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FOREWORD

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CONTENTS

ACRONYMS

AC	average cost
ADB	Asian Development Bank
AIC	average incremental cost
AIEC	average incremental economic cost
AIFC	average incremental financial cost
CAPM	capital asset pricing model
LRAC	long-run average cost
LRMC	long-run marginal cost
MC	marginal cost
MCC	marginal capacity cost
MCP	marginal cost pricing
MEC	marginal environmental cost
MOC	marginal opportunity cost
MPC	marginal private costs
MUC	marginal user cost
O&M	operations and maintenance
OPEX	operating costs
PBR	performance based regulation
ROE	return on equity
ROO	return on output
ROR	rate of return
ROS	return on sales
RR	revenue requirement
SFF	sinking fund factor
SRAC	short-run average cost
SRMC	short-run marginal cost
WACC	weighted average cost of capital
WSS	water supply and sanitation
WTP	willingness-to-pay

ABSTRACT

This paper reviews the literature on utility tariff setting with an emphasis on economic efficiency and financial sustainability. The paper first discusses the merits as well as practical limitations in applying marginal cost pricing. It then presents details on estimation of revenue requirements of utilities under two regulatory regimes: rate of return regulation; and performance-based regulation. Finally, the paper discusses how to set tariffs when an enabling environment for achieving both financial sustainability and economic efficiency is lacking. Under such circumstances, the paper argues that initial focus should be on cost recovery. As the enabling environment improves, goals of tariff setting can include broader objectives. The success of such a gradual approach depends on: (i) participatory and rigorous analytical work to assess the feasibility of the type of tariff; and (ii) policy and institutional reforms, regulatory enhancements, and performance improvements of the utility to create an enabling environment for implementing advanced types of tariffs.

I. INTRODUCTION

Utility tariff for public services affects the welfare of communities, economywide resource allocation, as well as the financial performances of public utilities. The Asian Development Bank (ADB) provides a significant proportion of assistance to sectors where utility tariff plays an important role.[1] Issues related to public utility tariffs are discussed in three ADB technical notes. Dole (2003) reviews the existing policy and practices relevant to utility tariff setting at the ADB. He identifies a set of likely goals for tariff setting: good governance, financial sustainability, distributive justice, economic efficiency, and fair pricing. Dole and Bartlett (2004) emphasize that that these goals should ensure that tariffs are simple, transparent, and predictable; are financially sustainable without subsidies; are affordable to the poor for meeting basic needs; promote efficient use of resources; and avoid cross-subsidies. Dole and Bartlett further elaborate the goals of tariff setting by describing a pricing rule to achieve each goal, and a general and flexible structure of tariffs to make room for achieving the multiple goals while minimizing conflicts among them. Dole and Balucan (2006) provide an example of the type of tariff reviews that could be undertaken using the framework developed by Dole and Bartlett to facilitate policy discussions and project designs. They review the water supply tariff in Metropolitan Cebu in the Philippines using the goals defined by Dole and Bartlett, and conclude that ADB's approach to tariff setting is realistic and relevant for tariff setting in developing Asia.

ADB's practice in tariff setting shows that ADB has paid the most attention to financial sustainability and affordability issues. Achieving economic efficiency, i.e., optimal resource allocation through tariff signals, has received little or no attention.

This paper discusses these two crucial issues in tariff setting, namely, economic efficiency and financial sustainability. Achieving economic efficiency may often conflict with financial sustainability under natural monopoly conditions; therefore, this paper further elaborates on the economic efficiency and financial sustainability issues in a public utility tariff setting. The paper points out that a gradual approach to tariff setting may be appropriate when policies, institutions, and capacity are not in place for application of advanced utility tariffs to ensure both financial sustainability and economic efficiency. In such a situation, utility tariff setting may initially emphasize financial sustainability and then gradually extend the tariff setting goals to encompass broader social objectives, including economic efficiency.

The paper is organized as follows. Section II reviews the issues related to economic efficiency. In particular, the following are discussed: the pros and cons of marginal cost pricing, the conflict between economic efficiency and financial sustainability under marginal cost pricing, the practical difficulties of estimating marginal cost and pragmatic approximations, and the two-part tariffs to

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[1] The major sectors are energy, and water supply and sanitation, which accounted for 28.7% and 33.4% of ADB assistance, respectively, in 2005 and 2006.

ensure both economic efficiency and financial sustainability. Section III discusses the issues related to estimation of the revenue requirement to ensure financial sustainability. Section IV discusses the gradual approach in setting tariffs to ensure both financial sustainability and economic efficiency. Section V concludes the paper.

II. ECONOMIC EFFICIENCY AND MARGINAL COST PRICING

Economic efficiency requires pricing goods and services at the short-run marginal cost (MC). This section describes the pros and cons of marginal cost pricing in public services in the context of natural monopolies. A natural monopoly is a firm with a declining long-run average cost curve over the range of output relevant to market demand. The technical features of many public utilities, which give rise to economies of scale,[2] characterize them as natural monopolies. For example, having only one electricity transmission line or one water main in the street provides possibilities of cost savings. A more refined concept called cost sub-additivity elucidates that the cost of meeting a given demand of public service by one firm will be smaller than the total costs of providing the same services by two or more firms. Cost sub-additivity thus precludes competition among firms, and justifies the presence of natural monopolies. The presence of natural monopolies brings about the basic problem of public utility economics: how to establish "benevolent monopolies", which take advantage of economies of scale but do not extract monopolistic surpluses[3] in the process of provision of essential public services. Public provision and proper regulation of private utilities are the possible options for supplying services when cost sub-additivity prevails. In both cases, tariff setting plays a very important role.

In well-functioning competitive markets, goods and services are priced at the marginal cost. It is well established that marginal cost pricing (MCP) ensures achieving economic efficiency, the basic logic of which is straightforward. If the price of a commodity is not equal to MC then that price would not reflect accurately the social cost of incremental provision of the commodity. Prices above or below the MC will fail to provide the correct signal to consumers to purchase the correct quantity.

Given that MCP is the mechanism that ensures efficiency in markets, it provides a good starting point to approach the pricing problem of public services (i.e., setting public utility tariff). Before further analyzing the relevance and feasibility of using MCP for utility services, it is worthwhile to briefly discuss the concept of economic efficiency. In particular, given that tariff setting requires meeting multiple goals such as good governance, distributive justice, and financial sustainability, what weight should be given to economic efficiency under conflicting situations?

Economic efficiency is generally defined as the condition whereby a society gets the highest social welfare[4] from its scarce resources. Economic efficiency can be defined at various levels such as efficiency at the firm level, efficiency of allocation of goods and services among consumers, and efficiency of allocating resources among different sectors. When all the conditions for efficiency

[2] Economies of scale refer to the condition whereby long-run average total cost falls as the output increases.

[3] Under monopoly conditions, firms produce at less than the optimal level of output and price it at a higher level. This results in lower consumer welfare and excessive profits (super normal profits) for the firm. Although the firm's profits are higher, the net gain to the society in terms of social surplus is less under monopoly. Because of this welfare loss, private monopolies are generally not allowed and public monopolies are regulated.

[4] Social welfare generally refers to the happiness or overall satisfaction of individuals in a society. More accurately, utility is the term used to describe social welfare in economics. Utility also refers to public utilities in this paper.

at different levels are simultaneously met, the economy is said to have achieved overall economic efficiency. Pareto efficiency[5] is a formal way to define the overall efficiency in the economy. Given particular resource endowments, technology, and preference, the highest level of aggregate utility (social welfare or satisfaction) is said to be achieved if the economy is at Pareto efficiency. It is the best way to allocate scarce resources to gain maximum social welfare.

The first fundamental theorem of welfare states that, under a set of assumptions, the free market equilibrium is Pareto efficient. The implication of this theorem is that if the market is allowed to allocate resources, it will find the best allocation of scarce resources to provide maximum social welfare. Thus, Pareto efficiency is a highly desirable aim for any society to actively pursue.

Although the nature of this paper does not warrant a detailed discussion on the subject of welfare economics, a note of caution is in order. While economic efficiency is a sound concept that guides overall economic policies, its practical application is hindered by a set of well-known limitations. One fundamental problem with economic efficiency is that it only allows maximization of the aggregate social welfare and hence fails to address the issue of welfare distribution among different segments of society (equity issue). Perfect market equilibrium that ensures Pareto efficiency requires competition among firms so that no firm can influence the price; and that there is perfect information, homogeneous products, free entry and exit, and no market failures. Such restrictive conditions are rarely met in the real world. On balance, the economic efficiency concept has been guiding economic policies all over the world despite these limitations. Widely observed empirical evidence, in the recent past, corroborates that market economies (of course together with appropriate policy interventions) exert significant influence in a country's development. This empirical observation reinforces the importance of the concept of economic efficiency despite its inherent weaknesses.

A. Problems of Marginal Cost Pricing

Marginal cost pricing ensures that the consumer pays the social cost of producing a commodity, which allows the production of optimal quantity that maximizes social surplus.[6] However, under natural monopoly situations, the simple and straightforward rule of using MCP as a guiding principle encounters a number of difficulties such as: (i) restrictive conditions; (ii) lack of simplicity and predictability; (iii) greater revenue variability; (iv) financial surplus/deficits; (v) practical difficulties in estimating MC; and (vi) equity related concerns. These issues are discussed in the next section.

1. Restrictive Conditions

There are a number of restrictive conditions that have to be met to ensure economic efficiency under the pure MCP rule. First, the basic premise of the efficiency argument of MCP is that consumers optimally adjust their behavior in response to price changes and such adjustments

[5] Formally, Pareto efficiency refers to a situation where one person cannot be better off without making another person worse off, implying that all potential inefficiencies are eliminated, and therefore there is no possibility for further increase in social welfare.

