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URBAN WATER SUPPLY
AND SEWERAGE PRICING POLICY

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A B S T R A C T

This note discusses the various objectives of pricing policy as applied to urban water supply and sewerage. Revenue-raising, equity, and administrative simplicity are important criteria to use in evaluating pricing policy, but the paper emphasizes an aspect that is usually neglected, namely, the role of price as means of influencing consumer behavior. The paper outlines an approach to tariff policy that recognizes all four objectives, and indicates the type of compromise that often has to be made between them.

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I. INTRODUCTION

1. As communities exhaust convenient sources of water supply and have to go further afield for additional supplies, and as surface and ground-water pollution increases, unit costs of water supply and of sewage disposal can be expected to rise. This necessitates efforts to ensure that ever scarcer water resources are not used wastefully. An important means of doing this is to apply pricing policies that reflect, not the historic costs of a utility's operations, but the real resource costs that are incurred as a result of additional consumption. If consumers are willing to pay prices reflecting these real resource costs, it will be demonstrated that those costs are worth incurring.

2. This general objective is necessarily subject to a number of constraints. The choice of the appropriate tariff structure in any particular case will involve judgements about equity and income distribution, about its financial and fiscal implications, and about the cost of implementing the tariff structure itself. There are, that is to say, multiple objectives of tariff policy, this being evidenced by the wide variety of tariff structures in use. Particular problems arise in charging for disposal of waste water, willingness to pay not being as effective a criterion of the value of sewerage as of the value of water supply.

3. This paper examines pricing policies in the sector in the light of the relevant objectives and constraints. Its emphasis is on the economic aspects of pricing policy, in other words, on the role of price as a means of influencing consumer behaviour, since this is the least familiar aspect.

II. METHODS AND OBJECTIVES OF CHARGING

4. Any charging system for water or sewerage or both must consist of one or more of the following:

- 1) A lump-sum payment at the time a consumer connects to the system, determined by one or more of:
 - i) The cost of the connection;
 - ii) The size of the connection;
 - iii) Characteristics of the consumer directly relevant to the amount of water to be used or amount and type of sewage generated (such as number of taps);
 - iv) Characteristics of the consumer not directly related to water use and sewage generation (such as property value or type of consumer).

- 2) A periodic fixed payment determined by one or more of:
 - i) Characteristics of the consumer directly related to the amount and type of sewage generated (such as meter inlet size, number of taps, presence of a garden, industrial process);
 - ii) Characteristics of the consumer not thus directly related (such as type of consumer or property value).
- 3) A periodic payment determined by metered water consumption. It may be a single rate or in blocks; it may vary seasonally, by type of consumer or property value; it may reflect the strength of sewage and it may differ between areas.

5. The choice from among these options of the structure of charges and the choice of their appropriate level has to be a compromise between four main aims. These will now be considered one at a time, after which the possible conflicts between them will be discussed.

6. The first aim is to raise some target level of total revenue. The target needs to be set so that the utility can service its debts and maintain the degree of financial independence necessary for it to be an efficient organization. This requirement is usually the dominant one, since it involves not only covering all current costs and debt service but also making some contribution to future expenditure. How large this contribution should be can only be a matter of judgement, but one relevant factor is the availability of capital from other sources. Where fiscal resources are especially limited, a high degree of self-finance will presumably be desirable.

7. Since required revenue is a cash-flow concept, the above considerations need to be looked at in cash-flow terms. But this does not mean that the target actually has to be expressed in such terms: given the depreciation rules and given the book value of assets, the gross revenue target can be translated into a target net rate of return on capital. However, it is important to realize that such an accounting rate of return on total assets is a very different concept from a calculation of the discounted cash flow rate of return on a new project. If the two are the same, it is only a coincidence.

8. Given the total target cash-flow of gross revenue, the second aim is to share out this burden fairly between the different users of the system (and also perhaps local or central government). The difficulty here is of course that what is fair is a matter of subjective political judgement. What the analyst personally feels to be fair may well be irrelevant, in which case all he can do is to get the borrower to formulate clearly what is deemed to be fair. This may entail some discussion, since clarity is not always easy. Thus a borrower who asserts that ability to pay as roughly measured by property values is a fair basis for charging should be asked why this applies to non-domestic consumers; the burden of high charges upon a firm may be borne not by its owners but by its customers. Again, the question of whether some part of the revenue should be provided by local or central government requires some thought. There may, for example, be cases where subsidy to poor consumers who use standpipes, or costs related to storm water are more fairly provided from general taxation than from user charges.

