

The Principles of Incremental Cost
Pricing

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In Docket No. 73694-EU, the Florida Public Service Commission has requested its regulated electric utilities to conduct investigations into the feasibility of long-run incremental cost (LRIC) pricing. This docket has triggered substantial debate regarding the practicality of LRIC pricing as well as the over-all impacts on individual customers (in terms of actual bills) accruing to this form of pricing.

This note draws heavily upon the work of Alfred E. Kahn regarding the merits of price discrimination under LRIC pricing as well as the disadvantage of fully distributed cost bases of cost allocation.¹ It is meant to be an expository piece for those interested in the justification for and implications of LRIC pricing.

At the heart of the principle of economic efficiency is the requisite that the price of a good or service should be equated with marginal costs. Marginal cost may be defined as the increase in total cost resulting from the production of an additional unit of output or, alternatively, the cost savings that are realized by producing one less unit of output. Since the total productive capacity in an economy is fixed in amount, a decision to produce more of one commodity necessitates less production of other commodities.

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¹ Alfred E. Kahn, The Economics of Regulation: Principles and Institutions, I (New York: John Wiley and Sons, 1970), Chapter 5. The supplementary bibliography found in Appendix B of this paper should prove helpful to the interested reader in providing a better understanding of the area.

Only when the price of a commodity reflects the attendant marginal costs, can an individual intelligently decide whether the satisfaction gained in purchasing that commodity is worth the sacrifice of satisfaction accruing to the consumption of other commodities. A price that is greater or less than marginal costs will violate the dictates of economic efficiency.

Public utilities have been historically characterized by decreasing unit costs with increasing levels of output (i.e., they have realized "economies of scale" in production). These firms fall under the heading of "natural monopolies," industries where economies of scale are continuous up to the point at which one single firm supplies the entire demand. Public utilities, or any on-going business for that matter, must set its prices such that total revenues will equal total costs (including the return on invested capital).

A utility which charges a single price equal to marginal (or, roughly, incremental) cost will be able to equate total revenues with total costs only in a situation in which marginal cost equals average cost. If marginal cost is less than average cost, the utility will encounter a deficit, while, conversely, if marginal cost is greater than average cost (a possibility only recently suggested in such industries as electric utilities), excess revenues will be realized. In the absense of equality between marginal and average costs, we are thus faced with a conflict between two fundamental rules:

1. price should equal marginal cost and 2. total revenue should equal total cost.

Consider a case in which a utility is operating within the range of output where marginal cost is less than average cost. In equating marginal cost with price, the utility would incur a loss. One means of recouping the loss would involve a direct subsidy from the government equal to the amount of the loss. With few exceptions (notably subsidized interest rates to rural

electric cooperatives), subsidies of this nature could not realistically be expected.²

As an alternative to direct governmental subsidy, the utility could practice one form or other of price discrimination (i.e., charging different purchasers prices that differ in varying proportions from the respective marginal costs of serving them or charging a single purchaser different unit prices for specific quantities taken without regard to the costs of providing those quantities). The underlying basis for price discrimination lies not in cost but in demand (i.e., the value of each unit of service to each purchaser). Price discrimination, when justified, may be shown to be an effective means of equating total revenues with total costs (when marginal costs are less than average costs) and/or permitting the utility to make fuller use of its productive capacity.

Suppose that an individual's demand for electricity and prevailing cost conditions are such that at no single price will total revenues cover total costs. As noted above, a price equal to marginal cost would be socially optimal, yet in this situation such a price would produce a deficit to the firm. Consumer surplus (the difference between the value a consumer attaches to each unit of consumption and the expenditure he must make for that consumption) is maximized when price equals marginal cost. Through price discrimination, the firm may capture any or all of the individual's consumer surplus, thereby increasing revenue. Perfect price discrimination involves the offering of each unit of output at the highest price an individual is willing to pay for it

²In addition, Professor Pigou noted that, even if such subsidies did occur, the net gains to society would be difficult, at best, to measure. A.C. Pigou, "Some Aspects of Welfare Economics," American Economic Review, June 1951, XLI, pp. 291-293.