[6] Social surplus includes both consumer and producer surpluses, in a Marshallian setting

eventually result in social welfare improvements. However, many services such as water supply and sanitation (WSS) are essential basic needs that generally show a price-inelastic[7] behavior. While the degree of influence of the prices is an empirical issue, there is no guarantee that consumers will adequately respond to price changes under all circumstances. Therefore, investigating price responsiveness is necessary before application of the MCP rule in tariff setting. If consumption is nonresponsive to price changes, efficiency improvements may not be achieved.

Second, perfect information regarding cost and price changes is necessary to ensure that consumers optimally respond to future price changes. A perfect flow of information, however, is hard to achieve under most circumstances. As shown later, pure MCP may result in unpredictable fluctuation in prices. Therefore, expected efficiency is unlikely to be achieved due to imperfect information on future price changes.

Third, in order for MCP to achieve economic efficiency, the sector should be free from market failures. In reality, many market failures such as externalities (air pollution by public transport, green house gas emission by energy generation, biodiversity destruction by large hydropower dams) and public goods (health benefits of water supply and sanitation) are a rule rather than an exception in the sectors where tariff setting is required. To ensure efficiency, MC should reflect additional social costs/benefits of market failures.

Fourth, it is generally assumed that no administrative and transaction costs are involved in administering MCP. Since meter reading, billing, etc., are involved, this assumption is frequently violated in many public utility tariff operations. Fifth, firm-level productive efficiency should exist and the utility should be operating at the minimum cost in order to ensure economic efficiency. Usually, MC is calculated using actual costs of the firm. If the firm is inefficient in its production processes, then costs estimated from the firm's data will overestimate MC and tariff will be higher than that under efficient pricing.

Finally, and more importantly, every sector in the economy should be operating efficiently to ensure that MCP is effective. If one or more sectors in the economy are inefficient, the MCP rule will not ensure efficiency.

Usually many distortions prevail in the economies of developing counties. In the presence of such distortions, MCP not only fails to deliver efficiency but also creates further inefficiencies when applied in already distorted situations. The presence of inefficiencies in other sectors requires second-best solutions to achieve efficiency. While the second-best problems may imply that the attempt to ensure efficiency through MCP is all in vain, one should not be overly pessimistic. There are ways to amend the MCP rule to take care of the inefficiencies in other sectors of the economy. For example, Ng (1987) suggests using price/MC ratio in the overall economy to adjust the MCP rule when distortions exist in other sectors of the economy. This type of "third-best" rules are generally applicable when a public service does not have close substitutes or complements.

[7] When demand is inelastic, the percentage decrease (increase) in quantity consumed is very low compared to the percentage increase (decrease) in price.

2. Revenue Variability and Financial Deficits

Theoretically, short-run MC (SRMC) and long-run MC (LRMC) can be equal if the utility is efficiently managed and the plant capacity can be optimally changed in small increments. However, the latter assumption is usually not valid for most public utility services due to technical reasons. Efficiently managed plants will always operate at a level at which the cost of producing an additional unit with existing capacity is equal to the cost of expanding capacity to provide the additional unit. However, capacity expansion in many public services requires large investments such as construction of dams, water purification plants, sewage treatment plants, and power transmission lines. Such capacity additions are lumpy and usually result in excess capacity immediately after the addition of the new capacity.

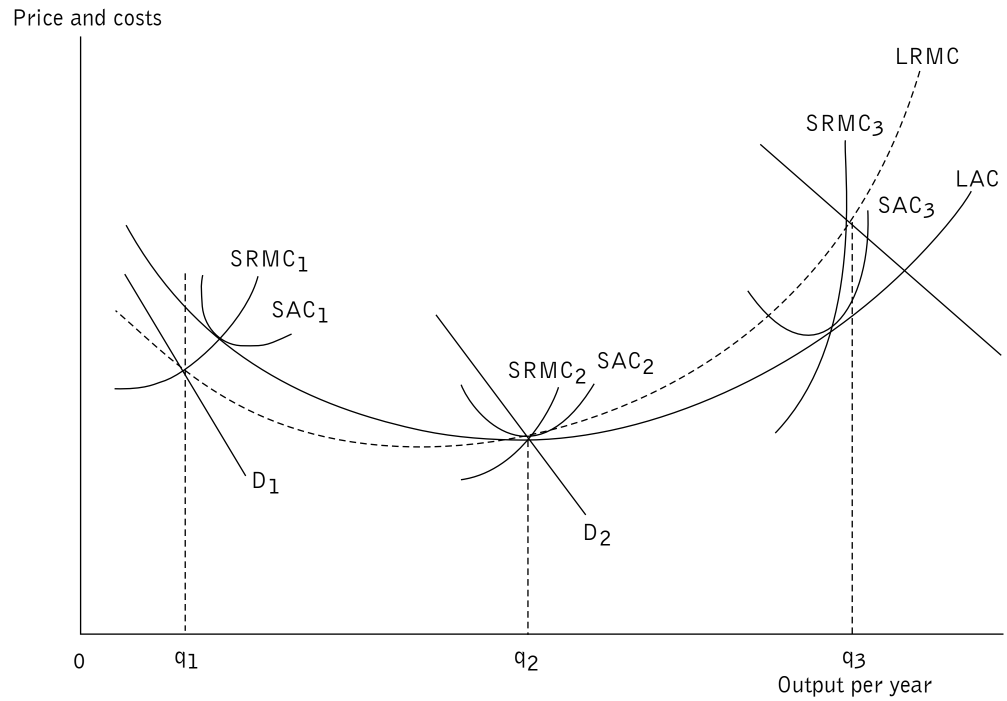
By definition, the SRMC will only include variable costs that are directly attributed to the provision of an extra unit of the service. For example, the SRMC would constitute additional pumping cost and treatment cost in the case of water supply or the fuel and operating and maintenance cost of the power plant producing the additional unit of electricity. The SRMC in an excess capacity situation, therefore, may be very low or even zero. For example, an additional cubic meter of water delivered to a household from a new plant, or an additional passenger in a half empty train, may not add significant additional costs. Therefore, SRMC is low or zero in the presence of excess capacity. On the other hand, as the excess capacity gradually reduces with time, SRMC increases until the next capacity expansion happens. When MC increases to a level wherein the incremental variable cost increase is greater than the cost of expansion, or results in unmet demand with an opportunity cost greater than the cost of expansion, new capacity is justified.

Some understanding of the shape of the cost curves and their relative positions are necessary to understand the revenue implications of MCP under excess capacity situations. Usually the short-run average cost (SRAC) and SRMC curves show a U shape owing to the diminishing marginal returns frequently observed in the production processes. The long-run average cost (LRAC) curve is an envelop curve that intersects the minimum points of the short- run cost curves.

Average and marginal cost curves behave in a particular manner. Whenever average cost (AC) is falling, MC is below AC and the reverse is true when AC is rising. As shown in Figure 1, if the plant operates at capacity q1, the firm is facing a declining AC and the LRMC is below the LRAC. At this capacity of operation the firm makes a loss if the tariff is set at SRMC because SRAC is above the SRMC and the price. At capacity q2 the firm breaks even.[8] The price is set at SRMC, which is equal to SRAC, LRMC, and LRAC (Hall 2000). At capacity q3 at which SRAC is rising, SRMC is above the SRAC. The firm makes a profit[9] at this point where the tariff is set at SRMC. As shown in this generic case, a public utility can potentially make a loss, break even, or earn profit depending on the capacity at which it operates. In industries such as water with declining average costs over a long range of output, utilities may operate at the declining portion of the LRMC curve and make losses, if the tariff is set at SRMC.

[8] At this point the firm makes a normal profit, which is considered to be part of the cost.
[9] At q3 the firm makes a super normal profit.

Figure 1
Short-Run and Long-Run Cost Curves



Source: Ng (1987).

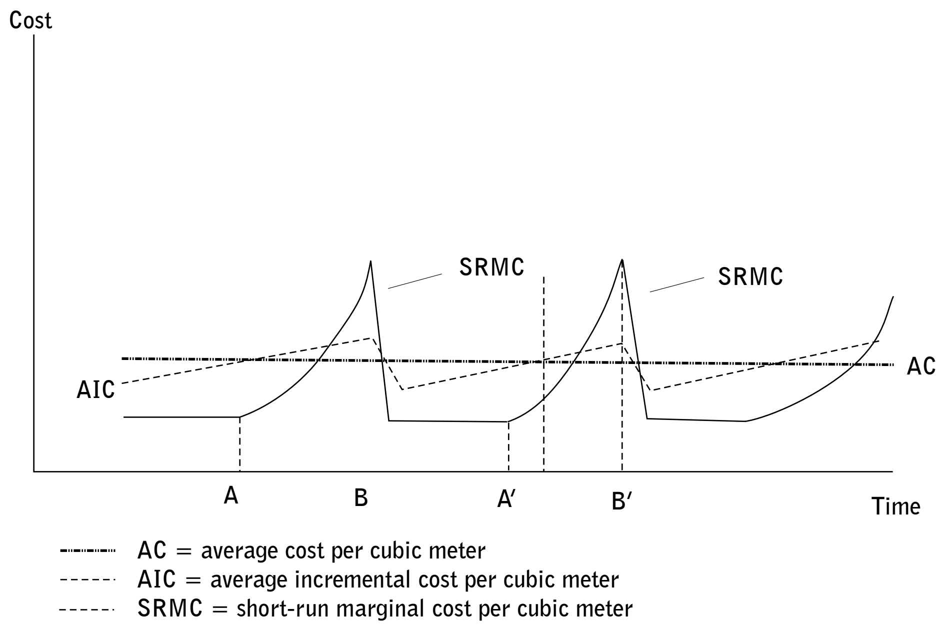
The application of the MCP rule to a private utility firm at the range of declining AC, may force the firm to go out of business. However, the natural monopoly feature should not be considered as given for all utilities. Recent evidence shows that some of the utilities such as water supply at times do not have scale economies, and competitive mechanisms on billing and maintenance can reasonably increase competition (Kim 1987, Easter and Feder 1997, Boisvert and Schmidt 1997). New technologies such as cable-based telephone access, cellular radio, and direct microwave links to local or long-distance switching nodes have also reduced the natural monopoly nature in the telecommunications industry (Swaroop 1994). The electricity sector has introduced competition in generation in many countries so that efficiency is no longer required to be achieved through artificially set prices (tariff). Therefore, it is not wise to assume natural monopoly in all utilities all the time.

