

Public Enterprise Pricing*

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There has been a great deal of public debate recently in British Columbia regarding the pricing policies of government-operated enterprises, e.g. B.C. Ferries, B.C. Hydro, the Insurance Corporation of B.C., hospital and health insurance, community recreation facilities, public transit, etc. There exists in the economics literature a well-developed theory of public enterprise pricing that, while well known to economists, has not been translated into easily understandable language for the layman. By attempting such a translation, the aim of the present paper is to raise the level of sophistication of the public debate. If the participants in the debate have an understanding of the underlying economic principles then they can expend their energies on the key issues and avoid the irrelevant ones.

The Theory of Marginal Cost Pricing

The theory of welfare economics provides quite an elaborate proof that optimal social welfare (i.e. a point at which no individual can be made better off without causing some other individual to be worse off) is achieved when all goods and services are priced at marginal cost. Most intermediate theory textbooks provide a proof of this proposition along with the qualifications and assumptions.¹ Nevertheless, it is possible to explain the theory rather simply without delving into the elaborate proof.

First we must define what is meant by "marginal cost." Marginal cost is the cost to a firm of producing one additional unit of its output; or, conversely, it is the saving of producing one less unit of output. (In mathematical terms the marginal cost is the first derivative of the total cost function). Figure 1 illustrates a typical U-shaped marginal cost function (MC). Also illustrated is the average cost function (AC), which is simply total cost divided by total output. The third function in the diagram is the demand function (D), which illustrates the quantity of a particular prod-

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¹ C. E. Ferguson, *Microeconomic Theory* (Homewood, Illinois: Richard D. Irwin, Inc., 1969), pp. 442-64.

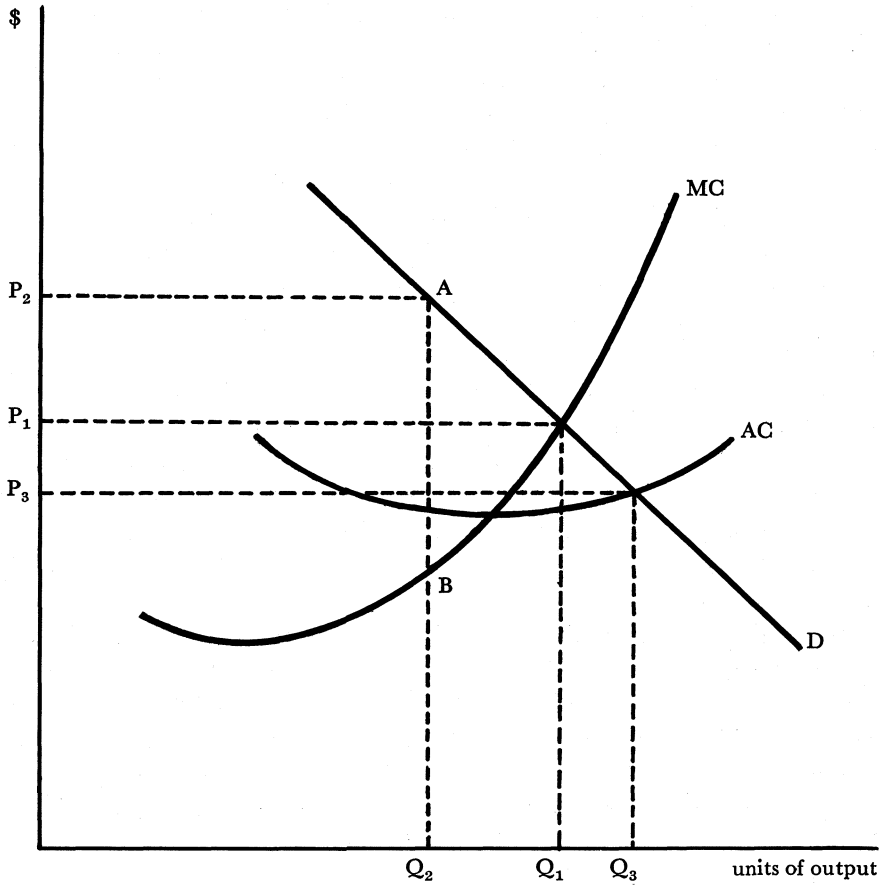


FIGURE 1

uct that consumers are willing to purchase at various prices. The demand curve is hypothesized to be downward sloping because as the price increases consumers are generally willing to purchase less of the product.