(that price being equal to the value the consumer attaches to a particular unit). Through such means, an individual's total consumer surplus may be captured.

In practice, perfect price discrimination is an impossible feat. As an approximation to perfect price discrimination, a declining block schedule of rates may be imposed whereby the customer's bill increases proportionately within a specific block of output but increases less than proportionately as output increases through succeeding blocks. That is, rather than offering a declining price for each successive unit of output, a declining per unit price is offered for successive blocks of output. Prices would decline up to the point at which price equals marginal cost, since a price less than marginal cost creates an incentive for resource waste. Through this form of price discrimination, the firm may be able to equate total revenues with total costs and make fuller use of its productive capacity.³

The previous example considered the case of price discrimination as applied to different quantities taken by a single purchaser. In the case of price discrimination between classes of customers, it may be demonstrated that such a form of discrimination may also permit a level of output closer to the optimum.

Consider a case in which a utility, subject to long-run declining average costs, serves two classes of customers which may be separated on the basis of their relative price elasticities of demand.⁴ The firm is attempting to

³ See Appendix A for a more detailed, graphical description of this form of price discrimination.

⁴ Price elasticity of demand is defined as the percentage change in quantity demanded as a result of a percentage change in price. Expressed mathematically=

$$\eta = \frac{\Delta Q}{\Delta P} \cdot \frac{P}{Q} \text{ or } \frac{\partial Q}{\partial P} \cdot \frac{P}{Q} .$$

choose the optimal plant size appropriate for serving its customers. Assume that the cost characteristics of the firm are such that the inelastic demand market may be served at a single price which covers average costs, yet the elastic demand market cannot be served at that price. In the absence of price discrimination, only the inelastic demand market would be served. Further assume that the customers in the elastic demand market are willing and able to cover the marginal costs of providing service to them. Given this situation, should not the inelastic demand market face a price equal to average cost and the elastic demand market face a price equal to marginal cost?

The answer is yes. By pricing in this manner, neither the firm nor the customers in the inelastic demand market are any worse off. Customers in the elastic demand market would be covering the additional costs of extending service to them. Such a form of price discrimination is justified provided that the price elasticity of demand in the relatively elastic market is sufficiently great that a rate reduction in that market will increase total revenues by at least as much as total costs. If the elastic demand market were not offered a lower price (in this case, equal to marginal cost), consumer surplus in that market would be zero. Through a rate reduction, however, this market experiences a net consumer surplus greater than zero, and, thus, a net gain in social welfare occurs.⁵

Under certain conditions, it is obvious that rate reductions down to marginal cost for "marginal buyers" are beneficial. By what criteria, however, does one determine which buyers are indeed marginal? In regard to causal responsibility for cost, all buyers are marginal. Consider a case in which there are two distinct groups of customers A and B, A having a stable demand, and B having an increasing demand. Eventually, the increase in demand by B may necessitate new

⁵A more detailed, graphical description of price discrimination between classes is treated in Appendix A.

capacity to serve their increased needs.. Which class is the class of marginal buyers who should bear the costs of new capacity? Certainly B is marginal in the temporal sense, but both A and B are marginal in the economic sense. Costs would be saved if B refrained from increasing their demands, but the same result would hold if A reduced their demands.

How then does one choose among classes of customers which class will receive the incremental rate? The solution lies in a comparison of relative price elasticities within the relevant range of demand (between average and marginal cost).

Under a condition of declining average cost, the difference between marginal and average cost is greater in the inelastic market than in the elastic market. The same price increase or decrease will bring about a greater reaction by elastic demand customers than by inelastic demand customers. The utility will assign a higher price to the inelastic demand market than to the elastic demand market. If the latter market faces a price which more than covers the variable costs of extending service to it, that market will make a net contribution toward covering common costs, thus enabling the inelastic demand customer to face a price lower than average cost. As was noted earlier, an extension of service to the elastic demand market through price discrimination is justified as long as price elasticity of demand in that market is of sufficient magnitude that a rate reduction in that market will increase total revenues by at least as much as total costs.