In order to understand the revenue fluctuations in a natural monopoly under the MCP rule, consider a natural monopoly that undergoes periodic capacity expansion. Figure 2 shows the SRMC curve of a water utility that undergoes periodic capacity expansion.[10] At point A capacity constraint is reached and after that SRMC started to increase. At point B the SRMC is high enough to justify capacity expansion. The cost of providing additional unit of service is greater under the current capacity compared to that under expanded capacity, including cost of capacity expansion. Soon after capacity expansion, excess capacity sets in and capacity expansion costs become sunk costs. Since the sunk costs are not included in SRMC it shows a sharp decline. Again at point

[10] It is assumed constant average cost in the diagram for simplicity.

A′ capacity limitation sets in resulting in rising SRMC. Next capacity expansion takes place at point B′ and subsequently MC sharply declines. It is clear from this analysis that SRMC shows a fluctuating behavior with time. Therefore, using SRMC as a pricing rule results in unpredictable prices over time. Such fluctuating prices seriously violate the simplicity and predictability goals of tariff setting. As a consequence, if the tariff is based on SRMC, the public utility's revenue fluctuates parallel to SRMC fluctuation. This results in greater variability in revenue and the utility finds it difficult to undertake proper financial planning under this circumstance.

FIGURE 2
VARIABILITY OF SRMC OVER TIME WITH CAPACITY EXPANSION



Source: Bahl and Linn (1992).

One objective of utility tariff setting is to ensure that tariff obtains adequate revenue for the public utility to meet its financial obligations. Financial obligations of a utility may include operation and maintenance costs, debt service, taxes, and returns on equity. In contrast to the financial obligations that depend on the above-described revenue requirements, the SRMC only includes costs attached to providing an additional unit of a service. Therefore, if the service has the characteristics of a natural monopoly with periodic capacity expansion and subsequent excess capacity, the revenue will be inadequate to meet the financial obligations of the utility. If the declining portion of the SRMC curve lasts long, the utility may find it difficult to provide its services without subsidies.

3. Practical Difficulties

Even though the MC seems to be a straightforward concept, there are a number of practical difficulties in applying the MCP rule. First, there are difficulties in estimating the MC. MC calculations are complicated by the presence of transmission, treatment (in the case of water), distribution, and storage costs. Some of these costs are joint costs and separating them poses practical problems. Economic costs are based on the concept of opportunity cost and translating accounting costs to economic costs can be challenging. Many services involve heterogeneous technologies and periodic demands. Costs vary with the time of the day or the season. Accurately accounting such variation is not easy. In the case of market failures social costs need to be estimated and added to the private costs. In such cases, nonmarket valuation techniques have to be applied, which could be technically challenging and time-consuming. As suggested in this paper, the LRMC, which avoids some of these problems, can be used instead of the SRMC to set the tariff. In this case, however, the deviation of actual system costs from optimal system costs used to derive the LRMC poses another problem.

There are spatial, temporal, and consumer class variations in MC: the MCP rule requires that each individual pay the MC he/she generates. If MC varies with the space, time, and customer class, that variation should be reflected in the tariff. Accommodating such variations require additional administrative and transaction costs. Such costs too should be accommodated in the tariff. Urban and rural differences can further complicate the application of the MCP rule. Rural service may have higher unit costs due to low population density. Interregional differences may also occur due to differences in availability/scarcity and quality of natural resources. Intracity differences may arise due to changes in population density and topography. Although efficiency requirements dictate the price according to variations in costs, such pricing may cause political feasibility problems. The public often views that the service is the same despite the time- and location-related cost differences and tend to oppose such price variations. If rural communities are poorer, the opposition to price rural water at higher levels[11] to accommodate efficiency requirements can face significant community resistance. Variations of MC over time of the day or seasons result in situations such as peak load demand for electricity and higher demand for water during dry season. If the capacity is installed to meet excess demand, it will result in idle capacity in off peak periods. Peak loads should be treated as temporal or seasonal excess demand and use of the service should be rationed using higher tariff during the peak periods.

The MCP rule needs to be adjusted if there is high inflation; otherwise the real value of the tariff will be reduced over time. If the inflation is not taken into account at the beginning of tariff setting, tariff will have to be increased frequently and that may not be politically feasible in many developing countries. In many occasions, the government itself introduces distortions such as trade tariffs on certain imported inputs which are required to produce the service in consideration. The municipal authorities, striking to ensure efficiency through tariff setting, may find it difficult to convince the national authorities to reduce such distortions.

B. Long-Run Marginal Cost Pricing

As discussed, two of the important problems involved in MCP are revenue fluctuations and financial unsustainability. The use of LRMC pricing is an alternative that avoid some of the difficulties discussed above. Munasinghe (1992) defines LRMC as the incremental system cost of supplying one unit of sustained service with optimal adjustments in the capacity. Thus, LRMC is

[11] Generally, the unit cost of rural services such as water is high because the rural population is spread out and the population density is low.

the sum of SRMC and marginal capacity cost (MCC). The SRMC is defined as the cost attributable to additional usage when system capacity is less than fully utilized whereas the MCC is defined as the cost of extending the capacity to accommodate incremental supply of one unit (Mann et al. 1980). SRMC and LRMC are equal as shown in Figure 1 at the minimum point of the LRAC curve. However, this is feasible only when capital is perfectly divisible. Munasinghe (1992) argues that the system needs to be optimally planned and operated for the SRMC and LRMC to coincide. When system planning and operations are suboptimal, significant deviations between SRMC and LRMC can occur. When investments are lumpy, LRMC is equal to SRMC plus MCC in years in which capacity expansions take place. In other years LRMC is just equal to SRMC.

LRMC has certain merits as a pricing rule because its definition allows consideration of capacity expansion. As Mann et al. (1980) argue, a pricing policy that considers only the optimal use of existing capacity (i.e., SRMC) may not provide correct signals for optimal investment decisions. Prices should play a dual role of: (i) ensuring an efficient utilization of resources when operating at less than full capacity; and (ii) providing signals to invest on additional system capacity. Therefore, when the utility is operating below its full capacity, SRMC should be used to price the service. When consumers' marginal willingness-to-pay (WTP) is adequately raised to meet the SRMC plus MCC, investment on additional capacity should take place. Once the investment takes place the price will again drop to SRMC because the utility will operate at a capacity less than its full capacity.

Use of the LRMC concept for actual tariff setting requires a least cost expansion path for the utility. LRMC includes both capital and operating costs. However, it includes only future capital costs, not the sunk costs. Munasinghe (1992) and Warford (1997) argue that, in addition, it should include resource depletion cost (in case of an exhaustible resource such as petroleum–depletion premium) and environmental damage costs whenever corresponding market failures exist. LRMC pricing ensures economic efficiency as it does exclude sunk costs while concentrating on economic value of future resources used or saved by consumer decisions. Tariff based on LRMC is better than that of SRMC pricing because LRMC includes future capital costs and provides signals on future investments. Moreover, LRMC calculations require detailed cost analysis and improved system expansion planning. Such long-term planning can allow internalization of the externalities too. However, the use of a strict definition of LRMC in calculating tariff will have two problems: (i) it may not recover the full cost; and ii) prices can fluctuate making it difficult for financial planning. The next two sections on two-part tariffs and average incremental cost pricing discuss solutions to these problems.

C. Two-Part Tariff Systems

As discussed, when LRMC is rising, LRMC is above LRAC and that generates a revenue surplus. This surplus can be managed to satisfy other objectives of tariff setting such as distributive justice by subsidizing connection charges or by providing a subsidized block of the service to the poor. As shown earlier, LRMC pricing could also result in a revenue deficit when LRMC is falling. When such a situation is encountered there are three possible ways to fill the financial deficit: (i) government subsidies; (ii) fix charges over and above the LRMC; and (iii) higher lump sum connection charges.

Government subsidy to fill the gap of financing is an issue that has been discussed widely in public economics. Generally, filling the financing gap from subsidies does not violate efficiency considerations if the subsidy is financed through nondistortionary taxes. Land taxes are nondistortionary but rarely adequate to fill the financial gaps. As taxes are usually distortionary, that leaves us with the question as to whether altering the MCP principle or financing the gap through general tax funding creates bigger inefficiency in the economy. In addition to this direct efficiency consideration, there are other related issues of subsidy financing. For example, provision of subsidies to public utilities to fill the gap may result in a general decline in efficient management of utilities. This may be largely due to inadequate incentives for cost-cutting measures by the public utility management. Moreover, such subsidies have distributive justice implications as well. Many public service provision decisions are made based on political rather than cost–benefit criteria. Especially in countries where there is no universal service coverage, a group of service users receive a subsidy at the expense of general taxpayers. When the access charge (connection charge) is relatively high, this favored group tends to be the nonpoor. More importantly, developing country governments generally face pressing needs other than subsidizing utility services, therefore, subsidies often become unsustainable.

