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Elasticity Based Pricing Rules in Telecommunications
- a Cautionary Note

by

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Abstract

To recover large common (sunk) costs, telecommunications operators are often recommended to follow an inverse elasticity based pricing; setting the highest markups for the services with the least elastic demand. This is based on the seemingly simple rule for profit maximization proposed in many microeconomics textbooks for marking up marginal cost. This inverse elasticity rule also appears in the well-known Ramsey rule, which has been frequently debated as a regulators tool for curbing monopoly pricing in telecommunications while minimizing deadweight losses.

The inverse elasticity rule is all too often described in a way that implies a myopic application, usually with a numerical example with input values for price elasticity of demand and marginal cost thus determining profit maximizing price (e.g. Dobson, Maddala, and Miller, 1995, or Mansfield and Yohe, 2000). This is unfortunate, as management in telecommunications and other industries may adopt the rule at face value.

However, if marginal cost and price elasticity depend on price, as is usually the case, a straightforward application of the rule will, in most cases, lead to an overshooting of optimal price; if the initial price were too low, then the prescribed price would be too high, and vice versa. Continued myopic use may even lead to divergence from the profit maximizing price. Only if both price elasticity of demand and marginal cost are constant, which is rarely the case, will the rule return the optimal price.

JEL classification: A22, D4, L19

Keywords: Markup pricing, elasticity, Ramsey pricing, telecommunications.

1. Introduction

In microeconomics textbooks, it is common to find a section on markup pricing or cost-plus pricing. Often authors caution against the use of this type of pricing rule in its standard form, which is as a percentage markup over average cost intended to cover overhead and yield a satisfactory return. Only under special circumstances will such a rule result in profit maximization.

Instead, authors often propose a similar rule based on economic theory for profit maximization, which incorporates the basic condition that marginal revenue should equal marginal cost (e.g. Mansfield and Yohe 2000, Nicholson 2000, Pindyck and Rubinfeld 2001).[1] Utilizing the relationship between price and marginal revenue, $MR = p\left(1+\frac{1}{\varepsilon}\right)$ where $\varepsilon \equiv \frac{\partial q}{\partial p}\frac{p}{q}$, and then equating marginal revenue and cost, the following rule for markup over marginal cost is prescribed:

$$p = \left(\frac{1}{1+\frac{1}{\varepsilon}}\right) mc \tag{1}$$

This is the basic form of so called "inverse elasticity rules" where the monopolistic price varies inversely with price elasticity of demand; products with less elastic demand receive higher markups and vice versa. A special version of the rule is Ramsey (1927) pricing, where a regulated monopoly reduces percentage profit uniformly on all units to satisfy some profit constraint set by authorities (e.g. Wilson 1993, or Baumol, Panzar, and Willig 1988). It is particularly relevant for industries with high common fixed costs and low variable costs, such as telecommunications, where (linear) pricing at marginal cost will lead to losses. Indeed, Ramsey pricing has been one of the most commonly debated pricing rules for dominant telecommunication operators (e.g. Gabel and Weiman 1998, Vogelsang and Mitchell 1997, or Laffont and Tirole 2000). If the Ramsey rule holds in optimum, deadweight losses for fully distributed cost pricing will be minimized (e.g. Viscusi, Vernon, and Harrington 1998). Profit maximizing prices in accordance with equation (1) are generally higher than Ramsey prices, but both follow the same inverse elasticity structure. We will focus on the profit maximizing version of these elasticity based pricing rules.

The marginal cost markup rule in equation (1) is all too often described in a way that implies a myopic application, usually with a numerical example with input values for price elasticity of demand and marginal cost thus determining profit maximizing price (e.g. Dobson, Maddala, and Miller 1995, or Mansfield and Yohe 2000). This is unfortunate, as managers with mainly introductory or intermediate level of microeconomics, may adopt the rule at face value and ignore that elasticity and marginal cost tend to vary with price. Statements such as: "this equation shows that a firm's management need only to know their product's marginal cost and price elasticity of demand to determine the price that maximizes profits", tend to draw attention away from the footnotes of caution (Mansfield and Yohe 2000, p. 375).[2]

The use of the pricing rule is not as straightforward as may appear from equation (1), as the relation only applies at the point of profit maximum.[3] If applied myopically, the rule will only prescribe the profit-maximizing price if price is already profit maximizing, and otherwise only if both marginal cost and elasticity are indeed constant.[4] Neither is usually the case.