The implication to be drawn from the above discussion is that the limits of price discrimination should be such that the price to inelastic demands is no higher than the average costs of serving them alone, while the price to elastic demands is no lower than the full additional costs of taking on their business (i.e., marginal or incremental costs). Once the limits of price

discrimination are determined, where should the discriminatory prices be set within those limits?

One theory advocates the practice of marking up prices above marginal cost in inverse proportion to the respective price elasticities of demand. The underlying principle of this theory states that an optimal pricing scheme is one which maximizes the surplus of all consumers on the whole. Consumer surplus is maximized under strict marginal cost pricing. In a case in which marginal cost pricing yields total revenues less than total costs, prices should be set so as to minimize the aggregate loss in consumer surplus. In so doing, the loss of consumer surplus is equalized for all classes of service. If losses of consumer surplus are not equalized, prices could be raised in the market where the loss of consumer surplus is relatively small and reduced in the market where the loss of consumer surplus is relatively large, thus increasing overall consumer surplus. Prices will be adjusted until the ratios to marginal costs, $(P-MC)/P$, are inversely proportional to the respective price elasticities.

In setting prices at or near the limits of price discrimination, customers with elastic demands would be receiving the benefits of increasing returns to scale. Such a pricing scheme would be justified in that welfare gain to the elastic demand customer is a compensation for the welfare loss to the inelastic demand customers. This pricing pattern would, however, redistribute incomes from inelastic demand customers to elastic demand customers in the absence of any real compensating arrangements. A major weakness of economic analysis lies in its inability to compare satisfactions of various groups of consumers, measured in dollar terms. To presume that all consumers realize the same marginal utility of money is simply unrealistic.

For this and other reasons, some economists would favor a different means of price discrimination designed to equate total revenue with total

cost. They advocate a constant markup (in absolute terms) of price over marginal cost for all classes sufficient to recoup the deficit between total revenue and total cost.

Other economists would argue instead that selective rate reductions be allowed only in so far as the benefits to customers discriminated against are maximized. Rate reductions would be permitted in elastic demand markets only if the degree of elasticity is sufficient enough to provide a net increase in contributions to common costs from that market. In addition, rate reductions would be made only to the point of maximizing that contribution. This implies that the price must be reduced to the point of equation between marginal cost and marginal revenue (the profit maximizing equality) rather than average revenue. In this manner, the price to the inelastic market could be reduced by the greatest amount.

Some observers have suggested that rates for off-peak service might similarly be set to maximize the contribution to overhead by that class of service, thus permitting a reduction in rates to peak service users. The conditions underlying this practice, however, are not similar to those of the previous discussion. In this case, the marginal costs of peak and off-peak service are not the same. Off-peak users would be discriminated against by charging them a price above their marginal costs in order to maximize the subsidy to peak users who would pay a price as far below their (higher) marginal costs as possible. This practice would be justified only to the extent that the elasticity of demand for peak users is sufficiently elastic to offer them a price containing a smaller markup over their relatively high marginal costs than is incorporated in the lower price charged to the off-peak users.

A necessary condition for justifiable price discrimination is the existence

of declining average costs in the relevant range of demand. The problem of excess revenues accruing to marginal cost pricing under increasing average costs was alluded to earlier. Certainly these excess revenues may be reduced through selective rate reductions in relatively inelastic demand markets; but would such a practice be justified? The answer is no.

Price discrimination was justified under decreasing average costs since, in such a situation, we were confronted with a dilemma between our two fundamental rules (i.e., price equal to marginal cost and total revenues equal to total cost). In the present case, the dilemma does not exist. To charge one group of customers less than the marginal costs of providing service to them would be economically inefficient. A more proper method of reducing excess revenues would involve taxing by the government. Another possible alternative would be to place these excess revenues in a contingency fund which could be used at a later time to cover total costs in a period of declining average costs.⁶

In designing their structure of rates to be charged various customers, public utilities do not generally rely on analyses of long-run marginal (or incremental) costs and demand elasticities. Instead, their rate setting process involves various methods of allocating total revenue requirements, including rate of return on invested capital, among the respective classes of service. The costs incurred by the utilities are fully distributed according to class and are further reduced to costs per unit based on a measure of the physical quantities consumed by each class. Thus, all utility services will earn the same rate of return on their allocated investment.

