WATER TARIFF DESIGN IN DEVELOPING COUNTRIES: DISADVANTAGES OF INCREASING BLOCK TARIFFS (IBTS) AND ADVANTAGES OF UNIFORM PRICE WITH REBATE (UPR) DESIGNS

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Abstract

Increasing block tariffs (IBTs), widely used in the developing world, are claimed to produce desirable income transfers, discourage wasteful use, promote economic efficiency, and assure access to sufficient water for basic sanitation. In fact, these claims are either excessive or incorrect. In practice, IBTs are likely to promote inefficiency, inequity, unfairness, net revenue instability, and other negative consequences. An alternative tariff design, a uniform price with rebate (UPR), is presented. A revenue-neutral comparison, using developing country data, shows the UPR to outperform the IBT on all counts, while avoiding certain undesirable aspects of IBTs.

I. INTRODUCTION

Increasing block tariffs (IBTs) have become the tariff structure of choice in developing countries. Multilateral donors, international financial and engineering consultants, and water sector professionals working in developing countries all commonly presume that IBT structures are the most appropriate way to determine water users' monthly bills. Most recent water tariff studies performed for developing countries propose IBT structures.

IBTs, like other block-type tariffs, provide two or more prices for water used, where each price applies to a customer's use within a defined block. Prices rise with each successive block. Some tariff structures have as many as ten blocks, each with a different price. The common characteristic of IBTs, as they are applied in developing countries, is that the first block price is deliberately set below cost, however cost may be defined. In the design of IBTs, much attention is given to the size and price of the first block.

The widespread consensus on the wisdom of IBTs deserves more careful examination than it has received. Even at first glance it appears somewhat curious because, although IBT structures were first designed in industrialized countries to assist poor households through revenue neutral cross-subsidies, they are now used by only a small minority of water systems in countries like the US.[1] The fact that IBTs have grown in popularity in developing countries while playing a minor role in industrialized countries could be due to differences in water and sanitation conditions, but it is not obvious why this should be so. In many cities in developing countries the majority of poor households do not have private metered connections to the water distribution system, and thus are not in a position to be helped by IBTs.

The objective of this paper is to critically examine the current fashion of using IBTs in developing countries. In the following section, we review the common arguments made to justify the adoption of IBTs, and present some actual IBTs currently in use in selected cities. In the third section of the paper we discuss the objectives and considerations involved in water tariff design so as to provide a basis for judging the appropriateness of IBTs.

In the fourth section we examine five problems and limitations of IBTs that have not been sufficiently appreciated by practitioners: (1) the inability of water utilities to limit the size of the initial block for residential users due to political and other pressures; (2) the difficulty of confronting users with the proper economic incentives without large departures from marginal cost pricing for some users; (3) the difficulty in raising revenues to meet a financial (cost recovery) constraint without large departures from marginal cost pricing due to lack of knowledge of household demand; (4) lack of transparency and difficulty of administration; and (5) problems posed when a household with a metered connection supplies unconnected neighbors or vendors. The fifth section compares a simple IBT structure with a tariff based on a uniform volumetric price coupled with a lump sum rebate (UPR), and illustrates the important advantages of the latter. Finally, we offer some concluding observations.

II. BACKGROUND

A tariff structure is a set of procedural rules used to determine the conditions of service and the monthly bills for water users in various categories or classes. A water user's monthly bill may include two distinct components: a part based on the volume of water used, and another part based on factors other than water use. Conceptually either of these components could be zero and the water bill determined solely by the other. For example, a water bill could be based on the value of the property on which the connection to a municipal distribution network is located; in this case the water bill would have no relationship to the volume of water used. Alternatively, a water bill could be determined by multiplying the volume of water used in a billing period by a per-unit price; in this case the nonuse component would be zero. An example of a tariff incorporating both components (a two-part tariff) would be a fixed monthly charge plus an amount equal to the volume used times a per-unit charge.

An IBT structure is a specific form of the volumetric component of the tariff. It may or may not be accompanied by a nonuse component. A water user in a particular use category (e.g. residential) is charged a unit price for the first units abstracted, up to a specified amount (this defines the end of the initial or first block). Above this amount, the user faces a higher price for additional units until a second specified amount is reached (the end of the second block), and so on until the highest (top) block in the increasing block structure. The user can typically abstract as much water as desired in this top (highest priced) block, but for each additional unit of water the bill increases by an amount equal to the highest price in the rate structure. Figure 1 illustrates actual IBT structures used for residential customers in six selected Asian cities.

In order to design an IBT structure, one must make three kinds of decisions for each category of water use.[2] First, one must decide on the number of blocks. Second, the volume of water use associated with each block must be determined. Third, the prices to be charged for water use within these blocks must be specified.

The IBT adopted by the municipality of La Paz, Bolivia, in conjunction with the local water utility (SAMAPA) and the Bolivian national tariff board in 1997 is a good example of the kind of IBT structure now used in many developing countries. The tariff structure is depicted in Table 1 and exhibits several characteristics common to developing country IBTs. First, residential users face large price differentials between blocks. In this case the price in the most expensive block is over five times the price in the least expensive block. Second, domestic water users generally attract most of the attention of tariff designers, with the result that there are more blocks in the residential use category than in the commercial or industrial categories. In this example there are four blocks for residential connections, two blocks for commercial connections, and one for industrial connections. Third, the prices charged industrial and commercial users are much higher than those applying to typical levels of residential water use.

The use of such IBTs is widespread. In a survey of water utilities in cities in Asia, the Asian Development Bank (1993) found that the majority of utilities in their sample (twenty out of the thirty-two) used an IBT structure.[3] The global movement to privatization in the municipal water sector has not decreased the popularity of IBTs, despite strong reasons to expect that profit-seeking purveyors would prefer other structures. In bidding documents and requests for proposals, governments often require the private concessionaire to use an IBT.

There are several arguments commonly made in support of IBT structures. First, it is claimed that IBTs promote equity because they force wealthy households to cross-subsidize poor households. The argument (which assumes that all households have private, metered connections) is that wealthy households will use more water than poor households because water is a normal good and use increases with income. For example, high-income households use more water in part because they may have gardens, more water-using appliances, and cars to wash. The low price in the initial block means that the poor can obtain a sufficient quantity of water for their "essential" needs at a low monthly cost. High-income households pay a higher average price for water because a greater percentage of their water use occurs in the higher priced blocks.