9. The third aim is that of administrative simplicity and efficiency. The strength of this consideration will naturally vary according to the competence of the utility and the characteristics of the users. Not much is said about this aim in what follows, but that is because it is obvious not because it is unimportant.

10. The fourth aim, which forms the main focus of this paper, is the one that is most generally neglected, namely that of influencing consumer behaviour. In the short-term this aim is to induce users to economize when there is a drought or when capacity is inadequate. More generally, the aim is to reflect the costs of system expansion in charges in such a way that users (apart from those who deserve subsidy) only choose to impose such costs when they are willing to bear them. A poor country needs to be very sure that it devotes scarce resources to water and sewerage only when this is at least as good a use of the resources as other kinds of investment.

III. PRICING AS AN INCENTIVE

11. The costs which are relevant to the aim of influencing consumer behaviour are the value of the resources which are made unavailable for other purposes by being devoted to water supply and sewerage. Sunk costs are thus irrelevant and it is the costs of future system expansions which matter; engineering cost estimates rather than historical accounting costs are therefore needed. The aim is to reflect these costs in the charges which affect user choices. If there is no conflict with the other three aims this would require, for example:

- low charges when additions to capacity can be provided cheaply;
- an incentive to reduce the strength of industrial effluents when this would lead to savings in treatment cost or a desirably improved standard of treated effluent from sewage works;
- a greater incentive to reduce water use in summer than in winter in cases where capacity and hence costs are predominantly summer-use related.

12. For consumers currently lacking piped water or main drainage, the costs which need to be ascertained are those of extending the system to provide them with service. For consumers who already have service but whose use is growing, the relevant costs are those of adding to existing capacity. In either case what has to be estimated are the additional costs resulting from additional use. The basic notion is thus that charges which vary with the use of the system should reflect the rate of change of system costs with respect to volume. This is what is meant by charges which reflect "marginal" costs.

13. Because new water supply schemes and sewage works are usually large units and because new mains and sewers may combine the purposes of reinforcement, extension and replacement, a refined analysis of marginal costs may not be possible. But this need not deter the planning engineers from deciding what sort of incentive structure would have to be provided by the charging system for it to convey a sensible message to users. Exact calculations are not required; the point is to reflect the approximate order of magnitude of

the costs of system expansion in the charges which vary with the amount of use of the system. This notion of simultaneously informing and inducing the users to economize most when economy on their part would do most to save scarce resources is, however, easily confused with the entirely different notion of allocating costs between consumers. An example will make this clear. Suppose domestic water consumption is closely related to property values. Then a fixed charge related to property value would approximately allocate costs between consumers according to consumption. Yet the incentive effects would be zero, since no consumer would save money by using less water or be charged more if he used more. Thus whatever the fairness or unfairness of such charges (a matter of the second aim) they would do nothing to realize the fourth aim. This, to repeat, is to influence user behaviour.

14. The distinction is so important that another example will be useful. Consider the collective metering of an apartment block. This makes the payment of all the families in the block vary according to their aggregate use, something which may or may not be deemed fair. But whatever subjective judgement is made on this point, and whatever the administrative advantages of collective metering, the incentive effects of the charging system are minimal. The individual family pays scarcely any more if it uses more and scarcely any less if it uses less.

IV. CONFLICTING OBJECTIVES: THE METERING DECISION

15. The last two examples illustrate very clearly the point that the aims of revenue raising, of fairness, of administrative simplicity and of influencing user behaviour can conflict with one another. This is why the choice of a charging system may involve a compromise. No general rules can be laid down about how to weigh up the achievability and the importance of the four main aims. But there are nevertheless three useful approaches to be adopted in seeking to reconcile them.

16. The first is to recognize that because judgements of fairness are subjective, sometimes reflecting no more than political expediency, they are not unique. Thus to judge one system of charging to be fair does not rule out all other possible systems. The analyst can try out various alternatives even when it is not his business to pronounce upon them.

17. The second is to recognize that while the aim of influencing user behaviour relates to the total charges payable by a potential user who is deciding for or against connection, things may well be different with existing users. Where they are extremely unlikely to seek disconnection, their behaviour will be influenced by the way their charges vary with use but not by their total level. Suppose, for example, that water and sewerage are to be jointly charged for by a semi-annual fixed charge and a charge per thousand gallons of metered water use. The aim of reflecting system expansion costs imposes limitations on the fixed charge only if it is use-related. But if it is determined by some non use-related characteristics of the consumer it will have scarcely any incentive effect and can be so chosen in relation to the metered rate as to make the consumers' total bill constitute a fair contribution towards the required revenue.