Higher lump sum connection charges will allow filling the financing gap but may result in change in consumer behavior. Some consumers, who may otherwise connect to the service, may not get a connection. Therefore, higher connection charges may eventually further increase the financing gap due to a lower number of households connected to the system. This approach also may have adverse implications on distributive justice. The lowest income category is more likely to remain unconnected under high connection charge regimes and this will eventually exclude the poorest segments of the community from essential services such as domestic water, sanitation, and electricity.

The above discussion shows that the general tendency is to favor fixed charges compared to the other methods of gap financing for public utilities. The basic economic logic for fixed charges lies on the premise that it does not alter the consumer behavior, i.e., the quantity of service consumed would not be affected by the fixed charge. This, however, happens only when the fixed charge is comparatively small compared to the usage charge based on LRMC. In addition to the above reasons, fixed charges are preferred by economists because they have a strong backing from economic theory.[12]

D. Average Incremental Cost Pricing

Early literature on the MCP assumed that the analyst can capture MC as a function, at least in the neighborhood of the range, of the demand. However, most utilities very often only have contemplated a set of possible capacity expansion projects over the planning horizon. Therefore, some approximation to the marginal cost function is necessary to resolve the utility pricing

[12] The economic reasoning for two-part tariff goes back to the 1930s as Hotelling (1938) argued that price should be set at marginal cost and any resulting financial deficit should be financed by lump sum taxes. When the welfare maximization problem is constrained by the revenue requirement of the utility, the first order conditions provide the rationale of the fixed charges. Coase (1946) first formulated the problem of utility pricing in this manner to show the economic rationale of two-part tariff. Russell and Shin (1996a) provided a succinct discussion on the variant of the different formulation of the pricing problem of the utility such as peak load pricing, Ramsey and Feldstein pricing.

problem. Three such methods to approximate LRMC have been widely discussed[13] in the literature: (i) text book marginal cost, (ii) Turvey marginal cost, and (iii) average incremental cost (AIEC). The Turvey method is also known as the present worth of incremental system cost method in some literature. These approximations have two features: (i) they are based on the available data on future expansion plans and not on econometrically estimated cost function; and (ii) they are considered to be practical because MC can be estimated with available data. Of these methods AIEC received the most attention. Many World Bank-funded water projects use this method for tariff setting (Bahl and Linn 1992). ADB's *Guidelines for the Economic Analysis of Projects* (ADB 1997) states that the economic price of water should be set equal to AIEC.

While it is not intended to provide a detailed discussion on the merits of AIEC in comparison with other methods that approximate LRMC, it is worthwhile to understand its basic advantages. AIEC is calculated by dividing the discounted incremental costs (which will be incurred in the future to provide estimated additional amounts of service) over a specific period by the discounted quantity of incremental outputs over that period. The main advantage of AIEC is that it provides a smoothing of price fluctuations created by LRMC pricing (see Figure 2). Therefore, AIEC is seen as a compromise solution between the quest for economic efficiency and price volatility resulting from LRMC pricing (Bahl and Linn 1992). Mann et al. (1980) assert that AIEC is a compromise between short-run allocative efficiency goals and the need for specific long-run resource allocation and investment signals. When investment costs are lumpy, AIEC estimates will not be equal to LRMC estimates. The price smoothening effect, practical feasibility of estimation using available data, and acceptable compromise in terms of economic efficiency seem to be the main features that make AIEC attractive as a proxy for LRMC. In estimating AIEC, average incremental financial cost (AIFC) can be first estimated using financial prices. Once AIFC is estimated, it can be converted to AIEC using appropriate shadow prices.

III. FINANCIAL CONSIDERATIONS IN TARIFF SETTING

The previous sections discussed how tariffs based on marginal costs of a public service could result in revenue deficit or surplus. This section discusses issues related to the estimation of the revenue requirement (RR) of a utility to meet financial obligations. A brief discussion on the different regulatory regimes is also presented at the end.

A. Revenue Requirement

Estimation of required revenue for financial sustainability seems to be straightforward. However, certain aspects of this exercise need careful thinking and better understanding, primarily due to two reasons: (i) different methods to estimate different components of required revenue lead to variations in required revenue; and (ii) revenue setting methods can provide incentives for utilities to behave in a socially nonoptimal manner.

For the purpose of illustration of the second reason, consider a utility that is privately owned. There are incentives for the firm to present overestimated costs to the regulator to justify a higher RR and tariffs. This will allow the utility to earn more profit at the cost of consumers.

[13] See Saunders et al. (1977), Mann et al. (1980), and Russel and Shin (1996b) for a good discussion.

On the other hand, publicly owned utilities may not face incentives to reduce costs due to various inefficiencies in its operation as the operating costs are usually considered as a pass through in estimating the RR. These unnecessarily higher costs will be transferred to consumers through tariff and consequently result in consumer welfare losses. Therefore, a transparent and systematic way to estimate the RR that provides incentives to the utility to operate in an economically optimal manner is necessary. The discussion on the estimation of the financial obligations of a utility presented here looks at the issues from the social planner's[14] perspective. The objectives of a regulatory mechanism should give reasonable weights to both financial sustainability of the firm and the maximization of social welfare of the consumers.

A public utility is financially sustainable if it has sufficient funds to meet its financial obligations in the future. The definition of the future, while theoretically unlimited, can in practice be taken as the period for which the agreed tariff formula will apply. The basic principle applied in the determination of the RR dictates that the RR should be equal to the cost of efficient service provision at an acceptable level of service quality. The service quality aspect is important especially in monopolistic situations where the consumer does not have the choice of selecting the supplier of services. Based on this definition the RR of a public utility includes operating costs, capital costs, and taxes. Operating costs (OPEX) include costs of administration, maintenance of assets and service delivery, and cost of any losses (i.e., the allowed transmission & distribution losses in the electricity sector and water leakages in the water sector). Taxes are an important source of government revenue in some utility industries such as telecommunications. The desirability of taxing some of the public utility services such as water supply and sanitation may be debatable because they are considered as essential services. However, despite the appropriateness of the tax, if any tax is imposed on a utility service, the required revenue should include the tax. The capital cost in turn is broken down into two components:

(i) amortization of investments in fixed assets, which is recovered through a depreciation allowance; and

(ii) cost of financing the investment recovered through an allowed return on assets.

Therefore the RR can be written as:

RR = OPEX + taxes + depreciation + allowed return

where

depreciation = asset base / average asset life

allowed return = asset base * weighted average cost of capital in financing the assets

In tariff setting, each of the parameters in the above equation has to be determined in a transparent manner to provide adequate revenues to the utility to meet its cost of service delivery. The required revenue should include adequate return on investment and incentives for the utility to operate and expand its network and asset base in a socially optimal manner. Estimation of required revenue depends on the existing regulatory framework. The traditional approach to rate setting (i.e., under rate of return [ROR] regulation) is based on accounting definitions, which

[14] The social planner's objective is to maximize social welfare considering both producers and consumers.

tends to guarantee that the utility would recover its cost of service provision. Under this approach due to guaranteed returns the risk premium will be low. However, this approach has well-known limitations such as:

(i) Lack of incentives to cost minimization and productivity improvement as OPEX are considered a pass-through item where productivity improvements translate to revenue decreases to the utility.

(ii) Incentives to overinvestment (i.e., gold plating) to justify higher revenues to the utility and higher tariffs to the consumer.

(iii) High cost of regulation as the traditional approach requires annual tariff reviews requiring verification of the actual costs of the utility.

(iv) Information asymmetry between the utility and the regulator as the traditional approach requires detailed and consistent information regarding operating costs and fixed assets. Usually the regulators, especially in developing countries, do not have access to this level of information.

To address the limitations to the traditional approach, certain modifications have been introduced in recent times and which are collectively referred to as performance based regulation (PBR).[15] The basic parameters of operating cost, asset base, and cost of capital still need to be determined under PBR but the methodology for determining these parameters and how they are interpreted for tariff setting are different from the traditional approach. The next subsections explain how these parameters are determined in the context of both traditional approach (ROR) and PBR approach.

Under the PBR approach, the regulator defines the caps on revenues to be earned by the utility over the rate setting period without explicit reference to the actual performance of the utility. Rather, revenues are set based on the allowed costs for a hypothetical efficient utility (i.e., reference utility) to efficiently deliver the services in the concession area of the regulated utility in compliance with the performance standards. This approach addresses the issue of information asymmetry between the regulator and the utility as the regulator does not have to know the actual costs of the utility. The revenues are set for a certain tariff period, usually 5–10 years, as against the annual tariff setting in the traditional approach. This provides incentives to the utility to reduce its cost during the tariff setting period as every cost reduction would result in additional profits compared to the starting point. The performance standard to be met by the utility in service delivery is usually set considering the consumer's WTP for services at certain performance standards and the cost of delivering the service. This requires information on the consumer's WTP and the cost of delivering the services (both capital and operating) at different performance standards. The information with respect to WTP is collected through sample surveys of the consumers while the cost of delivering the services is calculated through cost analysis of the reference utility.

[15] The paper discusses a few well known PBRs in Section IV.

1. Operating Costs

(i) ROR Approach

In the traditional approach of ROR regulation, operating costs can be easily estimated using the accounting data of the utility. However, proper regulatory mechanism has to be in place to periodically check the reasonableness of the operating costs of utilities and to address the issue of information asymmetry between the regulator and the utility. If the utility is privately owned, it has the incentive to present overestimated costs to the regulator when requesting the rate hikes to earn more profits. On the other hand, publicly owned utilities may not put conscious efforts to reduce costs since the losses are covered by government subsidies or higher regulated tariffs. The operating cost is also a function of the service quality; if it is not defined properly and depending on the degree of compliance with performance standards, there could be wide differences in operating costs among utilities.