Second, it is also commonly thought that the high rates charged industrial and commercial customers relative to most residential customers promote "equity" by allowing the water utility to cross-subsidize poor residential customers with revenues from rich industrial firms. Third, the argument is made that IBTs are desirable because the price associated with the highest block can be made punishingly high and thus discourage or stop "extravagant" or "wasteful" water use. It is thus felt that IBTs promote water conservation and sustainable water use.

Fourth, it is sometimes argued that IBTs are needed to implement marginal cost pricing principles. Assuming the marginal costs of municipal water supply are rising (due perhaps to increasing raw water prices or opportunity costs), presumably the rationale here is that if the price of water use in the most expensive block is set equal to marginal cost, then marginal cost pricing has been accomplished (Hall and Hanemann 1996). A more elaborated version of this argument is that an IBT is an optimal means of second best pricing, i.e., pursuing an economic efficiency objective subject to a cost recovery constraint (Porter 1996).

A variant of this fourth rationale is the claim that an IBT is needed to match a presumed rising marginal cost curve. It is argued that because marginal costs are expected to rise with total water use, prices should rise in the same fashion with respect to individual household use. Some multi-block designs, especially those with a relatively large number of blocks, have been justified in this way.

A final rationale sometimes offered in support of IBTs concerns the issue of public health externalities from the provision of potable water supply.[4] The argument is that the consumption of potable water by individuals in one household confers positive externalities on other households by reducing the risks of communicable diseases throughout the community. The existence of such positive externalities would argue for a subsidized price of water in order to "internalize" this externality. The flip-side of the argument is that high water prices (due perhaps to marginal cost or cost-recovery pricing) would reduce household water use and thus decrease these positive public health externalities.

III. Design of Water Tariffs

Water tariffs come into being in various ways. Sometimes the tariff is simply inherited from a prior period. If the existing tariff has not been controversial, and if no outside lending agency is pressing for change, water managers may choose to deal with current needs by making the smallest possible changes in the existing structure. In other cases, the tariff may be determined by a formula embodied in national legislation (e.g., Ukraine) which may also be administered and regulated by a national regulatory body (e.g., Colombia). These constraints reflect a social concern over the fairness of water tariffs, but they are rarely revised to account for changing circumstances or rising costs. Whatever the motivation, legislative and regulatory constraints often leave little opportunity for an individual water supplier to consider the broader issues of tariff design, at least in the short run.

Except for these special cases, water agencies must, from time to time, consider the proper design for the tariff. The process is often complex and can involve, in addition to the water agency itself, outside consulting firms, lending institutions, political leaders, various stakeholders from the user population, and sometimes local and/or national legislatures. Much of the complexity derives from conflicts among the various objectives and considerations that different parties bring to the discussion. The most common objectives and considerations are listed below.

Objectives

A water tariff is a powerful and versatile management tool. It is capable of promoting a number of objectives, although tradeoffs among them are commonly required. The usual objectives are described here, but it should be noted that not all parties to a tariff design effort embrace all objectives, and some may define individual objectives differently from what follows.

Revenue sufficiency. From the water supplier's point of view, the main purpose of the tariff is cost recovery. Before design can begin, there must be a decision as to how much revenue the tariff should recover. Tariff design, then, aims to achieve this target. To a large extent, this consists of setting the various prices and charges in the tariff at a high enough level, and has little to do with the other details of tariff design.

Economic efficiency. An efficient tariff will create incentives that insure, for a fixed water supply cost, that users obtain the largest possible aggregate benefits. A different, but equivalent statement of this objective is that for a given level of aggregate benefits from water use, the supply cost should be minimized. Generations of economists have insisted on the importance of this objective, and noted that it can be achieved by setting all prices equal to their relevant marginal costs.

Equity and fairness. These terms are often used either together or interchangeably. In fact, they have different meanings. Equity requires that equals be treated equally, and that unequals be treated unequally. In public utility tariff design, this usually means that users pay amounts which are proportionate to the costs they impose on the utility. Equity is thus a quantifiable proposition, subject to precise definition and verification. Fairness, on the other hand, is wholly subjective. Each participant in a tariff design process may have a different notion of the meaning of fairness. One may think it fair to set a high price for industrial water use, another may not. One may think it fair to charge all customers the same price (even when, because of cost of service differences, this is not necessarily equitable), while another may believe that fairness requires subsidies to some customers. A marginal cost-based tariff is expected to be equitable, but not necessarily fair.

Income redistribution. Although this objective may be considered part of fairness, it is so often explicitly stated that it requires separate treatment. Briefly, it is widely assumed in developing countries that utility tariffs should be used to redistribute income among groups of customers. IBTs, as usually applied, set a price below average revenue for the first block, with one or more prices above average revenue in the final blocks. This causes large water users (who pay more than average revenue) to subsidize small users (who pay less). Similarly, if industrial water prices are set above cost of supply and also above residential prices, then it is commonly assumed that income is redistributed from owners of firms to individuals.

Resource conservation. Water tariffs are often called upon to discourage "excessive" or "wasteful" uses of water, thus promoting the conservation of depletable sources, or the sustainable use of renewable water sources. If one assumes that large users of water are the most likely to engage in "excessive" or "wasteful" use, then the IBT design confronts those users with higher prices and thus discourages further use. This notion, of course, rests on the belief that only large users can waste water. It also assumes that these users are aware of the tariff design and of the significance of the various thresholds, and can respond accordingly.

Considerations

Other factors bear on tariff design, although they may be less fundamental and long-lasting than the objectives listed above. We refer to these as *considerations* to emphasize their lesser importance, while remembering that they are still very much on the table as alternative tariff structures are considered.

Public acceptability. A successful tariff design is one that is not controversial, or which does not serve as a focus of public criticism of the water supply agency.

Political acceptability. A tariff design that is objectionable to political leaders will lead to loss of political support and may cause increased political interference in the operations of the agency.

Simplicity and transparency. A tariff design should be easy to explain and easy to understand. It should be possible for most users to know what price they are paying for water.