Some costs may be assigned directly to a specific class, yet other costs,

⁶One problem with a scheme of this nature is the inherent possibility of subsidization between present and future customers.

by virtue of their common or joint nature, must be allocated among many service classes. Regardless of the cost allocation technique used by the utility, such common or joint costs are generally distributed on the basis of a common physical measurement (e.g., ton-miles, MCF, circuit miles, or kwh).

Implicit in the derivation of such costs is the false assumption that all costs may be traced to specific quantities of output. To express capacity costs of an electric system, which are common in nature, in terms of energy measurements (as in the case of residential electric rate schedules) seems a rather arbitrary cost allocation. An allocation of capacity costs of an electric system on a per kilowatt-hour basis ignores causal responsibility for those costs.

Consider a case of two residential customers who consume the same total number of kilowatt-hours yet have different consumption patterns with respect to time. Assume that the first customer makes all of his consumption during the system peak, while the second customer spreads his consumption equally over time. Certainly the first customer is causally responsible for more of the system's capacity costs than is the second customer; yet under a per kilowatt-hour allocation of capacity costs, both customers will contribute the same amount toward covering those costs. In effect, the second customer would be subsidizing the consumption of the first customer.

The major problem with fully distributed costs lies in the fact that such costs do not measure causal marginal cost responsibility. These costs are essentially average costs, and, as such, they cannot provide knowledge as to the increase in cost resulting from an extension of service, nor can they describe the extent of cost decreases resulting from curtailment of service. Fully distributed costs do not provide a means by which the profitability of a specific service may be measured.

Only under a condition of equality between marginal and average costs will this problem not exist. In the absence of such a condition, full cost distributions do not recognize the disparities between marginal and average costs. If total costs are to be matched by total revenues, these disparities may necessitate a set of prices based on both costs and relative demand elasticities.

Under declining average costs, if there exists some class of service whose demand is sufficiently price elastic such that a price to that class below average cost would contribute more to revenue than to cost, the continued reliance on full cost pricing would be irrational. On the other hand, if there exists no such highly elastic demand, any pricing scheme other than one based on fully distributed costs will ultimately involve subsidization between customers.

Appendix A

A Graphical Approach to Price Discrimination Within and Between Customer Classes

Price Discrimination Within a Customer Class

Figure 1 describes a case in which an individual demand DD' and the characteristics of cost are such that at no single price would revenues be large enough to cover costs. The socially optimal price P_3 would elicit a demand of Q_3 but would, at the same time, bring about a net loss equal to the area of the rectangle ZXYM. Perfect price discrimination would elicit the same quantity demanded but would provide revenue equal to the area under the demand curve, EDMN. If these revenues were greater than total costs (EXYN), the investment by the firm in its production facilities would be privately justified.

Price discrimination through a declining block structure of rates would approximate the result of perfect discrimination. The individual would purchase Q_1 units at a per unit price of P_1 , $Q_2 - Q_1$ units at a price of P_2 , and $Q_3 - Q_2$ units at a price of P_3 . Total revenues would equal the sum of the areas of the rectangles EFGH, HIJK, and KLMN or, alternatively, the area of the rectangle EXYN (which is equal to total costs). In such a manner, price discrimination may be recognized as a means by which a utility may equate (or approximately equate) total revenue with total cost and/or make fuller use of its productive capacity.

Price Discrimination Between Customer Classes

Figure 2 describes a situation of static, long-run decreasing costs coupled with two separable classes of customers, D_1 and D_2 , possessing quite disparate price elasticities of demand. The firm is attempting to choose the appropriate size of plant from among the infinite number of plant sizes tangent to the long-run average cost (LRAC) curve.