(ii) PBR Approach

The PBR approach uses operating costs of a reference utility for setting the RR to address the weaknesses in the traditional ROR approach. To ascertain the operating costs of the reference utility in a realistic manner, the benchmarked costs of similar, efficient utilities in other parts of the country or in the region can be applied. It is also important to set a value for technical (i.e., transmission and distribution losses in electricity supply, and water leakages) and nontechnical losses (i.e., nonrevenue water, and illegal electricity and water connections) that occur in the service delivery. Although a certain minimum level of technical losses is unavoidable, the nontechnical losses can be avoided using efficiency improvements of the utility. Hence, the regulators usually allow the cost of certain level of losses to be included in the operating cost. This level could either be fixed during the tariff setting period or reduced over the tariff setting period to provide further incentives to the utility to reduce the losses.

In the PBR approach it is also important to clearly define and then enforce the quality of service delivery. In a monopolistic market, the utility has the incentive to compromise on service quality to achieve cost reduction. Therefore, in a PBR system a detailed set of procedures allowing effective definition, measurement, and monitoring of parameters related to service quality; and a related regime of penalties and rewards are essential. These penalties and rewards could be structured as adjustments to the allowed operating costs that are subject to the degree of compliance with performance standards.

It is also important to allow for changes in inflation and exchange rates as the RR is set for a longer duration under the PBR approach. Depending on the operating cost structure of the utility the allowed operating costs are indexed to the variations in inflation and exchange rate. However, it is generally considered that a portion of the benefits due to efficiency improvements during the rate setting period should be transferred to the consumers. Hence, the adjustment for inflation is applied as "RPI (retail price inflation) – X" where "X factor" is set to transfer a certain portion of the efficiency improvements to the consumers. The "X factor" should also be appropriately set to retain the incentives for the utility to reduce the operating cost during the tariff setting period. The "X factor" should also take into account the productivity improvements that are not due to the efforts of utility management such as scale economies due to an expanding consumer base or an increase in unit consumption by existing consumers. The "X factor" is adjusted during the tariff setting period to account for scale economies based on the actual data during the tariff setting period.

2. Capital Costs

(i) ROR Approach

In the traditional approach of ROR based regulation, the capital costs of the fixed assets are apportioned over the life time of the assets and included in the allowed revenues for tariff setting. Usually the assets are valued at the historical value or at the replacement value when there are significant variations between the historical value and replacement value. However, in rapidly expanding utilities, the historical value and the replacement costs are close to each other as most of the assets are likely to be acquired in the recent past. Although the use of replacement cost allows the utility to earn a more realistic return on its assets, it may result in intergeneration transfers. Past and present consumers pay different amounts for using the same asset. Moreover the replacement cost approach introduces additional risks to the utility investor due to the risk of asset price reduction arising from technology innovation and obsolescence.

The allowed revenue to recover capital costs comprises the amortization of the cost of the fixed asset, and the return on investment in fixed asset. The amortization (or depreciation) is based on original costs designed to recover the initial investment by recouping the expenditure over the asset's service life. In using the depreciation values as part of capital charges, historical depreciation and revalued depreciation need to be distinguished. The historical method considers the original value of the capital asset whereas the revalued depreciation considers inflation to bring the asset values to the present. The historical depreciation may not set aside adequate resources to replace the capital assets while revalued depreciation makes an allowance for inflation. However, when there are technological improvements, inflationary impacts are partially counteracted by the lower costs of new technology.

The other component of capital cost—return on investments in assets—can also be considered as the financing cost (i.e., valued at opportunity cost) of investing in the fixed assets. This is equal to the product of the cost of assets and the weighted average cost of capital (WACC) of the utility. The WACC consists of the interest cost of debt financing and the return on equity for equity financing weighted at the ratio of debt and equity financing.

$$\text{WACC} = \frac{(\text{debt financing} * \text{interest cost}) + (\text{equity financing} * \text{return on equity})}{\text{total assets}}$$

where

$$\text{total assets} = \text{debt financing} + \text{equity financing}$$

Although most of the parameters in the above equation are readily available from the utility's financial statements, there are several methods for calculating return on equity (ROE). The most well-known method for calculating ROE is the capital asset pricing model (CAPM). Under this model, the cost of capital is calculated as the sum of the default risk-free rate of interest plus a risk premium to compensate the utility investors for bearing systematic market risk of the utility as denoted by the formula below.

$$E(r_i) = r_f + \beta_{mi}\left[E\left(r_m\right) - r_f\right]$$

where

$E(r_i)$ = the CAPM cost of capital for firm i

r_f = the expected return on a default risk-free asset (e.g., government bill or bond rate)

$E(r_m)$ = the expected return on the market portfolio, and

β_{mi} = firm i's "beta coefficient" for systematic market risk
= covariance(r_i,r_m)/variance(r_m)

The second term on the right hand side of the equation is the firm's beta coefficient multiplied by the expected market risk premium. In CAPM applications, this risk premium is proxied by the long-term average of the difference between the return on a broad market index (usually a stock exchange index) and the return on a risk-free asset, depending upon the time horizon of the firm being evaluated. Beta (β approximates risk) measures how sensitive an individual stock's return is to changes in the market's return. β is usually estimated by regressing a firm's stock returns on the returns on the market portfolio.

For utilities in underdeveloped capital markets and for utilities that are not listed in stock markets, it is difficult to determine the β_{mi} and E(r_m). In such markets, the ROE is usually estimated by adding a risk premium to the risk-free rate that is usually the interest rate on government bonds. For public utilities, the risk premium is estimated based on policy directives of the government for acceptable return on public investments. For private utilities, it is the ROE demanded by private investors for long term investments.

ROE corresponds to the term "profit" in economics and the inclusion of a profit element in tariff of public utilities sometimes creates confusion. Profit, in economic terminology, is the reward for entrepreneurship—the premium the entrepreneur expects over and above the risk-free returns[16] (such as interest payments by converting the assets to time deposits) for the risk he/she faces due to his/her decision to put the assets into production. This reward for the risk (normal profit) is considered as part of the economic cost. The normal profit in economic terms is essentially an opportunity cost—the return that the same assets would have earned if used for production under the next best alternative. In financial terms, a parallel logic applies to include returns on asserts in addition to capital charges and interests.

There are three arguments in favor of including profit in a utility tariff setting. First, since the prices of all the other goods produced by the economy include a profit, exclusion of profit in utility tariff creates a distortion in the economy, which results in misallocation and waste of resources. Second, it causes a distributional issue because users of the service are receiving a subsidy paid by taxpayers who funded the original investment and who paid for the financial losses of the utilities. Third, the resistance and negative public opinion against privatization at some point in the future will be a problem if the current tariff does not include profit because in such situations privatization may require a major upward revision of tariff. Moreover, if both public

[16] This corresponds to the second term of the right hand side of the equation for ROE.

utility and privately operated utilities co-exist, exclusion of profits will put the public utility at an undue advantage. This may discourage private sector participation in service provision.

While there is strong economic logic to support inclusion of profits in tariff, there are practical and political reasons that work against this principle. The government's sociopolitical obligations compel them to keep utility service prices low. This applies particularly to essential services such as water supply to the poor. Often, poverty and equity issues are intertwined in utility tariff setting and raising charges to cover full costs may find political resistance in some countries. Consumers sometimes argue that the service is a basic right and should be free or as low as possible. While this argument makes sense neither from an economic nor from a financial point of view, it is still very influential in political decision making in some countries. In fact, constitutions in some countries include supportive elements that give extra backing to that claim. Including a profit element to the tariff may result in a large tariff increase. When past investment has been grant-funded, tariffs will often be set at cash flow cost recovery levels. Raising them in one go to full cost levels could be socially divisive. The political economic equilibrium in a given country and the history of tariff setting will eventually decide whether it is practically feasible to add profit to tariff at a given time. However, the desirability of including profit should not be overlooked by decision makers in the long-term attempts to reform tariff for public utilities.

(ii) PBR Approach

In the PBR approach, the capital cost recovery component of the RR of the utility is also estimated with respect to the reference utility, similar to the estimation of the operating cost recovery component. The capital cost of the reference utility is estimated by identifying the key technical design parameters of an ideal utility to provide the utility services over the tariff setting period in the concession area of the utility concerned. There are two basic approaches to determine the capital cost of the reference utility.

(a) *"Green Field" Method.* The utility is defined in terms of the existing and projected consumers during the tariff setting period, its consumption pattern, the concession area, and the service quality standard. The existing network and assets of the utility is completely ignored. The capital cost of constructing the reference utility at current prices is estimated. Some of the capital costs to be incurred during the latter part of the tariff setting period may be adjusted for inflation during the tariff setting period.

(b) *Incremental Method.* The reference utility to meet the demand for utility service in the concession area at the defined service quality standard is built starting from the existing asset base of the utility. The existing assets that are either obsolete or redundant for the needs of the reference utility are not in the capital cost base of the reference utility. The existing assets that are included in the reference utility are valued at the replacement cost. The new assets to be procured are valued at current prices adjusted for inflation during the tariff setting period.

Although both methods are theoretically applicable, in practice the "incremental method" is preferred due to practical and political considerations. The optimum capital asset base of the reference utility is derived by an iterative process to minimize the present value of the sum of investment costs plus operating costs and cost of technical losses. The following considerations are taken into account during the optimization process.