Net revenue stability. When water use changes as a consequence of weather or economic conditions, revenue and cost should change by approximately equal amounts. When this does not happen, cyclical changes will result in net revenue volatility, creating cash flow and financing difficulties for the agency.

Ease of implementation. The promulgation and implementation of the revised tariff should not encounter significant barriers in terms of legal authority, administration competence, information requirements, or billing procedures.

IV. PRO-IBT ARGUMENTS REVISITED

The previous section listed six commonly stated arguments in favor of IBTs. The logic behind these claims can now be examined in the light of the conventional objectives and considerations of tariff design.

1. IBTs promote equity by creating desirable cross-subsidies. Cross-subsidies reflect notions of fairness, not equity, and are thus subject to a wide range of opinion. But even where the direction of the subsidy (e.g., from rich to poor households) is relatively uncontroversial, the limitations of this tariff characteristic should be kept in mind: (1) the maximum possible subsidy is small (the largest first block subsidy shown on Figure 1 is $2.96/month, most are much smaller[5]) and (2) it is blockwise regressive. The last point simply means that, in the case of the subsidy embodied in the first block price, it is necessary to use water through the entire first block in order to receive the full subsidy. Thus, as a household reduces its water use, its subsidy becomes smaller.

2. IBTs allow firms to subsidize individuals. Since separate tariffs are commonly used for separate classes of users, there is no need to employ an IBT in order to set industrial prices above residential prices. Furthermore, the desirability of creating such subsidies is dubious. This practice conflicts with the objectives of economic efficiency and equity, and it also applies the highest prices to those customers that are in many cases the most likely to exit the system. This may work to the long run disadvantage of residential customers as the water agency loses economies of scale in water intake, treatment, transmission and distribution provided by those large users who elect to exit.

3. IBTs discourage "extravagant" and "wasteful" use. Presumably "waste" refers to water used in a way that fails to provide a benefit commensurate with the resource cost of delivering the water. If the price is set equal to marginal cost, each user is required to pay the full cost of replacing each unit of water used. Economic theory holds that this is sufficient incentive to discourage wasteful use; a higher price merely creates inefficiency.

4. IBTs are consistent with marginal cost pricing. Economic efficiency is promoted when prices reflect the marginal costs of the services provided. IBTs result in different customers simultaneously paying different prices for the same service, the delivery of water. At most one of these prices can be equal to marginal cost. Whichever block price that is, a large number of customers will likely face different prices, either higher or lower. Marginal cost pricing requires a single price for all users with similar cost accountability (e.g., residential users), although that price may vary (for all users) according to time of use or location.[6]

5. IBTs are needed to match the rising MC of supply. Advocacy of this theory can only arise out of some basic confusion about the nature of costs and prices. Assuming that marginal costs do rise with increased aggregate use (they may remain constant or decline, as well), they do not rise perceptibly with any individual household's use. The role of the tariff is to present a user with the price equal to the cost of increased use **by that user**. There is only one such price at any given time. If all users increase water withdrawals over time, and marginal costs rise over time as a result, then the marginal cost price must also eventually rise, for all users, and for all use. A block-type tariff does not capture this relationship.

6. IBTs promote public health. The implicit assumptions behind the public health externalities argument are that (a) unconnected households are more likely to connect to a piped distribution system if an IBT is in effect, (b) the level of household water use among the lowest-income families will be greater in the presence of an IBT than for other tariff designs, and (c) the resulting increase in water use is significant with respect to public health externalities. In fact, there is no empirical evidence in the literature to support any of the three assumptions. Certainly water use increases dramatically when a household switches from a source outside the home (e.g., a handpump or well) to a private connection to a piped distribution system (White, Bradley, and White, 1972), perhaps from 20 liters per capita per day (lpcd) to 100 lpcd or more. Although available evidence is mixed, it is plausible to assume that this increase in water use generally confers some health benefits on the household (provided that it does not simultaneously create negative health externalities associated with wastewater disposal). There is little evidence that this increased water consumption confers health benefits on the wider community (Esrey, 1996;

Esrey et al, 1989). There is no evidence that households are more likely to connect to a piped distribution system if an IBT is in effect. Household connection decisions are more heavily influenced by the connection charge than by volumetric charges (Singh et al., 1993). But the argument in support of the health benefits from IBTs is even more tenuous. It is claimed that significant positive public health externalities will accrue to a community from connected households with private, metered connections increasing their water consumption in response to lower water prices on the first block of the IBT. To be more specific, this argument suggests that there are positive public health externalities from increasing per capita consumption in the range from, say, 100 lpcd to 120 lpcd, or alternatively from 75 lpcd to 85 lpcd. There is no evidence to suggest that such changes in water use result in either private health benefits to the household or positive public health externalities, nor is there any reason to think that this would be the case.

The usual rationale for employing an IBT design, then, is either incomplete (for cross-subsidies) or faulty. But it may be more important to examine issues that arise in the actual application of IBTs. Five such issues are discussed in the next section.

V. LIMITATIONS OF IBTS IN PRACTICE

Setting the Initial Block

It is possible to imagine an IBT structure that minimizes the conceptual problems mentioned above. It would be a two-step tariff, where the first block price is set below marginal cost and the second block price is equal to marginal cost. The size of the first block is set such that relatively few users terminate their consumption in this block. Then the regressivity of the subsidy would not be an issue, nearly all users would face the marginal cost price, and cross-subsidies would be limited to those who are generally considered the target of the redistribution.

However, the fact is that water utilities find it difficult to limit the size of the initial block for residential users due to political and other pressures.

The ability of an IBT to deliver on its promise of effectively targeting the poor depends on the tariff designer's success in setting the volume of water in the initial block equal to a household's essential water needs.[7] How much water does a poor household need? Internationally-cited standards for basic water needs are usually in the range of 25-30 liters per capita per day (WHO, 1997; United Nations, 1993; Gleick, 1996). For a household of five, this comes to 4-5 cubic meters per month per household.

The IBT structures used in most cities give households with private connections much more water than this at the lowest price. For example, of the 17 water utilities in the Asian Development Bank's data set that used increasing block structures and for which information was available on the size of the initial block, only two had a first block of 4-5 cubic meters per month or less (Table 2).[8] The majority of these utilities had initial blocks of 15 cubic meters per month or higher.