To price products at marginal cost means that price and output are determined by the intersection of the demand curve (D) and the marginal cost curve (MC). In Figure 1 this means that price should be P_1 and output Q_1 . Thus with the theory of marginal cost pricing, price and output are jointly determined. The optimality of this price and output can be explained in the following manner. The price that the consumers are willing to pay is equated to the value that society places on that output; thus at the equilibrium in the diagram, consumers are willing to pay P_1 for the final unit of output. Ideally the marginal cost curve should include all costs that society incurs to produce the final unit of output. Thus there is only one price/quantity combination at which the value of the last unit of output is exactly equal to the cost of producing it.

Now suppose the price had been set at P_2 , resulting in Q_2 units of output. This situation is clearly non-optimal because at this point the value of the last unit (distance AQ_2) is clearly greater than the cost of producing it (BQ_2), so that the situation can be improved by lowering the price and increasing the output. Similarly, if price is set below marginal cost such as P_3/Q_3 in Figure 1, then the cost of producing the final output exceeds its value.

Interestingly enough, the equilibrium established by P_3 and Q_3 corresponds exactly to the case in which price is set at average cost. Setting price at average cost means that total revenues will equal total costs — a situation which is often mistakenly equated with economic efficiency. Economic efficiency, however, is achieved when the value of the last unit of output equals the cost of producing it. Therefore average cost pricing in the circumstances illustrated by the diagram will result in overproduction and underpricing. It is also interesting to note that in this case, since marginal cost exceeds average cost, the efficient marginal cost price will result in a profit.

Figure 2 illustrates a situation in which the demand curve intersects the marginal cost curve below the average cost curve. The marginal cost price and output are thus P_1 and Q_1 . In this case the average cost price is above the marginal cost price (P_2 is greater than P_1). The result, which may appear counter-intuitive to the non-economist, is that marginal cost pricing and economic efficiency call for a price and output which will produce total revenues less than total costs, thus requiring subsidization of the enterprise.