At the uniform price P_1 , the D_1 customers could be served alone, and their demands would necessitate construction of the most efficient plant size for producing an output of Q_1 . The price P_1 would not, however, be optimal. Were price equated with long-run incremental costs (i.e., P_2), some D_1 customers and an entire class of D_2 customers would be willing to purchase substantially more output.¹ Given the cost conditions of our example, it is obvious that a price equal to marginal cost for all customers would result in a loss to the firm.

Suppose instead that the firm discriminates in price between the two markets, D_1 and D_2 . In reducing the price in the D_2 market to equate with marginal cost, the firm is able to pick up the D_2 customers and earn from them enough revenues to cover the additional costs of providing that service. The combined sales to D_1 of Q_1 units at a per unit price of P_1 and to D_2 of $Q_2 - Q_1$ units at a price of P_2 cover long-run average cost, and neither the firm nor the customers in the D_1 market are any worse off. A net gain in social welfare occurs through the increase in consumer surplus in the D_2 market (triangle IMJ) as a result of price discrimination.

Suppose that the objective of price discrimination is to maximize the gains to the market being "discriminated against" (in this case, D_2). That is, rate reductions will be allowed in the elastic demand market (D_2) only to the point at which that market makes the maximum contribution to overhead costs. This objective will be met when marginal revenue in the elastic market (MR_2) is equated with marginal cost. In Figure 2, the price at which marginal cost equals marginal revenue is P_3 . If the D_2 customers are charged a price P_3 , they will be making the maximum contribution to overhead (equal to the area of the rectangle IXYZ) and will consume $Q_3 - Q_1$ units of output. In this manner, the price charged to the D_1 customers may be reduced by the greatest amount below P_1 .

¹Note that the demand curve D_2 has been drawn as though the vertical axis were at Q_1 , rather than the origin. The quantities demanded at various prices by the D_2 customers would thus begin at Q_1 .