These data support the common observation that it is difficult for politicians and senior civil servants to restrict the size of the initial block of an IBT structure because a large initial block directly benefits not just the poor but also the middle and upper income households with private connections. Since in many cities the middle and upper income households have the majority of private, metered connections, it is often the case that such households receive the vast majority of water sold at the subsidized price. The size of the revenue loss associated with increasing the size of the initial block is generally not known. It is easy to assume industrial and commercial users will simply make up for any resulting budget shortfall.

Moreover, the amount of water a household "needs" for essential purposes is open to interpretation and debate. Because IBTs do not adjust the size of the initial block for the number of members of a household, one could argue that a volume of 4-5 meters per month does not meet the essential needs of a household with ten members. The political reality of most tariff setting procedures means that stakeholders or consultants participating in the process rarely pay attention to the adverse financial and economic efficiency consequences of expanding the size of this initial block.

The same political realities make it difficult to restrict the size of the middle blocks as well. For example, the IBT for La Paz, Bolivia shown in Table 1 permits a household to take 300 cubic meters per month before the highest price in the block structure takes effect. For a household with five members, this translates to 10 cubic meters per day, or 2 cubic meters per person per day--80 times the basic needs estimate of 25 liters per capita per day. These data suggest that in practice at least some IBTs are not performing as their advocates had anticipated.

Mismatch Between Price and Marginal Cost

The difficulty of confronting users with the proper economic incentives in the case of an IBT can be illustrated with the aid of Figure 2. This shows a cumulative probability density function for household water use in Soe, Indonesia, truncated at 50 cubic meters/month.[9] Suppose the strategy is to design a two-step IBT, with the second block price equal to marginal cost. In order to preserve the proper economic incentives, it is necessary that all or nearly all users terminate their consumption in the second block, where they will face the marginal cost price. Figure 2 indicates that this goal requires a very small first block, certainly not more than 5 cubic meters/month. But, as previously noted, political and consumer pressures make it difficult to set such a small first block. More typical block sizes, in the range of 10 to 20 cubic meters/month, would result in 30 to 75 percent of households seeing the artificially low first block price as the cost of water. This problem is exacerbated by multi-block designs, where the price closest to marginal cost may be at the third, fourth, or fifth block.

Revenue Sufficiency vs. Economic Efficiency

All tariffs have a revenue recovery function, even those designed to address other objectives. The most basic design criterion is that the tariff produce a particular stream of revenue, ranging from the full long run cost of operations down to a more modest partial share of variable operating cost. Designing an IBT to produce a specified revenue stream leads to two significant difficulties: (1) utilities typically lack the information about user demand needed to predict the revenue that any particular IBT will produce, and (2) compromises between revenue collection and economic efficiency objectives may further distort other functions of the tariff.

Forecasting the revenue that an IBT will produce, even approximately, requires knowledge of the probability distribution of water use under the former tariff (similar to Figure 2, but for all customer classes) and some way to estimate the price elasticity of customers at different points in that distribution. This information is almost never available for cities in developing countries. What may be available is a water use estimate for each customer class and a plausible estimate of overall price elasticity for the class. This information is sufficient to forecast the revenue produced by a single price tariff, but can lead to large errors in the case of multiple blocks.

The second issue pertains to the oft-cited claim of a conflict between revenue sufficiency and economic efficiency. It is usually argued that, where marginal cost pricing produces too much or too little revenue, prices can be adjusted in a way that meets the revenue constraint while minimizing the inevitable loss of economic efficiency. This type of adjustment is often called Ramsey pricing (Ramsey, 1927). Some authors, such as Porter (1996) have further claimed that IBTs can achieve an optimum balance between the two objectives. Porter provides a mathematical appendix which he represents as proving that, where additional revenue must be raised, an optimal departure from marginal cost pricing can be achieved with a two-block IBT.

Porter's conclusion seems counterintuitive in the light of the usual assumption that larger water users (e.g., upper income households) have a higher price elasticity of demand. A common characterization of Ramsey pricing is that it assigns the highest prices to the least elastic users, which in the case of residential water use would be the small users (e.g., poor households). This would contradict an IBT. But a closer inspection of Porter's derivation shows that his assumed linear demand curves actually make the demands of the poor more elastic than the rich, a highly implausible circumstance. Thus his conclusions as to the optimality of IBTs are unfounded.

But there is a more fundamental problem with both the Porter and the Ramsey approaches. Both assume that all revenue must be recovered from the volumetric charge. This is not true for public utility services (Ramsey's work has more often been applied to agricultural commodities). Rather, it is possible to levy a fixed charge, which in principle could be either positive or negative, as a means of adjusting revenue recovery. This possibility renders the "optimal departure from marginal cost" literature moot, as demonstrated later in this paper.

Simplicity, Transparency, Implementation

IBTs have achieved some degree of public and political acceptability, perhaps because they have been so routinely applied. But they are certainly not simple or transparent. With a typical IBT, it is impossible for all but the most analytical and determined user to deduce the average or marginal price that is actually being paid for water. The kind of price signal that most customers rely on (the change in total bill that results from a conscious change in water use habits) becomes misleading and confusing when the resulting water use moves from one block to another. This is an important point because when customers cannot detect a coherent price signal, they cannot respond as expected.

Perceptions of fairness may also be affected by the use of IBTs. When a tariff cannot be easily understood, it is easy to imagine that it incorporates unwarranted advantages for favored users. Complex tariffs may create customer relations problems, making it difficult for water agency representatives to explain bills or changes in bills to customers. IBTs are more difficult to implement. Also, because of the nature of the assumptions embodied in block size and block prices, a conscientious water agency would need to revisit the design details at intervals in the future. Conversely, a tariff with a single volumetric price is simple, transparent, equitable, robust, easy to implement, and creates understandable and consistent price signals.

