Some Thoughts on the Pricing of Electricity in Barbados

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Introduction

The pricing of electricity has received considerable attention in Barbados since the 1974 oil crisis. In fact between 1957 and 1973 there was only one rate hearing, which took place in 1966. Since 1973 there have been four such hearings. The lengthy debates which have characterised these hearings created the need for some investigation of the theoretical considerations of rate determination.

One thing is certain, buyers have to be protected from monopolistic exploitation and so price regulation is essential. According to Kahn "regulation should permit companies simply to cover their revenue requirements - to cover the money capital actually invested in the service of the public, to earn a return on investment sufficient to meet their actual debt service obligations and to attract equity capital". But recognising the necessity for price regulation does not solve the problem of which pricing strategy should be used in the determination of electricity rates. The segmentation of the electricity company's market provides the framework for employing a differential pricing strategy. This kind of pricing is, however, questioned on the basis of its allocative efficiency.

Khan further stated that "the commissions decide what total revenues the companies are entitled to take in then adjust permitted "rate levels" either selectively or across the board to

yield these totals. The determination of these rates involves tremendous legal and economic controversy. In this study we are concerned with resolving some of the economic controversy.

As a result we assess the historical development of electricity in Barbados. This involves an appreciation of the operating expenses and capital outlays of the company. The source of funding for capital outlays is extremely critical in the context of electricity pricing in a small-island economy such as Barbados. There are problems in attracting the large sums of equity capital because of the size of the capital market in Barbados. Consequently, capital has to be borrowed from foreign sources and this adds a new dimension to the debt service obligations of the company. In addition it creates new considerations in determining what constitutes a fair rate of return on capital.

We introduce a regulated cost function for the production of electricity power which reflects the cost of production under rate of return regulation. Of course, the determination of a fair rate of return is an essential component in the specification of the quasi-optimal pricing model which we intend to employ.

THEORETICAL FRAMEWORK

The determination of electricity rates among the different classes of customers should be informed by knowledge of the various elasticities of demand and some notion of the allocative efficiency of the pricing mechanism. The adoption of differential pricing without such prior knowledge must give rise to uncertainty about its effectiveness in attaining efficient allocation or something close to it.

In setting the price of electricity, we assume that the Public Utilities Board (PUB) considers adjusting the firm's revenue level to reflect a fair rate of return on capital. Simultaneously the PUB hopes to eliminate unfairness in the pricing system and discrimination among different consumers. But given the different demand elasticities among the various customers price discrimination is inevitable.

The regulator fixes the prices of electricity, while the levels of output are determined by consumer demand. This leaves the firm with the task of minimising costs. The notion of allowable capital cost becomes a major concern of the firm. According to Marino the firm's 'true' allowable cost is the sum of allowable capital cost and non-capital cost. The fixing of this figure is crucial since it assists the regulator in determining the firm's allowable revenue or revenue requirement.

These kinds of concerns have given rise to the development of quasi-optimal pricing in the presence of a rate of return constraint on capital. This literature is well documented in Baumol and Bradford [1970] and Marino [1981].

In this study we adopt the approach of Hayashi, sevier and Trapani [1985] which is based on the two papers cited above. They specify a regulated cost function for the production of electric power which reflects the cost of production under rate of return regulation and the role of the above normal profits the firm is permitted to earn on its capital stock. We conduct a time series analysis rather than the cross-sectional approach used by Hayashi et al.

To support our use of their model we quote from a report of the PUB "the law requires the Board to allow the company to earn a fair return on the fair value of its property used and useful in its public service. But nowhere does it spell out how to determine the fair value of a utility's property used and useful in its public service". From our investigation of the literature the regulated cost approach to assess the price structure of multiple outputs seems appropriate. According to Marino it reflects the potential impact on welfare of changes in the level of allowable economic profit as well as changes in direct production costs and the firm adjusts its level and constellation of output. Accordingly, it is regulated marginal cost which is pertinent for the test of quasi-optimal pricing under rate of return regulation. The full model of rate of return regulation and welfare maximisation is explained in a later section.