(i) meeting current and forecast demand from both existing and new consumers during the tariff setting period

(ii) meeting the applicable standards on service quality

(iii) trade-off between investment cost and operating cost including technical losses

(iv) optimum level of reserve capacity or redundancy in the network to meet the service quality (i.e., loss of load probability in the electricity supply industry)

(v) optimum unit size of the network due to the lumpiness of capacity additions

International experience shows that a proper regulatory definition of the above described issues has a significant impact on tariff level. In particular, the determination of the technical standards to be met by the utility is a crucial issue. They should be set at a minimum level allowing effective achievement of standards on quality of service. Standards set at higher levels than those required to comply with the service quality standards imposes higher tariffs than necessary on the consumers.

Although the capital cost component in the allowed revenues can be computed by calculating the allowed depreciation of the capital assets of the reference utility and the allowed return on investment in the reference utility, it is also possible to compute the capital cost recovery cost component using the amortization or sinking fund factor (SFF) method. The latter is preferred as it removes the degree of subjectivity associated with the computation of depreciation. The SFF is calculated for each asset class with the same economic life which in general is different from the life time considered for accounting purposes such as depreciation.

$$SFF_i = NRV_i * A_i$$

$$A_i = r / \{ 1 - (1/ (1+r)^m)\}$$

where

NRV_i = new replacement cost of asset group "i"

r = rate of return which is usually equal to the weighted average cost of capital

m = economic life of group of assets "i"

The total annual capital cost component to be included in the allowed revenues is obtained by adding SFF_i over all the asset groups of the reference utility.

B. Regulatory Measures

The objective of regulating the utilities is to ensure that the pursuit of profit does not conflict with social welfare. Therefore, regulation mechanisms aim to ensure socially desirable outcomes when competition cannot be ensured to achieve socially desirable outcomes. As explained in Section II, there are incentives for privately operated utilities to overestimate costs and pass them on to consumers. Moreover, public utilities usually do not have incentives to cut down costs. Therefore, continuous monitoring of utilities is required, especially when the tariff is set to recover financial costs. Utilities should be encouraged to keep systematic accounting and frequent auditing, preferably by independent third parties. In addition to these activities, some selected indicators that reflect outputs/processes, productivity/efficiency, and assets of the utility should be monitored to assess whether the utilities operate efficiently. Monitoring by external agencies such as regulatory bodies also reduces chances for information failures.

There are many indicators available to monitor the performance of public utilities, in terms of productivity and efficiency, such as: (i) unaccounted-for-water, (ii) cost of a cubic meter of water delivered, (iii) water quality, (iv) days without service for various types of customers, and (v) number of system breaks per kilometer of pipelines. Customer service quality can be monitored by: (i) restoration rate of repairs; (ii) percentage of repairs that do not fail within the year; (iii) number of complaints per 1,000 customers per month; and (iv) consumer satisfaction survey ratings. In certain situations, rate of return is calculated based on assets. Therefore, monitoring the changes in length of installed pipes, water processing capacity, number of employees, and employer education and experience over time is useful. Sometimes, financial and technical due diligence could be costly, ineffective and result in corruption too. Despite these difficulties, there should be some mechanism to track down the performance of the utility when tariff is not optimal.

The economics of regulation is a vast subject and what is discussed in this paper cover only a few major points. The most important problem faced by a regulator is information asymmetry. The regulator does not know whether the firm is using an efficient input combination to produce the output. Generally, utilities face incentives not to provide true information to the regulator. This forces the regulating body to use an incentive system that will ensure socially optimal outcomes. The following subsection briefly describes the different methods of regulation and potential outcomes under each regulatory system. Understanding the behavior of the firm under different systems of regulation enables the regulator to ensure that utilities will behave in a socially optimal manner.[17]

1. Rate of Return Regulation

Under this type of regulation, the firm is allowed to earn a predetermined "fair" rate of return. The rate of return is estimated based on the firm's capital investment. The firm is free to choose its price, output level, and inputs as long as it does not exceed the fair rate. Under this type of regulation it can be shown that: (i) the regulated firm uses inefficiently higher capital-labor ratio; (ii) the firm may produce less output and charge higher prices; and (iii) the firm will always produce in the elastic portion of the demand curve. Although the firm uses an inefficient mix of inputs, it produces as much as possible from each input employed; therefore, there is no waste incurred in inputs. Overall, the ROR regulation system provides incentive for the firm to increase its capital base unnecessarily making it costly for the consumers. The regulator's goal is to induce the firm to produce more output, decrease price, and produce at minimum cost. Under ROR regulation cost may not be minimum while there can be higher prices and lower level of outputs. Empirical evidence supports the above described theory[18] and cost recovering tariff under a ROR regulatory system may lead to higher inefficiency and consumer welfare losses.

[17] Readers interested in the economics of regulation may refer to Train (1997) for details.

[18] Averch and Johnson (1962) developed this theoretical model of ROR regulation, which is popularly known as A-J model. Courville (1974) studied the effect of rate of return regulation on the allocative efficiency of electricity generation firms. Of the 110 electricity generation plants studied, 71 showed the predicted impact of higher capital–labor ratio. He further demonstrated that the cost of some of these firms can be 40.6% higher than the minimum. On average ROR regulated firms had 11.4% higher costs.

2. Return on Output Regulation

Under the return on output (ROO) system of regulation, the utility is allowed to earn a certain amount of profit on each unit of output it sells. The firm is free to select its inputs, output levels, and price as long as its profit does not exceed the allowed amount per unit of output. Under this system of regulation, the firm is predicted to produce more output than an unregulated (monopoly) firm. The firm also chooses an efficient input combination for its level of output and does not waste inputs. When the regulator sets the return on output at sufficiently low level, firms tend to expand its output.

3. Return on Sales Regulation

The firm is allowed to earn a certain amount of profit on each unit of revenue. The return on sales (ROS) regulation is common when revenue collection is very low because it provides incentive for collecting revenue. In the region in which the marginal revenue is positive, the firm's behavior is exactly the same as in the ROO regulation. However, in the segment of the demand curve where demand is inelastic (and hence marginal revenue is negative), ROS regulation will produce different results from that of ROO regulation because expanding output provides higher profits under ROO regulation while profit decreases in the same region under ROS regulation.

4. Return on Cost Regulation

Under this regulatory system, the firm is allowed a certain amount of profit on each dollar it spends. The firm's behavior is similar to a firm under ROS regulation. The firm expands output using the least-cost path but not enter into the inelastic portion of the demand curve. The reason for this behavior is different from that of a firm under ROS regulation. Under this regulatory system, the firm is allowed to increase its costs to gain more profits. So long as the marginal revenue is positive, the firm increases its output (hence the costs) and earn more profits because marginal cost is less than marginal revenue. However, at the point at which marginal revenue becomes negative, the firm has the incentive to increase costs without increasing output. At this point, the firm starts to waste inputs.

In addition to the above basic types of regulation, there are varieties of other types of regulatory mechanisms such as price cap regulation, cost indexing, and incentive rates of return (Mann 1993). Price cap regulation, by unbundling rates from costs, provides incentive to the utility to increase productivity (thus reduce costs) while at the same time providing temporary consumer protection. Cost indexing generally involves automatically increasing tariffs on the basis of a specified cost index such as consumer price index. The incentive rate of return allows the utilities to earn a premium return on investment if it proved to be efficient by a predetermined standard. For example, if the unit costs are below some predetermined standard, the utility is eligible for premium rate of return.

The above described regulatory systems are supposed to provide incentive to the firms so that they would behave optimally. As mentioned earlier, one of the main problems in implementing these regulatory measures is information asymmetry—the firm knows more about its operations and costs than the regulator. Some simple and practical measures have been proposed by economists to overcome this problem. One such noteworthy mechanism is the Vogelsang-Finsinger mechanism (V-F mechanism). The V-F mechanism can be started at any point in time. In this dynamic approach to regulation, any reasonable price can be charged at the initial period. The regulator can observe the price, cost, and output of the utility. In the second period the regulator instructs the utility so that it can charge any price in the next period so long as the next period's price when multiplied by the first period's output does not exceed the first period's cost. Vogelsang and Finsinger (1979) showed that such a simple approach will enable the regulator to induce the firm to gradually approach Ramsey pricing without knowing them.[19]

Some of the regulatory measures described above seem promising as they force the utilities to operate efficiently. Although they are promising in theory, their application in the real world is far from optimal. There is a growing literature documenting areas of extensive waste, mismanagement, missed opportunities, and other social ills and governance problems associated with regulatory mechanisms in practice. Some authors[20] have even argued that the existence of a natural monopoly itself is not a necessary and sufficient justification for regulation. Therefore, proper assessment of the institutional capacity, overall governance, and law and order situation in a country have to be studied to understand the potential success of the regulatory measures. As suggested by Mann (1993) regulatory costs should be weighed against consumer benefits to ensure that the regulatory process improves social welfare.

Some authors who do not have much faith in the regulatory process argue that competition among many firms brings about the optimal behavior of firms even under natural monopoly situations. Here, competition is supposed to be not among the firms that actually produce the service but rather among firms who could produce. Even under natural monopoly situations numerous firms could produce the service. Pressure from these potential producers forces the monopolists to produce at the least cost and price the service as low as possible. If the regulator has the power to decide which firm among many will produce the good, the regulator can auction the franchise to produce the service. In the auctioning process, the firm should provide a price that the firm agrees to charge the customers. The regulator can select the firm that offers the lowest price. The winning firm becomes the monopolist who provides the service. This concept can be applied to various segments of a service such as water purification, transmission and distribution, billing, and other customer services. After unbundling the service the auction can be undertaken for one or more segment for which there is a large number of firms who can compete. There are some innovative approaches to introduce even direct product competition in water supply such as inset appointments, broader line completion, and common carriage (see Gunatilake and Carangal–San Jose 2008 for details). Tariff setting is one way to approach economic efficiency, but it is not an easy way to ensure efficiency. Therefore, some other feasible measures to introduce competition under a natural monopoly situation deserve due attention of policy makers.