Shared Connections

A final, serious problem with IBTs has been noted in the literature (Whittington, 1992). IBT structures can only work as their proponents advocate if each household (rich or poor) has a metered private water connection. In fact, in many cities in developing countries this condition is not met. Private, metered water connections are often only available to upper and middle income households; the poor must obtain water through shared connections, from neighbors with private connections, from water vendors, or from other sources. If several households share a metered connection and an IBT is in effect, water use by the group quickly exceeds the volume in the initial block, pushing water use into the higher priced blocks. To the extent that households sharing water connections are more likely to be poor than households with private connections, the IBT will have precisely the opposite effect from that intended: the poor will pay higher average prices for water than the rich.

A second, related problem with IBTs arises when many households do not have private, metered connections. Households with private, metered connections will often sell water to neighbors without connections or to water vendors who resell to unconnected households. If a household sells water to more than a few neighbors or vendors, the water volume billed through its metered connection will be pushed into a high priced block. This single household faces the same situation as households with a shared connection: the more water sold, the higher the average price. In this case a rich household with a metered connection can capture the benefits of the first block price, and then charge neighbors or water vendors a price that will recover the highest per unit charge in the IBT plus some markup for the inconvenience of selling water. Once again, the poor pay more than the rich.

It is possible to address this limitation of the IBT by increasing the amount of water sold at the first block price to account for the number of households sharing a private metered connection. But this kind of detailed oversight is time-consuming and subject to corruption. It requires an ability on the part of the water utility to fine tune household billing in a way that is often impractical, and conflicts with the goal of having a water tariff that is transparent and easy to administer.

VI. The UPR Tariff: A Practical Alternative to IBT Structures

If the marginal cost of supplying water exceeds the average cost, perhaps due to the increasing opportunity cost of raw water, setting price equal to marginal cost results in excess revenues for the water utility. In this case an important political issue in tariff design is how to achieve economic efficiency without collecting too much revenue. IBTs would appear to be one way of doing this because users in the highest blocks could be confronted with the marginal cost for only the last units of water used. However, a tariff in which a households' water bill is based on (1) a volumetric charge set equal to marginal cost, and (2) a fixed monthly rebate (negative fixed charge), can also result in lower revenues while fully preserving marginal cost pricing.[10] This alternative, the uniform price with rebate (UPR) structure, offers important advantages over an IBT.

Consider a situation in which the marginal cost of water supply is US$1.00 per cubic meter. Table 3 presents a comparison of monthly water bills for a household under two alternative tariff designs: (1) an IBT with two blocks: a charge of US$0.50 for the first fifteen cubic meters, and a charge of US$1.00 per cubic meter for quantities above fifteen cubic meters; and (2) a UPR tariff consisting of a single volumetric charge set equal to the marginal cost, coupled with a monthly rebate of US$6.69. Furthermore, to avoid zero or negative bills, both tariffs incorporate a minimum monthly charge of US$2.50. The amount of the rebate has been chosen so that the two alternative tariffs produce the same total revenue, when applied to a water use distribution similar to that shown in Figure 2. The differences between the tariffs lie in the size of individual bills and in the water use incentives created for various kinds of households.

With either tariff design, the presence of a minimum charge causes households to face a zero price for water at very low levels of use: below five cubic meters per month for the IBT and below nine cubic meters for the UPR tariff.[11] However, with the IBT, households do not face the full marginal cost of water supply until they use fifteen cubic meters per month or more. The UPR tariff, on the other hand, confronts all customers using more than nine cubic meters with the full marginal cost of water--US$1.00/cubic meter. Yet, for small users, the UPR tariff often produces smaller total bills. This is illustrated by an incidence analysis, depicted in Figure 3. Again based on the water use distribution of Figure 2, this indicates that some 48 percent of all households, specifically those with low water use, pay a bill under the UPR tariff which is equal to or smaller than the alternative IBT bill. The 52 percent of households with higher water use pay a larger bill under the UPR tariff, although the monthly differences are never more than US$0.81.

In this simple example, about ten percent of all households would receive the same bill under either structure, about 38 percent including most poor households would receive a lower bill under the UPR tariff, and the remaining 52 percent would receive a higher bill under the UPR tariff. The full marginal cost price would be confronted by 75 percent of all households under the UPR tariff, but only 46 percent under the IBT. Considering the objectives of economic efficiency and income redistribution, the UPR tariff is superior for all customers who use more than nine cubic meters (those who pay more than the minimum bill). Which design is preferable for customers below that level depends on a careful examination of the circumstances of very low water use.

The users of interest are those who fall between five and nine cubic meters per month (about 15 percent of all households in this example). Here the comparison is between a zero price for water (UPR tariff) and a low, first block price (US$0.50 for the IBT shown). Household water demand at such low levels of consumption is expected to be very inelastic with respect to price. Given that the practical necessity of a minimum bill prevents either tariff from revealing the full marginal cost to these customers, the presence of a zero price for the UPR tariff is unlikely to induce water use behavior that is significantly more inefficient than under the IBT.[12]

The numbers in Table 3 are simply used for illustration. The design decisions required for the tariff structures (e.g., the size of the rebate in the UPR structure, the number and size of the blocks and the price to charged at each block for the IBT, the minimum charge policy) would depend upon actual conditions and could vary widely. Real-world IBTs are typically more inefficient that the one proposed here: they are likely to have more blocks and larger differences among individual prices. Conversely, more efficient UPR tariffs are possible. The example given here uses a non-targeted subsidy, one that flows to all users regardless of need. If the subsidy is confined to low-income households, its size can be larger as can the fraction of total water use which is billed at the marginal cost, improving both income transfer and economic efficiency characteristics of the tariff. Reliable identification of low-income households is problematic, of course. But where the institutional capacity to do so exists, it may be possible to administer the subsidy through existing social agencies. This is the present practice in Chile, for example.

For most variants on these two tariff structures, comparisons will produce the same general conclusions. Both structures return excess revenues to households and can potentially distort incentives to use water efficiently. But because of the nature of household water demand at low levels of use, the UPR tariff has a smaller probability of inducing economic inefficiency and is more effective at transferring income. Furthermore, the UPR tariff is simple, transparent, easy to implement, appears fair, is equitable in most circumstances, and requires less data for design and revenue estimation. Altogether, we believe it is a superior tariff to the widely-promoted IBT.