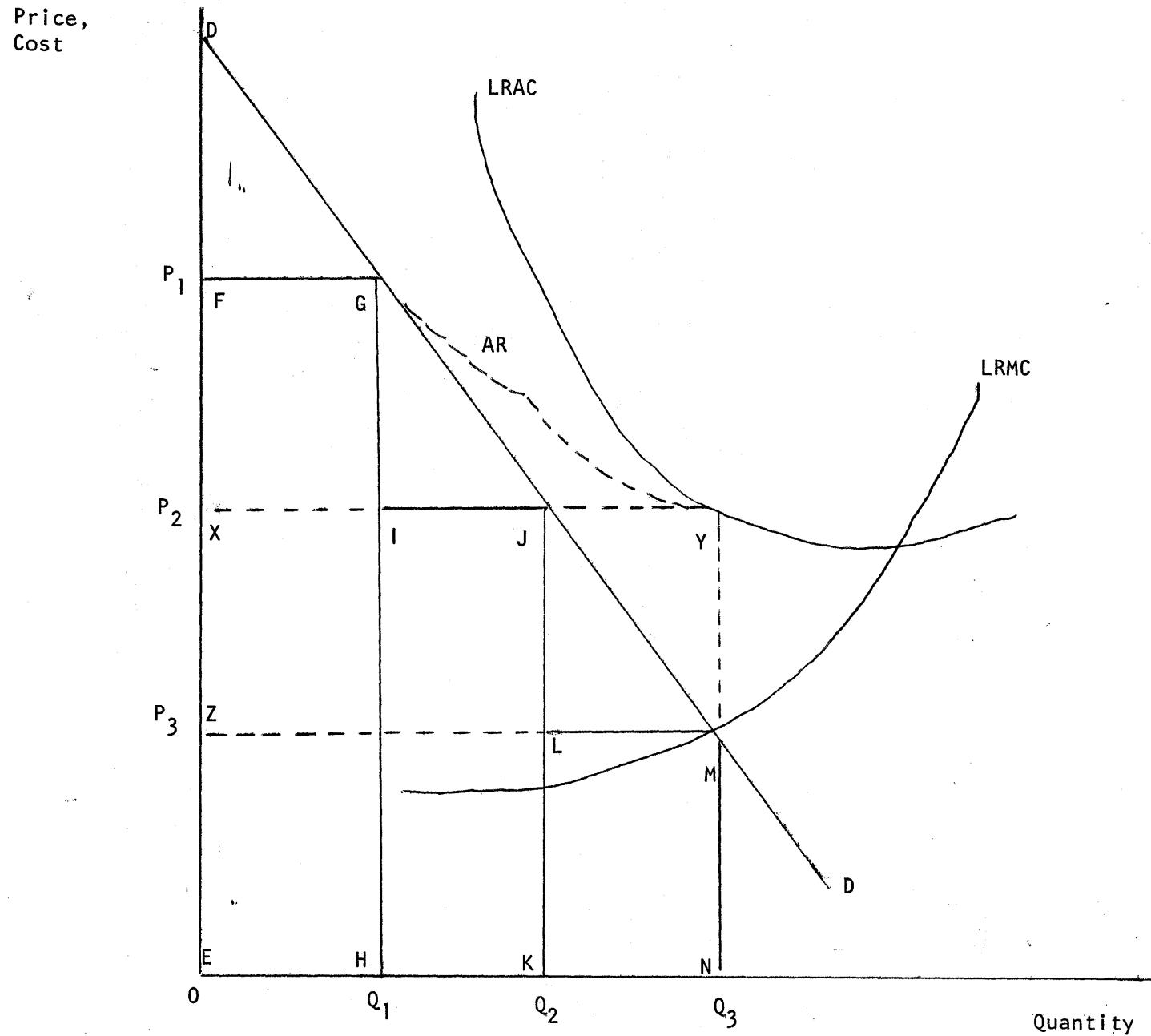


Figure 1

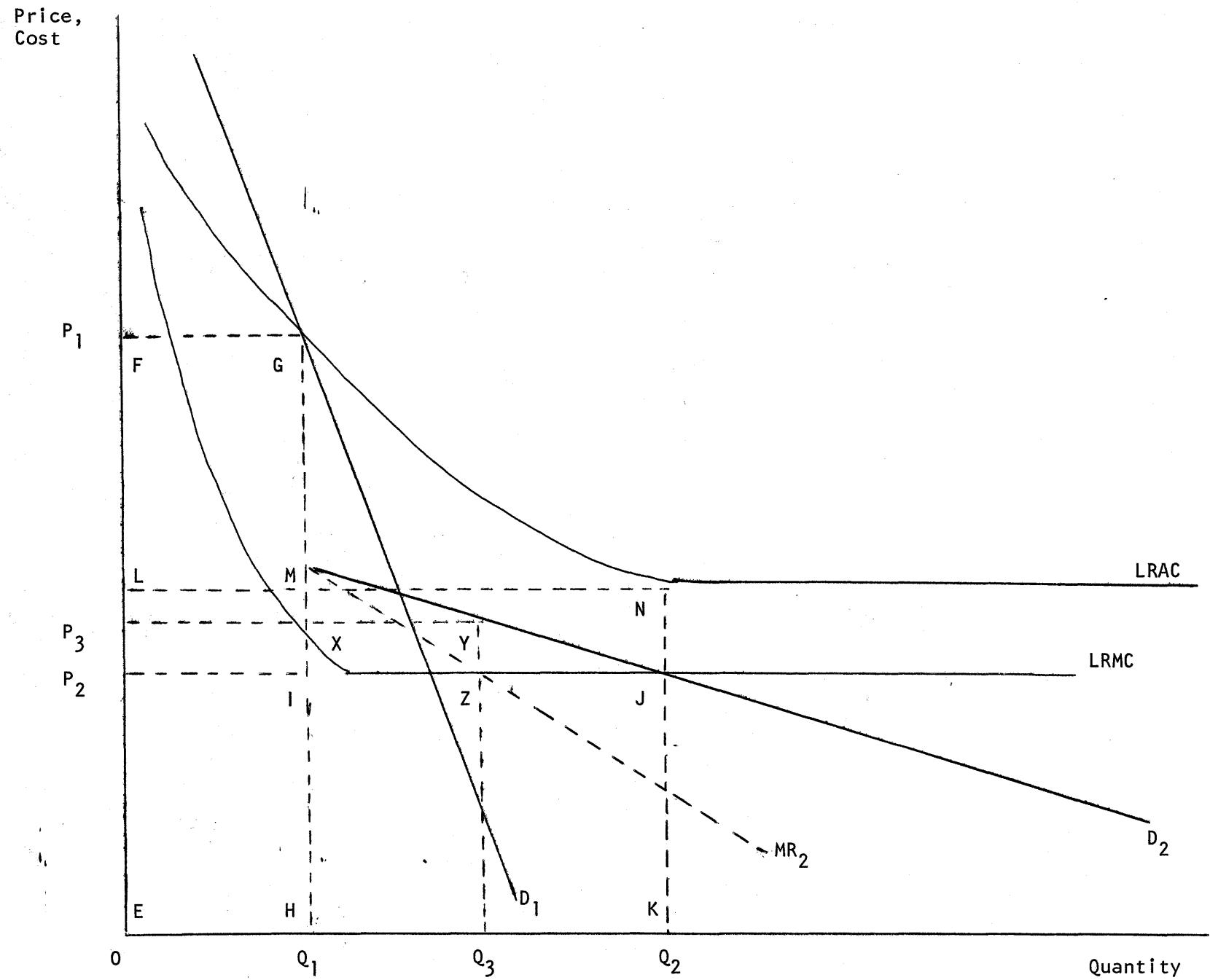


Figure 2

Appendix B

Supplementary Bibliography of Readings in the
Area of Marginal Cost Pricing, Price
Discrimination, and Fully Distributed Costs

- Bonbright, James C., Principles of Public Utility Rates. New York: Columbia University Press, 1961, Chapters 18, 19, and 20.
- _____, "Fully Distributed Costs In Utility Rate Making," American Economic Review (May 1961), LI: 305-312.
- Buchanan, J.M., "The Theory of Monopolistic Quantity Discounts," Review of Economic Studies (1953), XX: 199-208.
- Clemens, Eli W., "Price Discrimination in Decreasing Cost Industries," American Economic Review (December 1941), XXXI: 794-802.
- Davidson, Ralph K., Price Discrimination in Selling Gas and Electricity. Baltimore: Johns Hopkins Press, 1955.
- Harbeson, Robert W., "A Critique of Marginal Cost Pricing," Land Economics (February 1955), XXXI, No. 1: 54-74.
- Kahn, Alfred E., The Economics of Regulation: Principles and Institutions, I and II. New York: Wiley, 1971.