18. The third useful approach to reconciling conflicting aims relates to administrative simplicity versus influencing behaviour. The latter demands metering or ascertaining some use-related magnitude such as appliance ownership and either of these adds to administrative burdens. But most of the disadvantages of administrative complexity can be measured in cost terms; the more complex a system is, the more it costs to initiate and run it without any increase in fraud. This makes it possible to illuminate the trade-off in monetary terms. For the important choice between metering and not metering a particular group of consumers for example, the minimum reduction in their average annual water consumption which would be required for metering to be preferred can be calculated. It is that reduction which would make the saving in water and sewerage system expansion costs as large as the cost of metering. This requires information about:

- i) The capital cost of procuring and installing meters;
- ii) The annual cost of meter reading maintenance and billing;
- iii) The future cost of expanding the water supply and distribution system, plus the corresponding operation and maintenance costs;
- iv) The relationship between decrements of water use and the rate of flow of sewage;
- v) The future cost of expanding the sewage collection, treatment and disposal system, plus the corresponding operation and maintenance costs.

Note that (iv) and (v) are relevant according to whether reduced water usage will lower sewage collection, treatment and disposal costs, whether or not water and sewage are administered jointly. They are, of course, the same costs as are relevant to fixing the metered rate.

19. A calculation like that suggested need not be refined and accurate. If it indicates that an $x\%$ reduction in water consumption would be required for there to be a net cost saving, the analyst would only recommend the introduction of metering if:

- Metering with the proposed charges is highly likely to reduce average daily consumption by more than $x\%$;
- The proposed charge per thousand gallons does not exceed the average cost of additional capacity operation and maintenance.

If, in other words, water consumption is likely to be reduced more than enough to secure a net cost-saving by a charge which is not excessive, then metering is probably worthwhile.

20. A similar kind of analysis can illuminate such issues as whether to have seasonal or area differentials in charges per thousand gallons. If forward-looking expansion plans show there to be significant differences between seasons or between areas in the costs of adding to or operating capacity, the reconciliation of the third and fourth aims requires similar calculations.

21. Metering may turn out to be of dubious value in the case of poor consumers. Even if metering is on balance cheaper than unrestricted supply, the installation of some flow-limiting device may be preferable. A Fordilla valve, for example, limits the amount of water each consumer can get and so keeps down the cost of the reticulation system as well as saving on source costs. It costs less than a meter, and the consumers can pay a single simple fixed periodic charge. Possibilities of this sort merit examination when water supply is being extended to poor urban areas.

22. The conveyance of storm water and the treatment of sewage provide collective benefits to a town rather than individual benefits to those of its inhabitants who have sewer connections. As they involve a collective decision they are not necessarily best paid for by charges which vary with individual water use; some other way of recovering the cost will very likely be preferable. It is only where a change in an individual water consumer's water use results in a change in the cost of sewerage or sewage disposal that payment for the latter should be embodied in a charge which varies with water consumption.

V. THE SUBSIDY ISSUE

23. The issue of whether or not to subsidize particular groups of consumers often arises. It can best be looked at in terms of the aims of pricing policy, since this enables one to distinguish three quite separate reasons for a subsidy. Even though more than one of these reasons may apply in any particular case, clear thinking demands that they be separated. They are:

- 1) The willingness to pay for water supply and/or sewerage understates the strength of the case for providing it either because the consumers are poorer than is considered desirable or because there is not only a benefit to them but also to their neighbors in terms of amenity and health. In either case they may not agree to connection or will use too little water unless they are charged less than the effect upon system costs of providing the service.
- 2) A reduction in charges for water and/or sewerage will constitute a transfer of income to a deserving group of consumers.
- 3) The cost of charging for water from standpipes or for communal waste facilities such as public latrines outweighs the benefit.

The important feature of these is that 1) relates to the aim of influencing behaviour, 2) relates to the aim of fairness and 3) to the aim of administrative simplicity. Thus in 1) the purpose of subsidy is to encourage use of the service, in 2) the aim is to leave existing consumers with more money to spend on other things, while in 3) the aim is to save administrative costs.

24. It is not sufficient to examine the case for a subsidy solely in these terms. The subsidy must come either from other users of the system or from the general taxpayer. The effects on their behaviour, the fairness of making them pay for the subsidy and any extra administrative complications in raising the money from them all need to be considered. Thus subsidy of a group of poor consumers for reasons 1) and 2) might on balance be a bad idea if it were to be financed by extra taxation of some item predominantly consumed by the poor, including those who lack piped water.