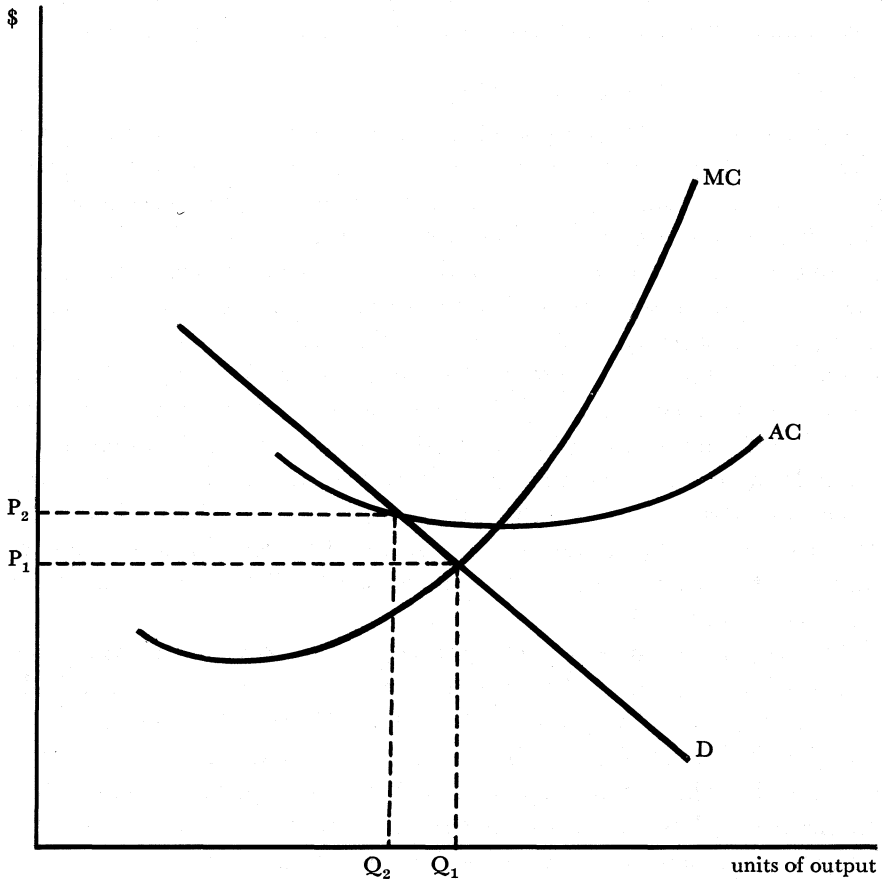


FIGURE 2

These diagrams reduce to a very simple form in the special case in which average costs do not vary with different levels of output. In this situation average and marginal costs are equal and can be represented by a single horizontal line in the diagram. This special case of constant costs means that marginal cost pricing and average cost pricing are identical.

The Assumptions and Qualifications

Up to this point, for the sake of simplicity, we have not mentioned the basic assumptions of the marginal cost pricing model. The first assumption is that all externalities are to be included in the marginal cost function. An externality is a cost (i.e. a negative externality) or a benefit (i.e. a positive externality) of a product which is not taken into consideration in the internal accounting of the firm producing the output. An example of a negative externality would be water pollution from a pulpmill which resulted in damage to a fishery. The fishermen would suffer a financial loss caused by pollution killing fish, but the pulpmill operator would not account for the fish loss in his financial statement. If, on the other hand, the pulpmill operator were required to account for this cost (perhaps by direct compensation to the fishermen), then the pulpmill would increase its price and reduce its output. The theory of marginal cost pricing requires that all externalities be accounted for even if there is no provision for direct compensation.

Another important branch of optimal pricing theory is known as "the theory of second best." The rule to price at marginal cost implicitly assumes that this pricing rule is followed elsewhere in the economy. The rules for efficient pricing must be modified if prices diverge from marginal cost elsewhere in society (e.g. because of taxes, imperfectly competitive markets, etc.). Very simply, the theory states that the price of one particular product should exceed marginal cost (or be less than marginal cost) if the prices of other goods and services in the economy are generally above marginal cost (or below marginal cost). It is often emphasized that in pragmatic terms it is usually sufficient to concentrate on products that are close substitutes or complements. Thus in the case of the B.C. Ferries' operation to Vancouver Island, one substitute is air service. If Air Canada, PWA and Air West are generally charging prices higher than marginal cost, then B.C. Ferries' prices should be proportionately above marginal costs; otherwise too few people will travel by plane. The problem of substitutes becomes more difficult to deal with, however, when it is realized that a major substitute for ferry travel to Vancouver Island is travel to another destination or no travel at all.

The tourist industry and trucking industry are complements to B.C. Ferries (i.e. ferry service is an input to both industries). If it is true that these industries are pricing below marginal cost then B.C. Ferries' prices should be proportionately less than marginal cost. There is no reason to believe that this is the case. Nevertheless, the statement is often made that ferry service produces a positive externality for the tourist industry, thus justifying ferry prices below marginal cost. The fact is that ferry service is a marketed input to tourism and thus externalities are non-existent or unimportant. Presumably the tourist industry by itself could undertake some scheme to provide tourists with a discount on the ferry service.

In order for marginal cost pricing to be socially optimal the distribution of income among individuals must be socially optimal. Unfortunately there is no scientific method by which economists can measure the optimality of income distribution. In many circumstances the most that can be expected from a pragmatic economist is a description of how a particular pricing proposal will redistribute income. For example, with respect to ferries a price increase will redistribute income from ferry users to non-users as the level of provincial subsidization is reduced. In some public enterprises, however, one of the arguments in favour of public support is the desire to redistribute income such as in the case of public education.

Non-priced Outputs

There are some government enterprises that are financed by means other than direct user charges, e.g. schools and roads. How do these public enterprises fit in with the theory of marginal cost pricing? Should not all outputs be priced at marginal cost?