- Lapinski, Martin, "Two-Part Tariffs for Public Utilities: A Brief Review of the Major Conceptual Literature," Public Utilities Fortnightly (December 5, 1974).
- Nelson, J.R., ed., Marginal Cost Pricing in Practice. Englewood Cliffs: Prentice Hall, 1964.
- Oi, Walter Y., "A Disneyland Dilemma: Two Part Tariffs for a Mickey Mouse Monopoly," Quarterly Journal of Economics (February 1971), LXXXV: 77-96.
- Robinson, Joan, The Economics of Imperfect Competition. London: Mac Millan, 1933.
- Shepherd, William G., "Marginal Cost Pricing in American Utilities," Southern Economic Journal (July 1966), XXXIII: 58-70.
- Turvey, Ralph, Optimal Pricing and Investment in Electricity Supply. London: George Allen and Unwin, 1968.
- Wald, Haskell P., "Theory of Marginal Cost Pricing and Public Utility Rates," Public Utilities Fortnightly (June 22, 1967): 15-24.
- Winestone, Robert L. and Arthur A. Wichmann, "A Reexamination of Discriminatory Price Practices," Land Economics (May 1957), XXXIII, No. 2: 149-153.
- Worcester, D.A., Jr., "Justifiable Price 'Discrimination' Under Conditions of a Natural Monopoly: A Diagrammatic Representation," American Economic Review (June 1948) XXXVIII: 382-388.