[19] Train (1997) provides an excellent discussion on the V-F mechanism.
[20] See Demsetz (1968), Posner (1972), Baumol et al. (1977), Baumol (1982), and Sharkey (1982) for details.

IV. TARIFF SETTING IN PRACTICE

A. Use of Marginal Cost Pricing

This section synthesizes the financial and economic aspects of tariff setting discussed earlier prior to discussing practical aspects of tariff setting. As shown earlier, adding a fixed charge to the tariff provided the basic modification required for the simple MCP rule to ensure financial sustainability of a utility under the natural monopoly situation. The initial formulation of the constrained welfare maximization problem to meet the RR showed that the optimal price deviates from MC (Ramsey 1927). The magnitude of deviation is inversely related to the price elasticity of demand. This modified pricing rule is known as Ramsey pricing. There are other modifications to amend the basic pricing rule to accommodate various other goals and issues pertaining to public utility service pricing. These variations are discussed very briefly here before initiating discussion on tariff setting in practice. The interested reader may refer to Russell and Shin (1996a) for a succinct discussion on the modified pricing rules.

After the Ramsey (1927) modification, another important extension to the basic pricing rule was introduced by Feldstein (1972) in order to address a problem created by the fixed charges in tariff. Fixed charges are independent of the consumption level and as such serve as a head tax on consumption. Incorporating different social weightings for different income groups, Feldstein derived his modified pricing rule—the so-called Feldstein pricing. His results show that the optimal price should exceed MC unless individual demands are independent of income. Environmental externalities and depleting resource stocks have also been becoming important development issues in recent times. Therefore, another set of modifications are required to the basic pricing rule to accommodate environment/natural resource issues in utility tariff setting.

Many utilities such as gas and electricity face demand that consistently rise during certain peak periods. Given that these utilities are often capital-intensive and face capacity constraints in the short run, price must be used to balance peak demand with existing capacity until the new capacity can be added. If the capacity is chosen to suit peak period demand, then there is excess capacity in off-peak periods. Under such circumstances, the pricing rule should be amended so that the price equals SRMC in the off-peak period and LRMC in the peak period. This is the basic principle underlying peak load pricing. In the case of domestic water supply, higher demands prevail during summer. Water tariff during the summer months should be adjusted appropriately in order to manage excess demand. In the case of electricity, the peak demand occurs during certain times of the day and seasons in countries where electricity is used for heating and air conditioning.

Despite their theoretical soundness, most of the modified pricing rules to accommodate various concerns of utility pricing have not been frequently applied in tariff setting, except for peak/off-peak tariffs in electricity, telecommunications, and transport services, and seasonal pricing of water supply. This lack of popularity of sophisticated pricing rules is largely due to practical difficulties to apply them in real world situations. Even the very first modification, Ramsey pricing, is considered as "red herring" by some authors (Russell and Shin 1996a). As discussed so far in this paper, despite the importance of applying the strict short-run MCP, it is difficult in practice under natural monopoly situations. Even though simple and elegant, the classical theory of marginal costs does not provide practical insights to apply them in utility tariff setting (Russell and Shin 1996a). Economists' abstract way of thinking about costs in terms of static, timeless concept with continuous cost functions are of limited value in the practical use of the concept in setting tariff (Turvey 2001). In the real world context, as Turvey (2001) asserts, what the regulator often encounters is a system that already exists, with an accumulated collection of assets whose accounting costs reflect past prices, past circumstances and arbitrary conventions about depreciation. Frequently for most utilities, what is known is a contemplated set of possible capacity expansions over the planning horizon. A pragmatic response to this situation has been to try to find ways to approximate MC that can be applied in a defensible way to make real utility pricing decisions.[21]

AIEC has been the popular approximation to LRMC in the WSS sector. The concept can also be used in transmission and distribution[22] of electricity as suggested by Munasinghe (1979). Its advantages are the smoothening effect on prices, practical feasibility of usage with available data, avoiding consideration of sunk costs in tariff calculation, and enabling a forward-looking approach to capacity expansion and its requirement for a least-cost expansion plan. However, applying AIEC in many countries is practically not feasible when there are no proper plans for future expansions. In developing countries the enabling policy and institutional framework are often not in place and chronic capacity and data deficiencies prevent application of sophisticated approaches to tariff setting. Furthermore, the public belief in some countries that access to utility services such as water is a fundamental right and should be provided free of charge makes it difficult to even introduce any tariff, let alone the sophisticated pricing rules. Under such circumstances, tariff setting can be initially approached from the financial side with the objective of recovering the cost. The following discussion focuses on the practical aspects of tariff setting in the WSS sector.

Emphasis on cost recovery in the WSS sector, while overlooking possible economic inefficiency in setting tariff seems to originate from pragmatism. Implementation of sophisticated tariffs to meet a number of social objectives becomes impractical when political economy is not conducive and institutional capacity is weak. ADB's tariff studies in the water sector reflect this reality to a large extent. For the period 1977–2006, ADB has commissioned a total of 35 studies on tariff setting in various sectors.[23] Of the nine water tariff studies, four were conducted for Southeast Asia (Indonesia, Lao People's Democratic Republic, Thailand, and Viet Nam) while the rest were undertaken for the People's Republic of China. The outcome of these studies led to the formulation of guidelines in identifying objectives for tariff setting, designing a methodology for calculating tariffs, developing institutional capacity to implement tariffs, and in some cases, improving revenue collection. Cost recovery seems to be the overriding objective of many ADB tariff studies in the WSS sector. In these studies, full cost recovery meant meeting operating and maintenance costs and capital costs.

Despite its importance as an objective for setting tariffs, economic efficiency is explicitly referred to in only five of the water tariff studies. Many of these studies argue that it is practically difficult to estimate LRMC, which reflects all economic costs associated with providing water or wastewater treatment; whereas one study (ADB 1997b) cited that the use of the average incremental cost (AIC)

[21] Russel and Shin (1996b) provide a comparative analysis of available approximations to LRMC. Turvey (2001) illustrated excellent examples of estimation of MC for various utilities such as electricity generation, electricity transmission, electricity distribution, water supply, and gas transmission.

[22] However, the LRMC of generation of electricity is generally defined as the cost of advancing future plants or inserting new units such as gas turbines or peaking hydro plants.

[23] Of this total, 17 were done for the energy sector; nine for water supply, sanitation, and waste management sector; seven for transport and communication sector; and one each for agriculture and natural resources sector; and law, economic management, and public policy sector.

cannot be uniformly and practically applied particularly for multiwater systems. Moreover, there are concerns that in order to achieve economic efficiency, tariffs will need to be raised at levels that poor households could not afford or may not be willing to pay. When practical realities make it difficult to set optimal tariffs to achieve both financial sustainability and economic efficiency, ensuring financial sustainability can be given priority at the initial stages. However, the ultimate goal of tariff setting should be to achieve both financial sustainability and economic efficiency. The next subsection presents a gradual approach to setting the water tariff—initially focusing on cost recovery, and later advancing the tariff to meet both cost recovery and economic efficiency as policy and institutions mature to an enabling level.

B. A Gradual Approach

Utility tariff setting has advanced over time but there are large differences in achievements between developed countries and developing countries. These differences are also significant across sectors. For example, tariff setting in the electricity and telecommunications sectors in many developing Asian countries depicts an advanced stage. Financial sustainability in these sectors has been successfully achieved. In contrast to the good performance in these sectors, tariff for household water supply and sanitation has shown mixed performance. Some developing Asian countries struggle even to introduce some tariff, let alone achieve cost recovery/economic efficiency. As a point of departure, one should view some tariff as better than no tariff in difficult circumstances. In such instances, it would be wise to adopt a gradual approach by initially setting the tariff at a level that will enable recovery of operating and maintenance expenses.

At the next stage, the tariff can be revised to include capital charges. Including capital charges may require a big increase in tariff, thus, it could be done in a few steps. Before introducing capital charges, certain supplementary measures are needed to prepare the public to accept tariff increases. One of the reasons for the public's reluctance to accept a tariff increase is the poor governance and service quality of the public utilities. Therefore, introduction of tariff to recover the operating and maintenance costs (in situations where service is free of charge) should be accompanied with additional measures to improve governance and service quality. Such improvements will lead to enhanced rapport between the public and the service utility. Consumers should feel that their payments have given them better service in return. Moreover, proper participatory consultation process should be used to explain the need to increase tariff. Assessment of WTP for improved services will greatly facilitate the consultation process as well as provide necessary information for designing the tariff (Gunatilake et al. 2006 and 2007).

The impact of the tariff increase on the poor is another important aspect the tariff reformers should pay attention to. Reluctance and lack of political will to increase tariff to cost recovery level is rooted in the belief that tariff increase will adversely affect the poor. A properly designed social safety net including subsidized connection charges,[24] if appropriate, has to be in place to ensure that tariff increase will not adversely affect the poor. As tariff setting advances further, regulatory mechanisms become important. Therefore, establishing a regulatory agency or reforming the existing agency deserves the attention of the tariff reforming process.

[24] Monthly charges are generally affordable to the poor. However, connection charges could have adverse impacts, which should be carefully considered in designing safety nets.

Improving governance, service quality, and enhancing the social safety net and regulatory mechanism should continue for a while to further enhance the rapport between the utility and the public before undertaking further tariff reforms. This process should also result in reduction in water losses, efficiency of the utility in the production and distribution of water, and expanded service coverage to ensure adequate revenue base. Once the public is assured that tariff increases will directly benefit them in terms of improved and more reliable service, the next level of tariff reforms can be implemented. When significant improvements are observed, profit can be added to the tariff so that full cost recovery can be realized.