Normally, both the elasticity of demand and marginal cost depend on price,[5] and if both vary considerably, one may need to know the entire demand and cost schedules to determine optimal price and output level (Pindyck and Rubinfeld 2001). If so, the marginal cost markup rule will not offer any advantage over simply equating marginal revenue and marginal cost directly. As will be shown, price dependent elasticity of demand and marginal cost will limit the usefulness of the rule and will in most cases lead to erroneous pricing.

2. Results

We begin by making the assumption that both marginal cost and price elasticity of demand are dependent on price. Rewriting equation (1), we get:

$$\hat{p} = \left(\frac{1}{1 + \frac{1}{\varepsilon(q(p), p)}} \right) mc(q(p)) \tag{2}$$

where $\hat{p}$ is the prescribed "profit maximizing" price from given elasticity and marginal cost. Next, we ask what would the consequence be of applying the pricing rule in equation (2) in a myopic manner? Differentiating equation (2), we obtain the effect on prescribed "profit maximizing" price by the rule following a change in initial price:

$$\frac{d\hat{p}}{dp} = mc \left(\frac{1}{\left(1 + \frac{1}{\varepsilon}\right)\varepsilon} \right)^2 \frac{\partial \varepsilon}{\partial p} + \left(\frac{1}{1 + \frac{1}{\varepsilon}} \right) \frac{\partial mc}{\partial q} \frac{\partial q}{\partial p} \tag{3}$$

When analyzing equation (3), we define three base cases: (i) Demand is elastic at the initial price $(\varepsilon < -1)$, and becomes more elastic as price increases $\left(\frac{\partial \varepsilon}{\partial p} < 0 \right)$. (ii) Price elasticity of demand is constant and elastic $\left(\varepsilon < -1, \quad \frac{\partial \varepsilon}{\partial p} = 0 \right)$. (iii) Demand is inelastic at the initial price $(\varepsilon > -1)$, and becomes more elastic as price increases $\left(\frac{\partial \varepsilon}{\partial p} < 0 \right)$.[6] To each of these cases, there are three sub-cases, depending on whether marginal cost is constant $\left(\frac{\partial mc}{\partial q} = 0 \right)$, increasing $\left(\frac{\partial mc}{\partial q} > 0 \right)$, or decreasing $\left(\frac{\partial mc}{\partial q} < 0 \right)$.

In case (i) where initial demand is elastic and elasticity increases in price, the first term in equation (3) will always be negative. If marginal cost is constant, the second term will vanish. Hence, $\frac{d\hat{p}}{dp} < 0$ and a myopic application of the rule will lead to an overshooting of the profit maximizing price. An increase (decrease) in price based on the rule, will increase (decrease) the price sensitivity and hence reduce (increase) the prescribed "profit maximizing" price. In other words, if current price is below (above) the profit maximizing price, the rule will suggest a price above (below) the profit maximizing price.[7] If marginal cost is increasing, the second term will also be negative and hence exacerbate the previously established overshooting effect. If marginal cost is decreasing, the second term will be positive, and this will counteract the overshooting effect – and possibly cancel it out (if the rhs in equation (3) is zero) or even reverse it (if the marginal cost effect dominates the elasticity effect and the rhs in equation (3) is positive).

In case (ii) where price elasticity of demand is constant and elastic, the first term in (3) will vanish. If marginal cost is also constant, then the second term will also vanish and the optimal price prescribed by the rule will be independent of current price $\left(\frac{d\hat{p}}{dp} = 0\right)$. Hence, in this case, a myopic application of the rule will indeed yield the correct, profit maximizing price – regardless of initial price. Indeed, this is the only case in which a myopic application of the rule will work. However, if marginal cost is increasing, the second term in equation (3) would be negative and $\frac{d\hat{p}}{dp} < 0$. Hence, a myopic application of the rule will lead to an overshooting of the profit maximizing price. If marginal cost is decreasing, then the second term in equation (3) is positive and thus $\frac{d\hat{p}}{dp} > 0$. This time a myopic application of the pricing rule will lead to an undershooting of the profit maximizing price. However, by continued myopic use of the rule, the prescribed price will tend to converge on the profit maximizing price.