VII. Summary and Conclusions

IBT designs are often promoted on the basis of arguments that they (1) promote "equity" by forcing rich households to cross-subsidize poor households, (2) promote "equity" by forcing firms to subsidize households, (3) discourage wasteful and inefficient water use, and (4) implement marginal cost pricing principles (thereby promoting economic efficiency). A discussion of the objectives and related considerations governing utility tariff design reveals that cross-subsidies are undertaken in the interest of a subjective view of fairness, not equity, and that some cross-subsidies have negative impacts on the presumed beneficiaries. For example, setting high prices for industrial use may drive large users off the system, to the ultimate detriment of residential and other industrial users. Effective incentives for efficient use do not require prices above the marginal cost of supply.[13] Also, block-type tariffs are shown to be fundamentally inconsistent with marginal cost pricing principles.

Assuming an IBT is chosen, some more practical problems arise. These include (1) the various political and other influences on setting the size of the initial block, (2) the mismatch between IBT prices and marginal cost, (3) the conflict between revenue sufficiency and economic efficiency, (4) lack of simplicity and transparency, and (5) perverse outcomes arising out of the reality of shared connections and water vending. In each case, IBTs are shown to have serious deficiencies. An alternative tariff design, the simple uniform price coupled with a rebate (UPR), meets the same objectives while avoiding most of the problems discussed.

Finally, a direct comparison of a hypothetical UPR tariff to a hypothetical two-step IBT, conducted on a revenue-neutral basis, shows the clear advantages of the former design. It accomplishes the intended income redistribution, increasing the maximum size of the transfer while eliminating the blockwise regressivity of an IBT. At the same time, the UPR tariff used for illustration confronts 75 percent of households with the full marginal cost of supply (limited only by the practical necessity of a minimum charge), as compared to only 46 percent under the IBT. The two-part tariff reduces the amount of data needed to predict revenue, is more likely to appear fair, and is generally equitable. It is simple and transparent, easy to implement, more likely to produce net revenue stability, and consistent with resource conservation objectives. Conversely, this paper shows that IBTs introduce inefficiency, inequity, complexity, lack of transparency, instability, and forecasting difficulties for no apparent reason. As reviewed here, every claimed advantage of an IBT can be achieved with a simpler and more efficient tariff design that does not use blocking.

But if increasing block tariffs have so many problems, why then are they so popular? There are two possible explanations: (1) policy makers do not understand the consequences of their actions; or (2) academics do not understand the consequences of their advice.

When policies are adopted that differ from those advocated by scholars and researchers, the academic's traditional explanation is that politicians and policy makers simply do not understand what they are doing, that they are ignorant of the indirect effects of their actions. We believe that, generally speaking, policy makers have carefully considered political and other reasons for favoring one policy over another, and that it is typically the academics that do not understand the political economy aspects of their policy advice. In the preceding discussion, we have noted political reasons why policy makers may prefer IBTs over other water tariff structures (e.g., lack of transparency and the resulting ability of the water utility to deliver cheap water to middle and upper income groups while appearing to serve the poor).

However, in this instance we do not feel that the political economy argument provides adequate explanation for the widespread popularity of IBTs. Based on our professional experience in the water sector, we are forced to return to what is usually an overly simplistic answer. It is our opinion that many water sector professionals really do not understand the indirect consequences and hidden costs of IBTs, particularly their often adverse effects on poor households.