Having achieved financial sustainability, tariff setting can be advanced to the next level to consider economic efficiency. As explained earlier, tariffs set to recover cost may not necessarily align with economic efficiency. Therefore, tariff reform should attempt to calculate a suitable proxy for LRMC and set the tariff at this rate. Cost recovery on a sustained basis, a mature regulatory process, availability of a least-cost expansion plan, and adequate capacity of the utility to implement a sophisticated tariff system should be in place by this time. A two-part tariff system can then be introduced. A user charge set at AIFC and a fixed charge independent of the level of consumption should be added to ensure cost recovery. At this level the information on the revenue requirement of the utility to set the fixed charges is readily available and the tariff will ensure both economic efficiency and financial sustainability.

Once the two-part tariff system is successfully in operation, further reforms can be introduced to achieve broader social objectives. Seasonal pricing to accommodate peak load demands, zonal pricing to adjust for zonal marginal cost differences, conservation surcharges to provide incentives for water conservation, and system development charges from new customers for financing the expansion are potential avenues for further improvements to the two-part tariff system (see Mann 1993 for a good discussion on these aspects of water tariffs). Proxies like AIEC do not usually consider all the costs attached to the provision of service. Therefore, at this level a closer look at MC with the question of "MC to whom?" in mind is necessary. The MC is conventionally defined from the perspective of private individuals or agencies—so-called marginal private costs (MPC). Therefore, at this stage the MC concept should be broadened to include marginal social costs. Marginal social costs consider costs to the economy as a whole, and it is equal to MPC plus any MC imposed upon others less marginal benefits conferred upon others. At this level of sophistication MC (marginal opportunity cost, MOC) can be defined as:

$$MOC = MPC + MUC + MEC$$

where

MOC = marginal opportunity cost

MPC = marginal private cost (AIEC)

MUC = marginal user cost

MEC = marginal environmental cost

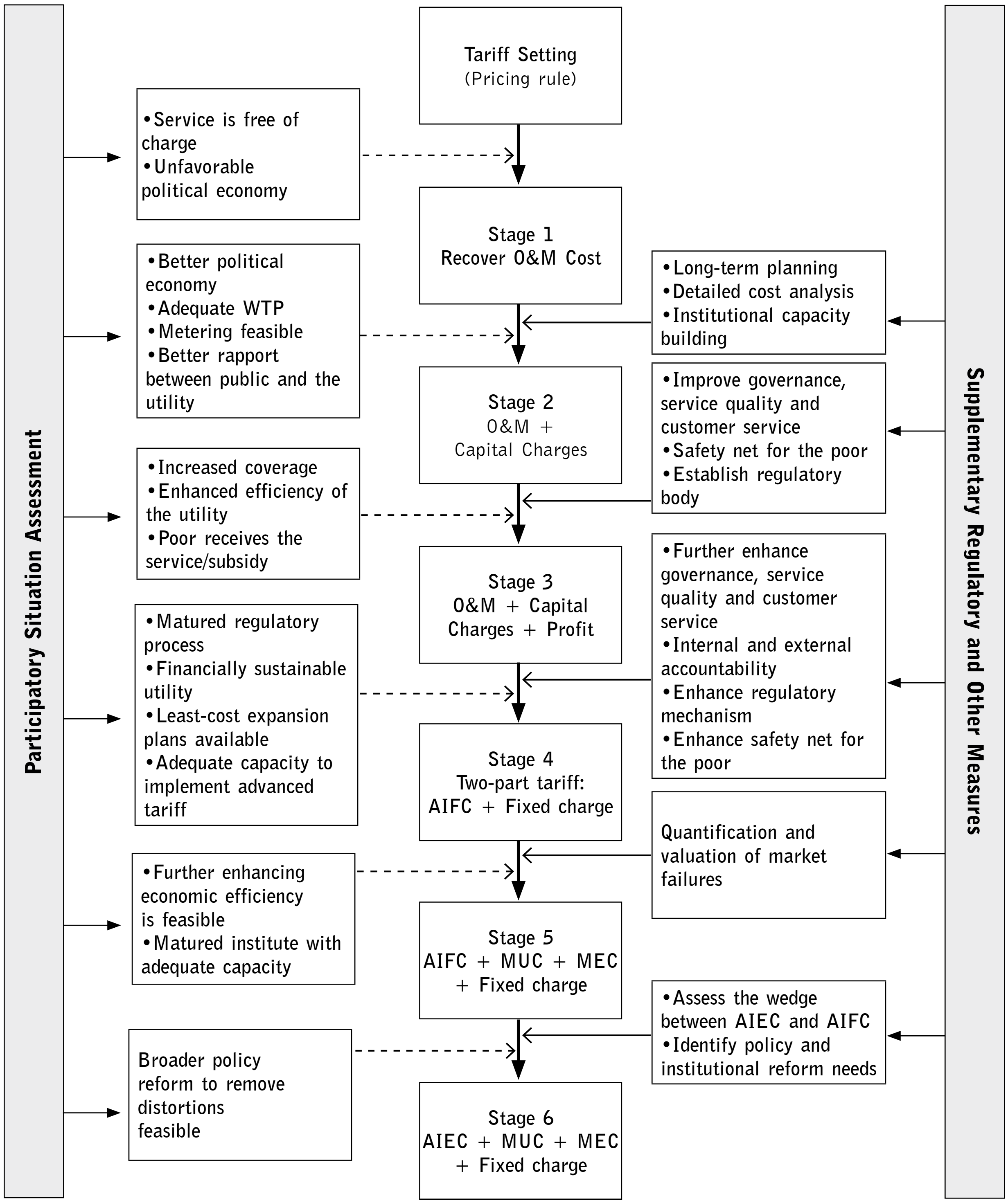
The marginal user cost (MUC) becomes important when ground water is used as the source of raw water. If the rate of extraction exceeds the rate of replenishment, the raw water source becomes an exhaustible resource. In order to provide the correct signal to the consumer, the user cost—present value of future cost increases—has to be added to MC. The other important element of the social opportunity cost is the marginal environmental cost (MEC). Upstream or downstream environmental externalities need to be quantified and added to the cost. Quantification and valuation of environmental damages require a higher level of technical competence and are data intensive. Therefore, incorporation of the MUC and MEC is realistic only at advanced stages in tariff setting.

As mentioned earlier, AIFC has to be used instead of AIEC in tariff setting. AIEC should be calculated using appropriate shadow prices to check how far the AIFC is from the economic efficiency point, i.e., AIEC. A large difference between AIFC and AIEC is an indication of large distortions in the economy. Such distortions arising from various government interventions and existence of market failures are indications of the need for policy and institutional reforms and internalization of externalities. These cannot be corrected by using the tariff as they require broader policy reforms in the economy.

The gradual approach depicted in Figure 3 provides a number of important messages. First, as described above tariff setting should be viewed as a continuous process rather than a one time deal. Second, a detailed analytical work should be undertaken prior to any tariff reform. These analyses should be participatory and transparent. At a given time in a given country, such assessment should indicate what type of tariff is practically feasible. The boxes on the left in Figure 3 indicate basic necessary conditions to introduce different levels of tariff. Third, before advancing to the next stage, necessary policy reforms, institutional capacity building, and regulatory enhancements should be undertaken. These requirements are identified in the boxes on the right. Fourth, stage six should be viewed as idealistic as one may never find an economy free of any distortion.

In many Asian countries, overall economic policies, institutional capacity, data availability, etc., may allow only cost recovery as the objective of tariff setting. For example, many South Asian countries may be in Stage 1 of tariff setting (Figure 3) in water supply and sanitation. As explained above, this situation should be gradually changed to enable more advanced water tariff that meets broader social objectives. Until policy and institutional maturity and awareness of the public is built to enabling levels, the tariff must remain at a partial cost recovery level. While continuous assessment and supplementary measures as indicated in Figure 3 are taken, the public utilities should be properly monitored to ensure that they operate efficiently, i.e., with minimum cost. There are two ways to achieve this: (i) through financial and technical due diligence, and (ii) through proper regulation. Private sector participation in certain suitable sections of the service is another avenue for increasing efficiency.

FIGURE 3
A GRADUAL APPROACH FOR SETTING TARIFFS



AIFC = average incremental financial cost, MEC = marginal environmental cost, MUC = marginal user cost, O&M = operations and maintenance, WTP = willingness-to-pay.

V. CONCLUDING REMARKS

This paper reviews the literature on utility tariff setting with an emphasis on economic efficiency and financial sustainability of the utility. The merits as well as limitations in applying the economic efficiency criterion in setting tariff are discussed first. Then the paper discusses the issues related to estimation of revenue requirements to design cost recovering tariff. The review provides meaningful insights to utility tariff setting in practice.

To what extent the tariff can achieve economic efficiency and financial sustainability depends on the prevailing policy, institutional capacity, and overall governance situation in a country. When the situation is not conducive for an optimal tariff that meets all the desired goals, the paper suggests using the gradual approach. Under such circumstance, tariff can be set to recover only operating costs and gradually advance to include broader objectives. Success of this type of step-by-step approach depends on two factors: (i) participatory and consultative assessments and rigorous analytical work on the enabling conditions to implement a particular type of tariff; and (ii) supplementary measures such as policy reform, institutional capacity building, regulatory enhancements, and performance improvement of the utility to create an enabling environment for advancing tariff to the next stage.

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About the Paper

Herath Gunatilake, Pradeep Perera, and Mary Jane F. Carangal-San Jose review the literature on utility tariff setting with an emphasis on economic efficiency and financial sustainability. The paper discusses the merits as well as the practical limitations in applying marginal cost pricing, and presents details on the estimation of revenue requirements of utilities. It also discuses issues related to reconciliation of economic efficiency and financial sustainability objectives in tariff setting.

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