:

$$R(P) \geq 0 \qquad R'(P) > 0 \qquad R''(P) \lesseqgtr 0$$

A potential price penalty is denoted $X(P)$, it again being assumed that:

$$X(P) \geq 0 \qquad X'(P) > 0 \qquad X''(P) \lesseqgtr 0$$

In both periods, a simple demand function is assumed:

$$P = 1 - Q, \quad P \in [0, P_M] \tag{2}$$

Fixed costs of production are assumed to equal zero. Variable costs are assumed to be constant, and may be positive.

3. REVENUE REGULATION

A firm maximizes the following two-period profit function:

$$\Pi = PQ - cQ + [1-\gamma(P)][PQ - cQ] + \gamma(P)[PQ - R(P) - cQ] \qquad (3)$$

where:

Π = firm profits;

Q = output;

c = constant variable costs of production.

Although not required for any of the results derived below, a range of constraints on upper limits of $R(P)$ can be envisaged, including profits in both or one of the modeled periods.

It is straightforward to confirm that price will be:

$$P = \frac{2(1+c) - \gamma(P)R'(P) - \gamma'(P)R(P)}{4} \qquad (4)$$

with the second order condition for profit maximization being satisfied if:

$$\frac{d^2\Pi}{dP^2} = -4 - \gamma(P)R''(P) - 2\gamma'(P)R'(P) - \gamma''(P)R(P) < 0 \qquad (5)$$

If unconstrained by potential regulation, a monopolist would charge:

$$P_M = \frac{1+c}{2}$$

each period. Hence, price will be less than a profit-maximizing monopolist would charge in the absence of possible regulatory intervention iff:

$$\gamma(P) > 0 \qquad (6)$$

Note that

$$\gamma(P) = 0 \Rightarrow R(P) = 0$$

Consequently, the threat of regulatory intervention impacts upon a firm's pricing decisions.

Three alternative regulatory scenarios can be envisaged:

i) $R \neq f(P)$ $\gamma = 1$ $\Rightarrow P = \frac{2(1+c)}{4}$

ii) $R = f(P)$ $\gamma = 1$ $\Rightarrow P = \frac{2(1+c) - R'(P)}{4}$

iii) $R \neq f(P)$ $\gamma = f(P)$ $\Rightarrow P = \frac{2(1+c) - \gamma'(P)K}{4}$

where:

K = R when $R \neq f(P)$[5]

By comparing the price charged in Equation (4) with that arising from Scenario ii) the condition to be satisfied for threatened regulation to have a greater impact on price charged in period one than certain regulation can be obtained:

$$R'(P) < \gamma(P)R'(P) + \gamma'(P)R(P) \quad (7)$$

i.e. if the marginal impact of regulation in the face of endogenously determined probabilities is greater than the marginal impact when the probability of regulation is exogenous.

Meanwhile, assuming that regulation is not certain, price will be lower when an endogenously determined penalty is imposed rather than an exogenously determined punishment iff:

$$\gamma'(P)K < \gamma(P)R'(P) + \gamma'(P)R(P) \quad (8)$$

[5] To avoid confusion between $R = f(P)$ and a revenue penalty labeled *R*, when $R \neq f(P)$.

i.e. if the marginal impact of intervention given an endogenously determined penalty outweighs the marginal impact of intervention given an exogenously determined penalty. Note that in scenario i), i.e. when the penalty is exogenously determined and regulation is certain (i.e. $\gamma = 1$), then the firm will choose to charge the same price as if unconstrained by potential regulation, P_M, each period.

Specific functional forms for $\gamma(P)$ may be considered. For example, if the probability of regulatory intervention is the following linear function of price, i.e. the ratio of price charged to the monopoly profit-maximizing price:

$$\gamma(P) = \frac{P}{P_M} = \frac{2P}{1+c} \tag{9}$$

A firm's optimal price is:[6]

$$P = \frac{(1+c)^2 - R(P)}{R'(P) + 2(1+c)} < P_M \tag{10}$$

Similarly, when $\gamma(P)$ has the following linear functional form:

$$\gamma(P) = \frac{P-c}{P_M - c} \tag{11}$$

$$P = \frac{(1+c)(1-c) - R(P) + cR'(P)}{[2(1-c) + R'(P)]} < P_M \tag{12}$$

This model can be used to explore the effectiveness of the provision in the 1998 UK Competition Act whereby firms can be fined a maximum of 10% of turnover for three years. It can be assumed that:

[6] The second order condition for profits being maximized is easily verified for both of the specific functional forms of $\gamma(P)$ considered in Section 3.