VI. SOME PRACTICAL APPLICATIONS

25. The analyst attempting to look at a charging system in the light of this paper will often find that his task is to suggest improvements to an existing system rather than to design a totally new one. The adequacy of the total revenue generated can easily be studied and views can be obtained on the fairness or unfairness of the charges. Their administration can also be studied, very often with the result that more should be spent on meter maintenance, on chasing up defaulters and so on. What is most demanding is the task of examining and evaluating the impact of the present system upon the allocation of resources. While it is impossible to provide a generally applicable checklist of matters for investigation, some examples of the kind of work that has to be done may be useful.

26. Once-and-for-all charges upon connection can have some effect upon the number of connections. If they do, then their level has to be looked at in relation to other parts of the charging structure and not in isolation. For users not judged to need a subsidy, it is often the burden of all the charges together which will influence their choice for or against connection and which thus needs to reflect the addition to system costs caused by their connection. In these circumstances, it is the total of connection charge and the periodic fixed charge which matter rather than the split between them. In other circumstances a property developer may pay a connection charge (or meet the cost of connection and of the local reticulation system himself) while subsequent charges are met by whoever buys or rents the developed property. Yet the difference in circumstances will not usually be significant, since the developer will pass on the cost to the buyer or tenant who can well decide whether or not the service is worth having. It is true that connection is often compulsory, and it may appear that in such cases the question of what the charge is and who pays it is not one of resource allocation effects. But it is possible that compulsion may divert development to areas outside the town. Where the choice lies between a shanty outside the limits without water or sewage, or a dwelling within the limits with higher charges for the services than people are willing to pay, then development is unduly handicapped.

27. In practice, charges not related to metered water consumption or to factors directly related to it, such as tank size or number of taps, probably have little influence upon the amount of water used and sewage generated by existing users. It is true that lower charges will make users richer and that this may lead them to spend more money in various ways, some of which will involve an increase in water use. But such indirect effects upon water use are exerted equally by the charges and prices they pay for anything else. Hence the main point about charges to existing users which are independent of water use and of the volume and type of sewage is that they neither encourage economy nor reflect the system-cost consequences of changes in usage of the services. Whatever their merits in terms of the aims of raising revenue, fairness and simplicity, such charges are no use at all in achieving the aim of influencing consumer behaviour.

28. A metered rate is at the opposite extreme. Whether or not its proceeds are used for sewerage as well as for water supply, if it affects water consumption it will usually affect the amount of waste water to be handled by the sewerage system as well. Hence the costs of both must be brought in, as was suggested earlier. These costs, as a rough order of magnitude, need to be compared with the effective incremental rate paid by users. The sort of thing to look for is:

- i) Rates which are the same in dry as in the wet season, even though the risk of shortage or the need for investing in more capacity results exclusively from dry season conditions.
- ii) Rates which fail to reflect significant differences in the pumping or capital costs of supplying different areas.
- iii) Rate differences reflecting no cost differences, a result which can easily be produced by some consumer-class differentials or by block tariffs.

29. Complicated block tariffs are fairly common. They often result in differences in the effective marginal cost of water as borne by consumers which reflect no corresponding differences in the marginal cost of supply. In such cases it is important to ask, on the lines suggested above, whether the implicit subsidy to those consumers effectively paying less is justified and whether the burden of the cross-subsidization is appropriately distributed. A cheap first block may suffice as a simple way of making minimum water requirement available to all consumers at a low price. If nearly all consumers take more than this first block it needs to be looked at together with the fixed charge.

VII. SUMMARY

30. The main point of this paper is that as the level and structure of charges can affect consumer behaviour and hence system costs they should reflect the way those costs vary with the use of the system. The relevant system may include sewers and sewage disposal whether or not these are financially separate. Revenue-raising, fairness, and administrative

simplicity are the other objectives of a charging system. Compromise between all four objectives will be necessary.

31. The improvement of a charging system normally raises severe political and administrative problems, so that all that is possible initially may be to improve it rather than to move over all at once to a well-conceived system. But the first and subsequent steps of improvement are best chosen in the light of an ideal system. Consequently an attempt should be made to work out such a system, at least in broad outline, to serve as a standard of reference. This involves:

- Analysis of system cost structure in forward-looking terms;
- Considering where metering or flow limitation devices are appropriate;
- Formulating cost-reflecting tariffs;
- Articulating the revenue and fairness objectives;
- Modifying the tentative cost-reflecting tariffs in the light of these objectives;
- Examining necessary institutional and administrative improvements.

32. Armed with this information, the analyst can then judge the main defects of the existing system and work out priorities for action. In particular, he can find out:

- How nearly an appropriate revenue target is met;
- What are the main inequities of the present system;
- How well metering, billing and revenue collection are performed;
- What are the main divergences between the incentives currently presented to users and those in the ideal system;
- What obstacles to improvement have to be overcome.