In the case of roads, user charges are generally not employed because of the excessive transaction costs. That is, the cost of setting up toll booths and collecting charges on roads, and the resulting delay to motorists, probably constitutes a greater expense in most cases than the revenue that could be raised. On the other hand, on highly congested roads some sort of direct user charge may be very desirable. Other methods of collecting the toll such as permits or electronic metering may be feasible.²

A classic example that has received much discussion in the theoretical literature is the case of bridges. Once a bridge has been built the marginal cost (i.e. the cost of carrying one additional vehicle) is virtually zero, and therefore the pricing rule calls for no charge. However, when demand increases to the point where congestion is prevalent, then a charge may be

² W. S. Vickrey, "Pricing in Urban and Suburban Transport," *American Economic Review*, May 1963, pp. 452-65.

justified since carrying one additional vehicle means further delays for every other vehicle using the bridge. In addition, if prices in the long run are held below marginal cost then too much traffic will be generated and investment in new capacity will be premature.

A physically similar example to the bridge problem is that of ferry transportation. The pricing rule, however, produces very different results in each case. The reason that the bridge price should be zero during uncongested periods is that it is not possible to temporarily alter bridge capacity. For a ferry service, on the other hand, capacity can be temporarily reduced by reducing the number of sailings. It is the short-run flexibility of ferry capacity that makes it a unique problem — quite different from the pricing problem of bridges and roads, where the physical capacity is fixed for a much longer period.

Financing Public Enterprises

As we have seen, there are circumstances in which it is appropriate to subsidize public enterprises: (1) in a decreasing cost industry where marginal cost is below average cost, and (2) where the income redistribution effects or the transaction costs are such as to preclude direct user charges.

One suggestion that has been put forward is that profitable public enterprises (those where marginal costs exceed average costs) should subsidize the enterprises where marginal cost is less than average cost. There is no assurance, however, that the profits from the former group will balance the losses from the latter group.

Each enterprise should be examined individually to determine the most appropriate means of financing. The provincial highway system is partially financed through gasoline taxes, which are a rough proxy for a user charge. A valid method for financing the remainder would be through property taxes, since the construction of a new road creates additional value (rent) for the property along the perimeter and in the general vicinity of the road. This unearned increment in land value is an appropriate target for taxation and financing of roads.

A parallel example is provided by ferry service to small coastal islands. Undoubtedly the current fare structure on many routes is far below marginal cost, but it is likely that even marginal cost pricing will not result in a break-even operation since average costs are likely declining, with marginal costs being less than average costs. In this case it is abundantly clear that the landowners on islands served by ferries are the primary beneficiaries (along with ferry users), and therefore it is appropriate that the unearned increment in their land values should be taxed to support

the ferry system. That this unearned increment is fairly substantial can be illustrated by simply looking at the real estate columns in the local papers. Property values differ immensely between islands served by ferries and those with no ferry service.

In cases where the public enterprise has strong positive externalities or the redistribution effects are important (e.g. schools and hospitals) and as a result direct user charges are not employed or are very small in relation to marginal costs, financing is probably most appropriately done by means of general provincial revenues (i.e. government revenues from income tax, corporate tax, royalties, sales tax, etc.). Living near a hospital or a school probably has no significant impact on property values and therefore there is no unearned increment to tax away.

In the case of subsidized enterprises, however, there may be some argument in favour of limiting the size of the subsidy in order to avoid excessive administrative inefficiency. Vickrey has warned, however, that partial subsidization should not be restricted to a particular category of cost because the resulting distortions may be severe. This should serve as a warning to provincial enterprises — particularly transit services and B.C. Ferries.

In New York City, for example, transit system expenditures that could be classified as capital outlays were for a long time subsidized from general city revenues while operating expenses had to be met from fares, with fare increases being mandatory if operating expenses were not so covered. As a result, levels of service were drastically cut and maintenance expenditures skimped. At the same time new appurtenances were furnished with a relatively lavish hand, new construction proceeded, often without adequate thought as to how the new facilities would be used when ready, and new equipment was purchased to replace equipment prematurely retired because of the poor maintenance.³

An Extension: Peak Load Pricing

An extension of the theory of marginal cost pricing which is relevant for many public enterprises is referred to as peak load pricing. Peak load pricing is simply a special case of marginal cost pricing in which the demand for a product varies substantially, but predictably, from period to period. Examples abound: urban roads are congested from 6 a.m. to 9 a.m. and 4 p.m. to 6 p.m.; water supply systems are used more heavily during the summer than winter and more heavily during the day than at

³ W. S. Vickrey, "Economic Efficiency and Pricing," in *Public Prices for Public Products*, ed. S. Mushkin (Washington, D.C.: The Urban Institute, 1972), p. 61.

night; electricity exhibits a similar daily pattern, but on a seasonal basis the peak occurs in the winter rather than in the summer.