$$R(P) = 0.1[P(1-P)] \tag{13}$$

Setting variable costs of production equal to zero as a simplifying assumption, it is straightforward to show that if:

$$\gamma = f(P) = \frac{P}{P_M} = 2P$$

$$P = \frac{1-R(P)}{2+R'(P)} = 0.4868 < P_M \tag{14}$$

if the revenue penalty is imposed for a single period. Meanwhile, if the penalty is imposed for three periods, price falls to:

$$P = 0.4798$$

If $\gamma(P)$ takes the following non-linear functional form (and the penalty continues to be imposed for three periods):

$$\gamma(P) = \frac{P^2}{P_M^2} = 4P^2 \tag{15}$$

$P = 0.4630$ [7]

and is expected to fall further if a discount rate is applied to future profits. Hence, in this stylized example, a 10% penalty is sufficient to force firms to set price below the monopolist's profit maximizing price, although the impact on price charged is relatively small. In reality the effects of competition policy provisions may be expected to be greater, given their wide ranging impact, for example due to the effects of uncertainty on a firm's performance (including share price performance) during investigations.

[7] This solution is found using the trigonometrical solution method for cubic equations with three real roots (the discriminant of the cubic function is negative).

Note, however, that the impact of a threatened revenue penalty can be further increased if $R(P)$ increases non-linearly. For example, if, in the above analysis:

$$R(P) = P^2 \tag{16}$$

a firm's price falls to:

$$P = 0.314$$

4. PRICE REGULATION

For comparison purposes, the implications of a related form of price regulation are briefly considered. Potential price regulation takes the form of an endogenously determined price cap

$$P - X(P)$$

where:

$X(P)$ = a price penalty as defined in Section 2.

It is the endogenous nature of the price regulation that distinguishes this form of regulation from price caps of the basic RPI-X form.

The formal analysis of a firm's decisions in the face of a potential price penalty is more complicated than the analysis of Section 3. The following specific functional form for the threatened price penalty is assumed:

$$X(P) = \frac{P}{2} \tag{17}$$

Variable costs of production are set equal to zero, or alternatively, it can be assumed that the price variable reflects the excess of price charged over constant, positive variable costs of production. Maintaining the same simple demand function as above, and:

$$\gamma(P) = \frac{P}{P_M} = 2P$$

a firm will maximize the following two-period profit function:

$$\Pi = PQ + [1 - \gamma(P)](PQ) + \gamma(P)[P - X(P)]Q \qquad (18)$$

The optimal price to be charged is:[8]

$$P = 0.42265$$

Clearly, price is less than that charged by a monopolist unthreatened by potential price regulation.[9] The probability of price regulation being imposed is approximately equal to 0.84. While the probability of regulatory intervention remains relatively high, in this formulation of the model a price penalty would be imposed with certainty if a firm ignored the regulatory threat.

5. CONCLUSIONS

> '… in many circumstances, the regulator need not confine his or her actions to direct licence amendments. The *threat of regulation* can prove a powerful tool in gaining compliance.'
>
> Helm and Jenkinson (1997, 11)[10]

In this short paper we have illustrated how the adoption of very simple regulatory rules can impact upon a firm's pricing decisions, such that the threatened regulation may not need to be realized. The probability of regulatory intervention increases with

[8] It is straightforward to confirm that the relevant second order condition is satisfied.

[9] Note that if $\gamma(P)$ once again takes the non-linear functional form $\gamma(P) = \frac{P^2}{P_M^2} = 4P^2$, price falls to $P = 0.3904$.

[10] Quotation contains the original authors' emphasis.

the level of price charged, as similarly does the toughness of the regulation imposed. The regulatory rules do not reflect optimal regulation; they do not reflect the optimization of a specific regulator objective function. Rather, the simplicity of the regulatory rules envisaged are intended to provide a countervailing force when regulation implementation and the associated monitoring of firms is necessarily complicated and costly.[11] Further, through the use of simple regulatory rules, concerns regarding opportunities for regulatory capture are minimized, while the regulatory process will have the advantage of transparency if the regulatory rules are publicly announced prior to firm decision making. Hence, while the threat of regulation alone does not lead to the equilibrium outcomes suggested by the theory of perfectly contestable markets, prices are lower and so output levels correspondingly higher than in the absence of any regulatory threat. This type of regulation meets the five key principles of good regulation: transparency, accountability, targeting, consistency and proportionality. The paper focuses on a form of revenue regulation that is equally applicable to industry specific regulation and general antitrust policy. A stylized example of the comparable form of price regulation is also offered.

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[11] Although the analysis does not take explicit account of the costs of regulation and threatened regulation envisaged.

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