In case (iii) where initial demand is inelastic and elasticity increases in price, the first term in equation (3) will again always be negative. If marginal cost is constant, the second term will vanish and the result will be overshooting like for constant marginal cost in case (i). However, for increasing or decreasing marginal cost, the results are now reversed relative to case (i) and the overshooting effect will be reduced or exacerbated respectively.

In the cases above in which the rule leads to an undershooting of the optimal price, it is obvious that a continued myopic use of the rule will converge on the profit maximizing price. However, in most of the cases, the rule will lead to an overshooting of the profit maximizing price. Continued myopic use may or may not lead to convergence. Indeed, the prescribed price will converge if $\frac{d\hat{p}}{dp} > -1$, otherwise not.

3. Conclusion

The elasticity based pricing rule discussed in this note is often proposed by economists to management as a superior alternative to more standard cost-plus pricing or average cost markup rules. Its advantage is that it takes into account the demand side through the elasticity and that the markup is applied to marginal rather than average cost. The rule is seemingly well suited for pricing of telecommunications services as a tool for determining profit maximizing prices for multiple services with large common costs. For regulated services, the rule often shows up in the form of Ramsey pricing as a proposed method for achieving full recovery of costs while minimizing deadweight losses. However, the marginal cost markup rule has severe shortcomings. However, the marginal cost markup rule has severe shortcomings.

First, accurately determining price elasticity of demand as well as marginal cost requires significant amounts of information which management may not have. Second, which was the focus of this note, the application of the rule is far from as straightforward as one may be lead to believe by many microeconomics textbooks likely to be used in the education of management. This is because both elasticity and marginal cost tend to depend on price, the importance of which is barely mentioned in relation to the pricing rule, if at all. This second point means that a myopic application of the rule will in most cases fail to generate the profit maximizing price for management. Rather, it will in most cases result in an overshooting of the profit maximizing price. That is, if the initial price were too low, then the prescribed price would be too high, and vice versa. Continued myopic use may even lead to divergence from the profit maximizing price. Indeed, the only case in which the rule will return the profit maximizing price is if both elasticity and marginal cost are constant.

With only local knowledge of marginal cost and demand, it will be difficult to compensate for the above effects, although it may be sufficient to determine whether the rule will prescribe too high or too low a price. The marginal cost markup rule will, however, provide the direction of change from a non-profit-maximizing price, and confirm when the profit-maximizing price is established. Thus, it offers some use to management if applied with caution. However, the same can be said for an analogous process of comparing marginal revenue and marginal cost. Altogether, it is difficult to see any significant advantage to management of using the marginal cost markup rule over the more direct approach of simply equating marginal revenue with marginal cost.

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Notes

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[1] Pindyck and Rubinfeld (2001) call it "The Rule of Thumb for Pricing." (p. 341).

[2] Mansfield and Yohe (2000) do caution against the difficulty of accurately estimating the price elasticity of demand and marginal cost and of the sensitivity of the rule to faulty estimates, but do not caution against the dependency of the rhs on the lhs in equation (1), which is the focus of this note. Such a caution is sometimes made, and rarely as explicit as in [Besanko, 2002 #71], however, the effects of myopic application of the rule are not explored.

[3] Pindyck and Rubinfeld (2001) point this out in a footnote (p. 334), as do Baumol, Panzar, and Willig, 1988, p. 295).

[4] Elasticity and marginal cost need also to be accurately estimated, as cautioned by Mansfield and Yohe (2000).

[5] Marginal cost is based on quantity, which in turn is dependent on price for a firm with market power.

[6] Constant and inelastic demand is not included as a case, since it would be unrealistic for a price setting firm not to be able to operate in the elastic range of demand. Equation (3) is not defined for unit elastic demand.

[7] If demand becomes more price elastic with time (as consumers have greater opportunities to adapt), this will exacerbate the overshooting effect.

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