In a peak load situation the products should be priced higher during the peak period than in the off-peak period. The rationale for this policy is often misinterpreted. Spreading the demand more evenly across the whole period results in a more efficient operation and while this *may* result from peak load pricing, it is not the underlying rationale. Peak and off-peak prices should differ simply because marginal costs differ between periods. In addition to current operating expenses, future capital costs must also be included in the category of marginal costs. It is peak users who are responsible for future capital costs because any major increase in peak demand can only be handled by building new capacity. Any increase in off-peak demand, on the other hand, can be accommodated by existing excess capacity. In general, then, off-peak users are responsible for current operating costs while peak users are responsible for operating costs plus a portion of future capital costs.

An alternative manner of interpreting the higher peak period costs is to consider the phenomenon of congestion. If a facility (a road, a ferry terminal, a supermarket, etc.) is congested during the peak period it means that the addition of one more customer will further delay other customers. The problem is that a new customer only takes into consideration his own delay and not the additional delay he imposes on other customers. Essentially, congestion costs and future capital costs are simply two techniques for determining the marginal cost function. In some cases one method may be theoretically superior to the other, while in other cases one method may be empirically superior to the other.

Efficiency and Equity

The principle of marginal cost pricing clearly establishes the correct criteria to achieve economic efficiency. On the other hand, equity considerations may be important in particular cases. Milliman summarizes the general view of the public finance literature: "The equity aspects of benefit taxes (prices) are viewed generally as a matter of simple justice; i.e., users of a public service should pay for its costs when the benefits do not spill over to other people."⁴

Applying this rule to B.C. Ferries would indicate that the province should probably not be responsible for subsidizing prices below marginal

⁴ J. W. Milliman, "Beneficiary Charges — Toward a Unified Theory," in *Public Prices for Public Products*, p. 29.

cost on coastal ferries. On the other hand there may be some justification for coastal communities bearing some of the costs of the ferry service if indirect benefits are significant. This clearly applies in the case of property values on the Gulf Islands.

In any particular case there are always going to be individuals who are hurt when the pricing rule calls for a major increase. In some instances it may even be feasible to pass some of the efficiency savings back to the affected consumers in the form of direct compensation. In other situations it might be suitable to provide a gradual adjustment of prices to their marginal cost levels. In any event, the ultimate objective of establishing marginal cost prices for each user remains unchanged.

Summary

So far we have not attempted to draw a fine distinction between the short run and the long run, although such a distinction has been implicit in the preceding discussion. In the short run the pricing rule provides a criterion for efficiently allocating a fixed capacity. But by pricing at marginal cost in the short run, the long-run decision of whether to invest in new capacity becomes less complex. Ideally, as the demand and congestion for a fixed facility increases over time, the price will also increase. Eventually the increasing prices provide a market signal to the public enterprise to invest in new capacity. If, on the other hand, short-run prices had been held below marginal cost, then excess demand would be generated and congestion would occur, placing premature pressure on the public enterprise to expand capacity.

In the economic jargon, marginal cost pricing yields economic efficiency, which means resources will be allocated to their highest and best use. What this means is that each consumer should be faced with prices which accurately reflect the marginal cost of production. If, for example, television sets are priced below marginal cost and bicycles are priced above marginal cost, then consumers will tend to purchase too many television sets and not enough bicycles. That is, if they had been faced with the real costs they would be able to make a more intelligent decision about their purchases. It is a situation analogous to voting on a referendum without knowing the details of the referendum. Just as voters should be informed of the issues, consumers should be informed of the costs.