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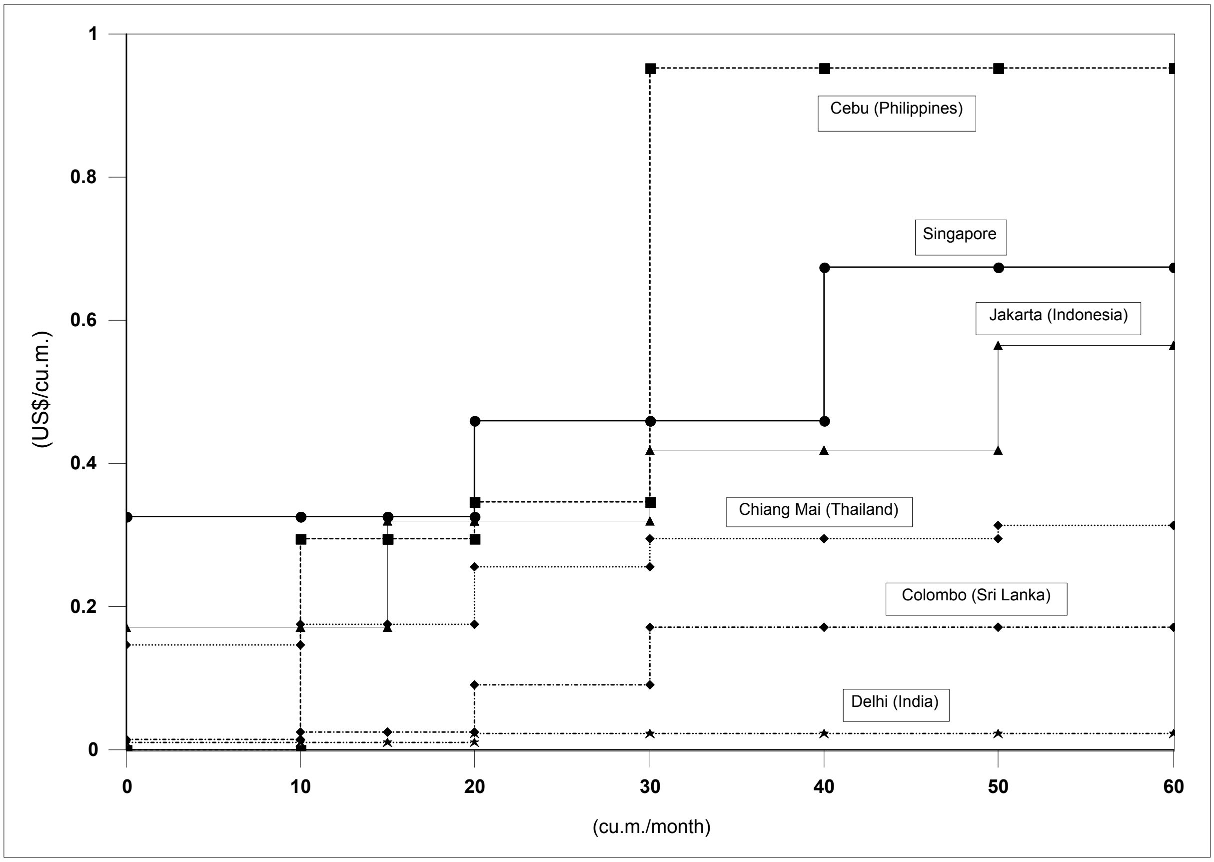
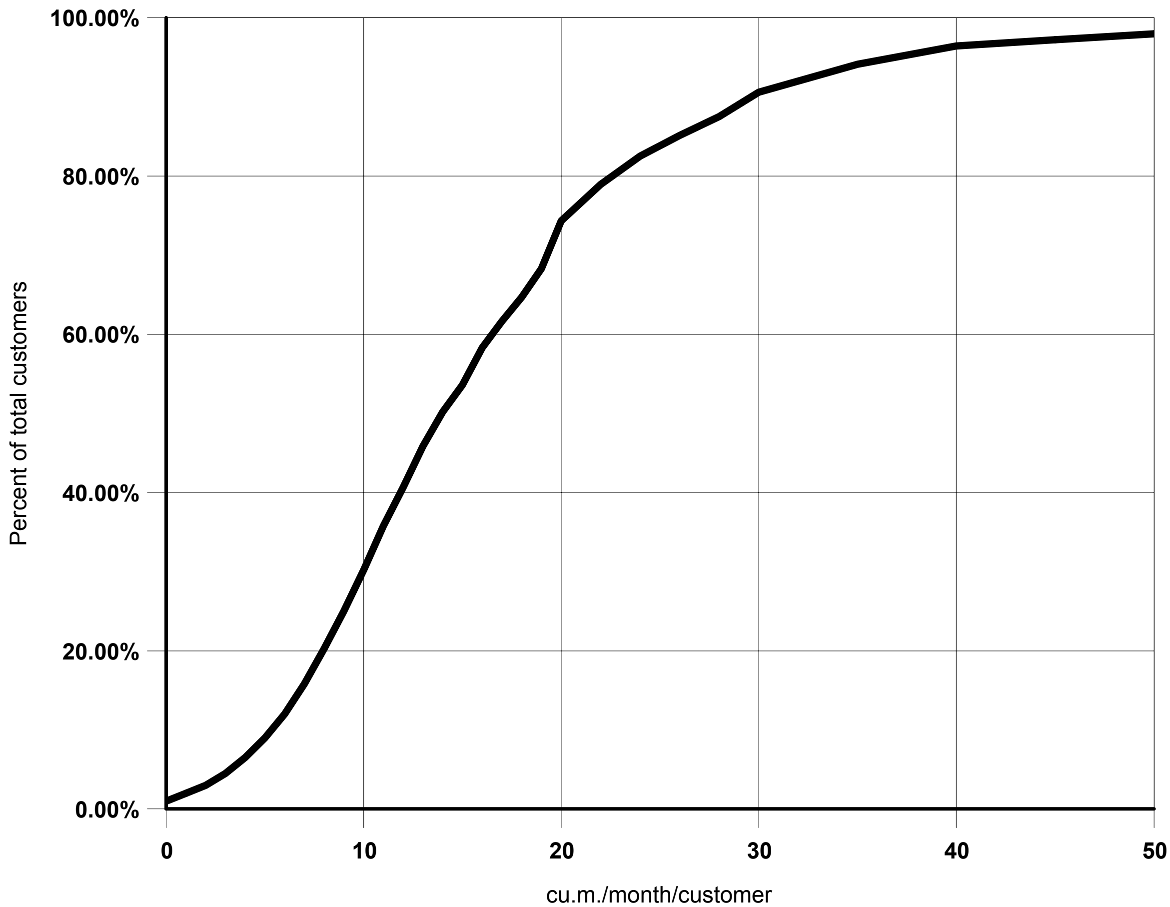


1
0.8
0.6
0.4
0.2
0
(US$/cu.m.)
0
10
20
30
40
50
60
(cu.m./month)
Cebu (Philippines)
Singapore
Jakarta (Indonesia)
Chiang Mai (Thailand)
Colombo (Sri Lanka)
Delhi (India)

Source: Asian Development Bank. *Water Utilities Handbook*.