Selecting a Fair Rate of Return

Determining a fair rate of return on capital is the first constraint in the pricing strategy of a multi-product firm. The regulatory body chooses the fair rate of return, s, under the assumption that its value must lie between the market cost of capital, r, and the rate which coincides with the monopoly's profit maximising solution, π, That is $\pi > s > r$. The upper and lower units of s, are determined with the social welfare effects in mind.

The choice of s is one which has to be made from considerable knowledge and data on the utility being considered and each case is unique. Khan (p.42) states "there is no single, scientifically correct rate of return, but a 'zone of reasonableness' within which judgement must be exercised". This is why we cannot simply adopt the approach of the above studies, since there are special circumstances to be considered in the pricing of electricity in a small island economy such as Barbados.

It requires only one electric plant to serve the needs of Barbados. This means features such as competitiveness and alternative sources of electricity are ruled out. As a result the analysis of a 'true' natural monoply could be conducted. But we need to alter the classical approach mainly because of the difference in the source of funding/capitalisation of the plant's operations. Whereas in the developed countries equity capital can be raised in the money market, the smallness or lack of such a market means that capital is raised primarily from foreign sources.

The interest rate levels and consequently the interest payments create problems over the repayment period. The ability of the company to service these foreign loans seems to influence the regulator's choice of the rate of return. This introduces the question as to who should bear the burden of the company's debt problem; whether present or future customers.

Model

Having decided the value or range of values that s may assume, we find the quasi-optimal pricing by solving the optimisation problem of maximising consumer plus producer surplus subject to the constraint that the firm will earn the minimum allowable profit. We specify

$$L = S + R - C^r + \lambda[R - C^* - (s - r)K^*] \quad (1)$$

where R in total revenue, S is consumer surplus, C^r is regulated cost, C^* is total production cost, and K^* is the firm's capital choice under rate-of-return obligation. C^r is defined as

$$C^* + (s - r)K^* \quad (2)$$

where C^* is the cost incurred by the firm maximising profit subject to a rate-of-return constraint. C^* will depend on the value of s and, in general, be greater than the minimum cost of production, C. see Hayashi et al [ ].

Differentiating equation 1) gives

$$\frac{\partial L}{\partial q_i} = \partial(R + S)/\partial q_i - MC^r_i + \lambda[P_i(1 - 1/e_i) - MC^r] \quad (3)$$

Setting equation 3) equal to zero and imposing the condition that $\partial(R + S)/\partial q_i$ is at the optimal solution, we get

$$(P_i - MC^r_i)/P_i \lambda = \lambda/(1 + \lambda)\ 1/e_i. \quad (4)$$

See Marino for the verification. Condition 4) is the quasi optimal pricing rule for welfare-maximisation in the presence of a rate of return regulatory constraint. We need to determine a method for estimating MC_i^r and e_i so that observed prices of electricity can be evaluated on the basis of the condition (4).

We now use equation 2) to show the relationship between regulated marginal cost and marginal cost to the producing unit. From equation it follows that

$$MC^r_i = MC^* + (s - r)\, \partial K^*_i / \partial q_i \qquad (5)$$

where

MC^r_i is regulated marginal cost. This is the combination of the marginal cost of society involving MC*, the production cost incurred under rate-of-return regulation, plus the excess valuation of additional capital employed.

We also derive another form of the quasi-optimal pricing rule.

$$(p_i - MC^*_i)/P_i = \lambda/(1 + \lambda)\ (1/e_i) + [s - r)/P_i]\ \partial K^*_i / \partial q_i \qquad (6)$$

Equation (6) states that the percentage mark-up of price over marginal cost for each output produced should be equal to the usual fixed-profit distortion term $\lambda/1 + \lambda)\ (1\ /ei)$ involving the price elasticity of demand plus an additional term

$[(s - r)/P_i]\ \partial K^*_i / \partial q_i$ reflecting the excess capital valuation under rate-of-return regulations. If s is equal to r, then this new term vanishes from expression (5). However, if s is greater than r and k is a nominal input then the presence of the rate of return constraint will require a greater difference between price and marginal cost at the optimal solution.

References

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