FIGURE 1

SIX EXAMPLES OF INCREASING BLOCK TARIFF DESIGNS



Source: Water billing data from Soe, East Timor, Indonesia

FIGURE 2

RESIDENTIAL WATER USE DISTRIBUTION FOR A DEVELOPING COUNTRY

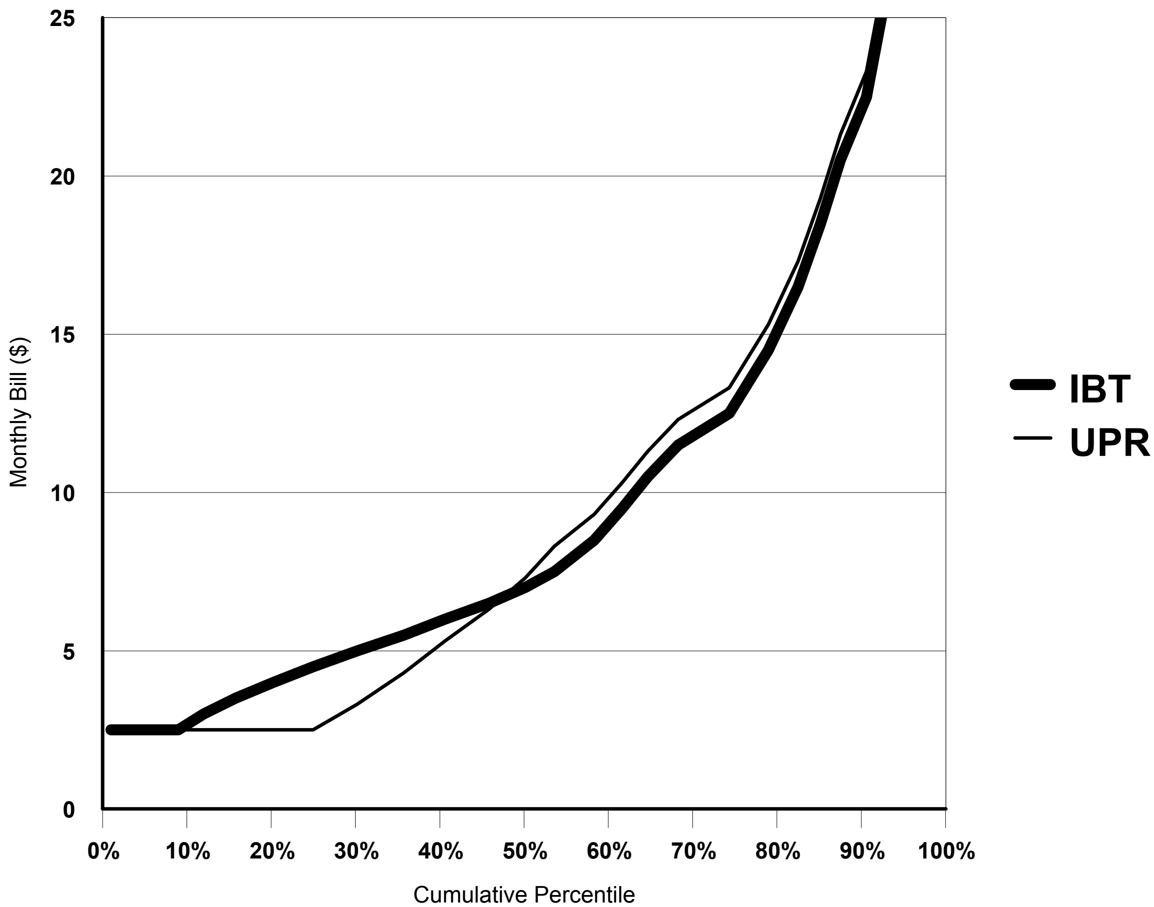


FIGURE 3

COMPARISON OF INCIDENCE FOR IBT AND UPR DESIGNS

TABLE 1

EXAMPLE OF AN INCREASING BLOCK TARIFF STRUCTURE

(Aguas del Illimani, La Paz, Bolivia)

Volumetric Charge (US$ per cubic meter)	Domestic water connections	Commercial water connections	Industrial water connections
1.19	301 m^3 and above	21 m^3 and above	1 m^3 and above
0.66	151 to 300 m^3	1-20 m^3	
0.44	31 to 150 m^3		
0.22	1 to 30 m^3		

Source: Komives (1998)

TABLE 2

SIZE OF THE FIRST BLOCK IN UTILITIES EMPLOYING AN INCREASING BLOCK TARIFF STRUCTURE

First Block Size (cubic meters)	Number of Utilities	Percent
4	1	5.9
5	1	5.9
10	6	35.3
15	4	23.5
20	4	23.5
30	1	5.9
Totals	17	100

TABLE 3

COMPARISON OF AN IBT WITH A UPR MARGINAL COST-BASED TARIFF

Monthly Water Use (cubic meters/household)	UPR Structure (Water bill = US$1.00 per cubic meter minus US$6.69 rebate, US$2.50 min.)	IBT Structure (Water bill = US$0.50 per cubic meter for the first 15 cubic meters; US$1.00 per cubic meter for use over 15, US$2.50 min.)
0	$2.50	$2.50
5	$2.50	$2.50
10	$3.31	$5.00
15	$8.31	$7.50
20	$13.31	$12.50
25	$18.31	$17.50
30	$23.31	$22.50
35	$28.31	$27.50
40	$33.31	$32.50
45	$38.31	$37.50

ENDNOTES

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[1] Surveys published in 1990 and 1992 by Ernst & Young found that 18% and 16%, respectively, of a non-random sample of US water utilities used an increasing block design for at least some customers (Ernst & Young, *National Water and Wastewater Rate Survey*). A larger (n=827) but also nonrandom survey by the American Water Works Association recorded 22% with some form of increasing block tariff (AWWA, 1996). Increasing block designs were abandoned by some large utilities in the last decade (East Bay Municipal Utility District, CA, and Phoenix, AZ) while they were adopted by others (Los Angeles, CA).

[2] Residential, commercial, and industrial users are commonly placed in different categories, but some cities define several categories of residential user, based on housing type or neighborhood characteristics.

[3] Of the twelve utilities that do not use an IBT, eight use constant volumetric charges. Four receive payment through a property tax.

[4] See, for example, Vincent *et al*. (1997, p.242).

[5] The first block for Cebu (Philippines) has a zero price and a size of 10 cubic meters per month. If the second block price ($0.296/cu.m.) applied to this use, the cost of the first block would be $2.96. At the other extreme, the first block subsidy for Delhi is $0.24.

[6] It is, of course, possible for different residential users to impose different costs on the water system. An obvious example is the case of a service area in hilly terrain, where customers at different elevations may impose widely different pumping costs.

[7] The criterion assumes that all households have private, metered connections.

[8] The two cities with initial blocks of 4-5 cubic meters or less were Nuku'alofa (Kingdom of Tonga) and Vientiane (Laos).

[9] Since no measured use data were available below 10 cubic meters/month, the lower tail of the distribution is extrapolated for illustrative purposes.

[10] The same option, with many of the same advantages, applies where marginal cost is less than average cost. In this case, a uniform volumetric price plus a fixed monthly charge (instead of a rebate) can be used to cover the potential deficit while preserving marginal cost pricing.

[11] One reviewer noted that, despite the claim of a "uniform price," there is a sense in which the hypothetical UPR tariff is also an increasing block tariff: price rises from zero to $1.00 at nine cubic meters per month. This is the necessary consequence of introducing a minimum bill, and the point applies to any tariff design which has a minimum bill.

[12] It is possible that the size of the rebate in a UPR tariff would become the subject of political pressure, in the same way that the size of the first block in the IBT has often been politicized. In this case, the main advantage of the UPR tariff is the transparency of the subsidy. Subsidy increases resulting from political intervention would be fully visible to those larger, wealthier users who must provide that subsidy.

[13] Where the water resource is not fully renewable, marginal cost must include any charge necessary to account for resource depletion.